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ENVIRONMENT AND DISTRIBUTIONAL ISSUES: ANALYSIS, EVIDENCE AND POLICY IMPLICATIONS

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FOREWORD

This synthesis report was prepared as part of the OECD programme on the "Social and Environment Interface". It is based in particular on the outcome of the OECD Workshop on the "Distribution of Benefits and Costs of environmental Policies", 4-5 March 2003, and on other relevant material. The proceeding of the Workshop will be published separately as a co-publication with Edward Elgar. The report was written by Ysé Serret under the supervision of the Working Party on National Environmental Policy (WPNEP). It benefited from extensive comments from Nick Johnstone as well as delegates to the WPNEP. The paper is published under the responsibility of the Secretary-General of the OECD.

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INTRODUCTION

I-1 Background

The social dimension of sustainable development

The links between the economic, environmental and social dimensions of sustainable development have been stressed since the 1987 Report of the World Commission on Environment and Development (the "Bruntland report"). The Rio Conference on Environment and Development (UNCED) in 1992 reasserted the importance to consider simultaneously these three pillars of sustainable development, and more recently the 2002 World Summit on Sustainable Development in Johannesburg.

The significance of the interactions that exist between these three pillars of sustainable development, in particular between the social and environmental ones on which this report focuses can be illustrated by looking, for instance, at how the introduction of environmental policies can be put into question for social reasons. Examples of the possible adverse effect of equity considerations on the implementation of environmental policies can be seen by previous efforts to introduce or increase energy taxes for environment-related reasons. The social protest that followed the oil price increase of 2000 prompted reductions in environmentally-motivated taxes on oil products in countries such as France, Italy, or Australia, and the postponement of planned tax increases in others, like the United Kingdom or Germany delayed planned tax increases (OECD/IEA, 2001a).

Another example of the importance of the links between the environmental and social spheres is provided by the potential adverse effects of exposure to environmental hazard on human health.[1] Substantial evidence is, for instance, available on the seriousness of the deleterious effects of exposure to air pollution or noise, and the social inequities in the distribution of environmental-related diseases in a subject of concerns in a number of countries.

Work within the OECD framework

In the past, the environmental and economic interface has been at the centre of various work programmes of the OECD Environment Directorate, resulting in a number of publications. The linkages between social and environmental matters have received relatively less attention until recently. As such, a new work programme on the "Social and Environment Interface" has been designated as one of the key priorities of the OECD's Environmental Strategy for the First Decade of the 21st Century. The workshop on "The Distribution of Benefits and Costs of Environmental Policies" was organised in the context of this programme of work on distributional aspects which is at the centre of this activity.

The project builds upon earlier work undertaken by the Environment Directorate, which has mainly focused on the distributional effects of the use of economic instruments as environmental policy tools[2]. The question of the distributional implications of economic instruments was first addressed in an earlier publication (OECD, 1994). Further work on the distributional effects of environment-related taxes

1 See in particular the current OECD activity on the valuation of environmental health risks for children.

2 See also (OECD, 2001) and (Johnstone, 2001)

has been carried out as part of the OECD programme on taxation and the environment (OECD, 2001; OECD, 2002a). The distributional impacts of tradable permits schemes have also been reviewed, albeit to a lesser extent, in the guidelines published on domestic tradable permits (OECD, 2001b). In addition, some issues raised by the distributional implications of the provision of environment-related public services have been explored, in particular in the context of the recent work programme on the social aspects of water pricing (OECD, 1999; OECD, 2003).

I-2 Objectives of the study

The objectives of the report are threefold:

- to provide a conceptual framework to better understand the disparities in the distributional effects (environmental and financial) of environmental policy;
- to review empirical evidence on the distribution of environmental quality and in the distribution of financial effects of environmental policy; and
- to analyze policy implications by reviewing some of the challenges facing policy makers as they seek to design environmentally effective and economically efficient environmental policies while ensuring that social concerns like distributional effects are simultaneously addressed.

This synthesis report is based *inter alia* on the outcome of the Workshop on "The Distribution of Benefits and Costs of Environmental Policies", 4-5 March 2003, and on other relevant material. It draws in particular on:

- the conceptual framework for analysing the distribution of environmental benefits and costs prepared by David Pearce – University College London, and the conceptual framework for assessing the distributional effects of environmental policy by Bengt Kriström – SLU-Umea, Sweden;
- selected case studies undertaken on the distributional implications of: the ecological tax reforms in Germany by Christhart Bork – German Council of Economic Experts; regulatory approaches to air pollution control in the United States by Christine Bae – University of Washington, USA; the provision of public water supply by R. Herrington – University of Leicester, UK; access to environmental amenities in the Netherlands by Hanneke Kruize and Arno Bouwman - Utrecht University and RIVM, The Netherlands; exposure to noise in the United Kingdom by Julii Brainard, Andrew Jones, Ian Bateman, Andrew Lovett and Brett Day - University of East Anglia, UK; and, proximity to hazardous waste facilities by James T. Hamilton - Duke University, USA; and
- the experience in introducing measures to address distributional concerns shared by Member countries, in particular the contributions from Canada, Germany, Ireland, Korea, Norway, the United-Kingdom and the European Commission.

I-3 Focus of this report

In order provide some focus to the work, it was decided to concentrate on the distributional effects on households. Competitiveness issues are touched upon in other areas on the Environment Directorate - in particular the activity on taxes - but are beyond the scope of this project.

The report focuses upon distribution according to economic status, which is only one criterion by which to examine distributional questions. Other possible criteria could include ethnicity, age, geographical distribution or temporal distribution. Each perspective raises complex issues addressed in a specific literature and can be the subject of a further study by itself. Given the richness of the topic addressed in the work programme, the idea was to centre the approach on one distributional perspective in order to further develop the analysis.

Thus, issues such as temporal inequality arising from distributional effects across generations is not covered. Similarly, distributional effects along racial-ethnic lines are not discussed. However, it must be recognised that there can be strong links between these different characteristics. As such, some of these other elements are addressed, in cases where they are particularly strongly related to the distribution of household wealth and income.

The basic unit of analysis applied is the household with a focus on relative wealth. However, different criteria can be applied as "proxy" for wealth such as household current income or life-time income, household expenditures or expanded notions of wealth. In the analysis carried out, the current annual income has generally been used as a proxy for household's wealth. Such a proxy is flawed due to its inability to reflect differences in household assets, life-cycle income effects, and other factors. However, while imperfect, it is a measure which is widely available. Where possible, other measures are sometimes used in the empirical studies discussed.

The report examines environment-related distributional issues considering both concerns related to the distribution of environmental quality and those associated to the distribution of financial effects of environmental policies as noted above. The distribution of environmental quality includes both 'goods' (i.e. urban parks) and 'bads' (i.e. air pollution). When examining the distribution of financial effects of environmental policy, efforts are made to examine both direct compliance costs (i.e. payments of residential energy taxes or catalytic converters), indirect compliance costs (i.e. higher costs for goods and services due to increased costs of production arising from upstream environmental policies), as well as effects arising through public finance, labour markets, etc.

I-4 Scope of analysis

The synthesis report intends to widen the scope of analysis on the distributional effects of environmental policies of previous work in a number of ways, in particular by:

- Bringing together key aspects necessary to better understand and take into account distributional effects of environmental policy: theoretical analysis, empirical evidence and policy implications;
- Addressing simultaneously the distribution of environmental quality and the distribution of financial impacts;
- Adopting a comprehensive approach when looking at the distribution of environmental quality: by considering exposure to environmental disamenities (e.g. pollution, noise and health hazards) on which the literature generally focuses, as well as the provision of environmental services (e.g. water) and the distribution of access to environmental amenities (e.g. urban parks) which have been less widely analysed;
- Adopting a wide perspective when considering the distribution of financial effects of environmental policy, by not just looking at economic instruments - on which the literature generally focuses - but considering these impacts for a full range of environmental policy instruments, and particularly regulatory approaches (e.g. standards);

- Adopting a wide geographical perspective when reviewing the literature, in an effort to mitigate the strong geographical bias in favour of the United States that exists, in particular with respect to the assessment of disparities in the distribution of exposure to environmental hazards (e.g. hazardous waste sites, toxic releases);
- Developing policy implications for the design and implementation of environmental policy, drawing in particular from the experience of OECD countries in addressing distributional concerns.

I-5 Structure of the Report

The report is divided into three chapters structured as follows:

The first chapter raises key conceptual issues for addressing the disparities in the distribution of environmental impacts and in the distribution of financial effects of environmental policies. The chapter reviews the mechanisms through which the benefits and costs of environmental policies impact upon the individual household, and the reasons why such impacts are likely to be unevenly distributed.

The second chapter examines empirical evidence on the distributional implications of environmental policies in the light of a literature review and insights from the selected case studies: the German ecological tax reform, regulatory approaches to air pollution control in the United States, the provision of water services, access to environmental amenities in the Netherlands, exposure to noise in the United Kingdom, proximity to hazardous waste facilities in selected OECD countries.

The last chapter of the report examines policy implications and draws policy conclusions on how to address distributional concerns in the design and appraisal of environmental policy in order the bring the social dimension together with the environmental and the economic pillars of Sustainable Development.

CHAPTER 1: KEY CONCEPTUAL ISSUES

1-1 What type of environment-related distributional concerns can arise?

Typology of environment-related distributional concerns

As noted above, when looking at environment-related distributional issues, a distinction can be made between the concerns related to the distribution of environmental quality and those associated to the distribution of financial effects of environmental policies.

– The distribution of environmental quality can be further classified into household access to environmental amenities, or in the provision of basic environmental services, and in exposure to environmental disamenities. Examples in these three areas would include:

  - *Disparities in access to environmental 'goods'* - access to urban environmental amenities such as urban parks; and, access to conservation areas such as lakes or natural parks.

  - *Disparities in the provision of environmental-related public services* - provision of potable water services; provision of residential energy services; and, provision of waste collection and treatment services.

  - *Disparities in exposure to environmental 'bads'* - proximity to hazardous-waste disposal sites, wastewater treatment facilities, or polluting manufacturing facilities; exposure to local air pollutants or the local and regional impacts of global environmental problems; and, exposure to noise pollution.

These examples are not meant to be exhaustive, but they do reflect the wide range of issues which need to be addressed if one is to examine the distributional implications of environmental policy.

– What is meant by the distribution of financial effects of environmental policy refers to the fact that the implementation of environmental policies can be socially regressive, that is, lower-income groups may be subject to a disproportionately higher share of environmental compliance costs. As mentioned earlier, this can include direct compliance costs (i.e. payments of residential energy taxes or catalytic converters), indirect compliance costs (i.e. higher costs for goods and services due to increased costs of production arising from upstream environmental policies).

However, the overall financial incidence of environmental policies also includes even more indirect effects arising through effects on public finance, labour markets, real estate markets, etc. These can either exacerbate or counter the distributional impacts associated with more direct financial effects. However, this is an area for which the evidence remains very limited.

The question of the distributional implications of economic instruments was first addressed in an earlier publication (OECD, 1994) and further work on the distributional implications of environment-related taxes and tradable permits schemes and has been carried out since (OECD, 2001; OECD, 2001a;

OECD, 2002a). This report elaborates on it by extending the analysis to include other forms of environmental policies. The objective is to provide insights on the effects of a broad range of types of environmental policies, including: (i) direct regulations (e.g. on discharge or emission standards, technology standards); (ii) price reforms or full-cost pricing intended to internalise externalities; (iii) environmentally-motivated taxes; (iv) environmentally-motivated subsidies; (v) removal of environmentally harmful subsidies, and (vi) tradable permits.

Economic and institutional characteristics of environment-related distributional concerns

The main economic characteristics associated with the provision of environmental "goods" and "bads" can be described using the standard criteria used to describe public goods (i.e. degree of excludability, degree of rivalry). Non-excludability and non-rivalry can result in a misallocation of resources, with too little environmental quality provided. Indeed, it is for these reasons that public intervention is required in the environmental sphere.[3]

For a pure public good, environmental quality is non-rival in use, in the sense that one person's consumption of a good (exposure to a bad) does not reduce the quantity available (level of exposure) to the others. This seems to apply to some environmental hazards like air pollution. Up to a certain extent, it may also characterise some environmental goods such as access to parks. Non-excludability is another characteristic of public goods, implying that use can not be restricted. Important examples include aquifers, high seas fisheries, etc.

Access to a pure public good is identical for all socio-economic groups. As such, it would appear that distributional issues arise in so far as the financial costs of its provision differ, and not with respect to the level of provision per se. However, if preferences for the good differ across socio-economic groups distributional effects can arise (see Chichilnisky and Heal, 1994).

There are, however, very few pure public goods in the environmental sphere. For instance, in conservation areas or natural parks, access to the good can be restricted by price or by quantity. The provision of environment-related services offers another example of possible excludability. The use of some services, like water or energy services, can be restricted to those consumers who are willing to pay. Moreover, most environmental goods and bads are at least partly rivalrous. For instance, congestion effects can affect the quality of local environmental amenities.

Indeed, it is the imperfect 'public good' nature of environmental quality which makes the distributional effects of environmental policy so important. On the one hand, since environmental goods have some attributes of pure public goods, public intervention is required to ensure that resources are not misallocated. On the other hand, since there is at least a degree of excludability and rivalry, the impacts of such policy interventions (in financial and environmental terms) across socio-economic groups can be significant.

The institutional characteristics of the provision of environmental quality relates to the means of provision of the good or service (i.e. urban park, hazardous waste facility, manufacturing plant, etc.) which has impacts on the level and distribution of environmental quality. This includes such aspects as the participation of public and private sectors in the provision of the good or service, as well as the competitive structure of the market.

[3] Market failures are characterised by the inability of a system of markets to allocate certain goods or services at the level which is socially optimal.

For instance, on the one side, the provision of urban parks is clearly in the public hands. The public sector plays a direct role in determining the level of provision and the location of such amenities. The same is true for publicly-managed facilities, such as public wastewater treatment facilities, airports, and hazardous waste transport, storage and disposal facilities. On the other hand, exposure to air pollution is largely determined by activity directly within the private sector, as does exposure to noise pollution. However, even in these areas, the public sector plays an important role in determining levels of exposure for different socio-economic groups through land use planning and the permitting process.[4]

For some questions like the provision of environment-related services (e.g. water services), public-private partnerships are very characteristic. For instance, the role of the private sector can range from the management of operations (i.e. related to metering or billing) with the asset ownership remaining public to the ownership of infrastructure assets (OECD, 2003).

Also, the mix between public and private interests involved appears to be very much country specific with for instance the provision of waste services presenting different features in France and the United Kingdom. In addition, the manner in which different interests are combined and the respective role of private firms and public entities is going through major changes in the current context of deregulation and globalisation.

These broad institutional characteristics need to be borne in mind when addressing distributional concerns since the possibilities to address environment-related distributional concerns through policy measures will not be the same according to economic and institutional characteristics involved.

1-2 What is a "fair" distribution of environmental policy incidence?

Concern with the distributional impacts of environmental policy arises in part out of a widespread fear that such measures can be regressive. This comes from two general perceptions (or perhaps misperceptions):

A) poorer households pay disproportionately more of the financial costs associated with the introduction of environmental policies; and

B) richer households receive disproportionately more of the benefits associated with improved environmental quality.

Both of these assertions are biased and the evidence concerning their validity is discussed in greater detail below. However, what is not generally discussed is the more fundamental issue of whether any given distribution is 'fair' or not. While this is not the place to examine the links between theories of justice and public policy interventions (see Rawls, 1972; Nozick, 1974), it is important to bear in mind the different kinds of objectives which can lie behind the widespread view that distributional issues need to be taken into account when introducing and assessing environmental policies.

With respect to financial impacts, the issue is not significantly different from the effects of any public policy. Any policy will result in costs which are different across socio-economic groups depending upon their expenditure patterns, behavioural responses, employment opportunities, etc. Whether or not such differences are 'fair' needs to be seen in the broader overall context of government policy with respect to distributional matters and social justice.

[4] However, the public sector is indirectly involved, as a land use planner and a provider of infrastructures (e.g. airports) and can be indirectly implicated through military aviation and publicly-owned civil aviation.

If it is assumed, as seems reasonable, that the existing economic distribution prior to the introduction of a particular environmental policy is considered not to be such as to necessitate additional redistribution policies above and beyond those which are already in place to meet these social objectives (i.e. progressive income taxation, social welfare systems, etc.) then the key issue is whether or not the effects of the policy are 'marginal' or not.

If a particular policy (i.e. a carbon tax or a new pollution regulation) is thought to have non-trivial regressive impacts on distribution, then in the interests of social justice it is important to mitigate these impacts. However, as noted below, this may not (and usually should not) be done within the context of the environmental policy itself. It may be neither economically efficient nor environmentally effective to use modifications of an environmental policy to meet social objectives. More importantly, it is unlikely to be the optimal means to address the distributional concerns themselves.

The issue of environmental quality is, however, more complicated. With respect to environmental quality, some conceptions of "fairness" generally discussed in the literature to assess the distribution of environmental impacts include:

- Equality of Environmental Exposure – e.g. all households have the same level of exposure to pollution (concentration);
- Equality of Risk – e.g. all households face the same level of risk, taking into physiological and other differences;
- Progressive Inequality – e.g. systematically using environmental policy as a redistributional mechanism to favour poorer households;
- Procedural Fairness – e.g. ensuring that all households have the opportunity to express their environmental preferences effectively; and,
- Situational Fairness – e.g. ensuring that households continue to enjoy the level of environmental quality to which they have become accustomed (such as when a house was purchased).
- "Preference-based" notion of equity – e.g. in this approach that reflects personal preferences, a fair distribution may be one in which levels of environmental quality differ according to differences in demand for environmental quality.

Some of these notions are just elaborations upon one another (i.e. equality of exposure and risk). In other cases they are potentially complementary (i.e. procedural fairness and equality of risk). They may also represent different fundamental conceptions of fairness (i.e. preference-based notions of equity vs. equality of environmental exposure). Moreover, it is important to recognise these differences when trying to identify a government's objective with respect to a particular measure which seeks to redress some distributional imbalance.

Equity is, of course, only one criterion for assessing environmental policy[5]. Other criteria set out in a previous report on *Evaluating Economic Instruments for Environmental Policy* (OECD, 1997) include: environmental effectiveness, economic efficiency, administration and compliance costs, public finance, dynamic effects and innovation, soft effects like possible effects of the use of instruments on attitude and awareness, and other wider economic effects.

[5] The focus is here on equity according to economic status but other dimensions of equity could be brought into this discussion like inter-generational or regional equity.

The tension which can exist between equity and efficiency objectives is key, and the debate is not fully resolved in the literature. According to the Kaldor-Hicks criterion, a policy is "welfare-improving" when the sum of benefits exceeds the sum of costs. So it is socially beneficial if the winners can compensate the losers; whether or not the compensation is actually paid is a separate decision pertaining to the political decision, as recalled by Kriström (2003).

In effect, the Kaldor-Hicks criterion can be interpreted as a way of allowing for the separation of equity and efficiency[6]. It can be seen as an argument for removing the burden for addressing distributional matters from the sphere of environmental policy. This may not, however, be politically feasible since – as noted above – the implementation of environmental policies is often constrained in practice by concerns over distributional matters. As such, if the effects on distribution are not trivial, then the 'possibility' of compensating poorer households may not suffice to justify a given policy intervention according to the government's own criteria.

1-3 Why disparities in the distribution of environmental quality can arise?

Several factors can contribute to possible inequities in the distribution of environmental quality like the differences in preferences for environmental quality between different types of households, including different income classes; information failures which are unevenly distributed across households; failures in associates markets which affect low income particularly acutely (e.g. housing market and labour market); and policy failures limiting the access of low-income households to political decision-making. These are now discussed in more details:

Differences in preferences

Differences in preferences for environmental quality between different types of households, including different income classes, are a factor of possible inequity. As noted by Pearce (2003) "since the willingness to pay for environmental quality is itself a function of income, regardless of the cost of supplying that quality, the rich will receive a higher level of quality that the poor". As long as the willingness to pay (WTP) for quality is positively related with income, and households have some means (however imperfect) of expressing this demand, wealthier households will tend to enjoy greater levels of environmental quality.

However, it is not clear that demand for environmental quality rises more than proportionately with economic wealth. The notion income elasticity of 'demand' for environmental quality is useful to examine the issue of whether incremental change to a status quo condition of the environment is regressively or progressively distributed, as pointed out by Pearce (2003). Overall, while the evidence is limited, the general trust is that, for individual goods, the income elasticity of willingness to pay (WTP) is less than unity.

Recent empirical work tends to support Pearce's (1980) early suggestion that the assertion that the environment is an 'elitist' good is not justified. The implication for policy is that environmental policy – if its effects on general environmental quality are uniformly distributed across different socio-economic groups - is probably biased towards benefiting the poor rather that the rich. In effect, since environmental quality is a proportionately larger (even if absolutely smaller) component of their total welfare,

[6] The notion of separability refers here to the fact that the pursuit of equity does not undermine the efficiency goal and conversely. The literature which advocates for the so-called "separability" of efficiency and equity is however controversial as some discussion on climate change policies show. In an international market for tradable greenhouse gas emissions permits, Chichilnisky and Heal (1994) argue that in the case of a pure public good efficiency cannot be separated from equity.

distributionally-neutral improvements in environmental quality will benefit poorer households relatively more than richer households.

Information barriers and failures

Differences in access to information which prevent households from expressing their underlying demand for environmental quality can also contribute to possible disparities in the distribution of environmental quality. These are not necessarily market failures requiring policy intervention since obtaining information imposes costs and households may willingly choose not to have full information with respect to some elements of environmental quality. Nonetheless, even when information related to the geographical location of environmental hazards is publicly available, the likelihood of having access to it tends to vary according to households socio-economic characteristics such as income level.

The process of being aware of the existence of such information and of seeking it out (e.g. on the internet, by phone, or by mail) is likely to be less for lower-income households (e.g. possible costs associated with access to information, lesser access to information and communication technologies).

Moreover, for some types of environmental impacts (i.e. polluted drinking water, exposure to toxics, etc.) there is a clear case for the provision of reliable information to all households. If poorer households are disproportionately affected by lack of access to such information, then this can have significant distributional implications. The risk of inadequate disclosure tends to be limited with noise pollution which is more perceptible. In the case of environmental 'goods' such as urban parks and other amenities there is likely to be full information. For instance, real estate agents will emphasise proximity to such sites to prospective buyers.

This form of information failure can be expected, in principle, to have a similar effect on all households, whatever their income. However, since low-income households tend to locate proportionally more in exposed areas, in part because of their attractiveness on other grounds, as will be discussed later, the lack of information on environmental quality can affect them more specifically. Paradoxically, in the absence of such information, at the same time that poorer households may be facing greater levels of exposure than recognised, they will also not be reaping the full financial benefits associated with their increased levels of exposure.

Policy failures

Disparities in the propensity to engage in collective action between different types of households, including different income classes appears as another factor of possible disparities in the distribution of environmental quality (e.g. cost of organisation, regulatory capture with pressure from higher-income households). In a growing body of literature, this propensity, which can be proxied by the voter participation, is found to be a statistically significant predictor of toxic air releases (Brooks and Sethi, 1997) and of the siting of TSDF[7] (Hamilton, 1993). Thus, areas in which voter turnout is high are less likely to have hazardous waste facilities, even when other factors are taken into account and similarly, in areas where the average level of education is high, hazardous waste facilities are less prevalent.

Examining the dynamics of environmental degradation, Boyce (2002) provides evidence on how inequalities of power and wealth may affect the distribution of environmental costs. The *decision power* which prevails in contests over policies ranks among the different dimensions of power influencing decisions on the level of environmental protection (and conversely on the degree of environmental degradation) distinguished by Boyce (2001). For instance, government decisions on pollution control are

7 Transfer, storage and disposal facilities.

not only based on the calculation of social benefits and costs but also outcome of a competition between winners and losers (e.g. intensity of lobbying).

Failures in associated markets

While rights to environmental quality per se are not usually defined, environmental quality is an input into other markets where right are defined. In some sense, since most elements of environmental quality are not pure public goods environmental quality is embedded in other markets.

For instance, most of the studies support the hypothesis that environmental quality is an input into the real estate market[8]. Houses which are close to city parks and far from polluting plants will tend to be more expensive. As such, through the real estate market, there is a process of "sorting", whereby households are able to express their preferences for environmental quality (see Tiebout, 1956 for the original paper on this issue).

The literature also appears to indicate that local employment opportunities are "traded off" against local environmental quality. In such circumstance, the tendency for lower-income households to be more exposed to lower environmental quality is hardly surprising, even if there is no market for the environmental good in question. It is merely a reflection of the fact that households with constrained budgets "trade off" environmental quality for other goods.

1-4 Why disparities in the distribution of financial effects of environmental policy can arise?

As emphasized by Kriström (2003), the main objective of all environmental policies is to change consumption and production patterns. As such, they will have by their very nature distributional impacts on households. Many studies focus on the distributional issues related to the direct financial incidence of individual environmental policies. For example, the distributional effects of an environmentally-motivated fuel tax will depend upon how important fuel consumption is in the total basket of expenditures for low-income and high-income households.

However, this can provide misleading indications of the degree of progressivity or regressivity of the impacts of the policy. A fuller picture of mechanisms involved includes a discussion of the overall economic impacts for the household. Additional channels through which distributional effects can arise include:

- The indirect financial effects associated with the household purchase of the good or service which is targeted by the policy. For instance, a fuel tax would have effects not only on fuel consumption expenditures directly, but also indirect effects on expenditures for goods or services whose production processes are intensive in the use of fuel.

- The potential for differences in behavioural response by different income groups (i.e. demand price elasticities of targeted goods or services are not equal across income groups). For instance, poorer households may have fewer substitution possibilities than richer households due to market failures or barriers.

- Differences in the effects of policies depending upon whether or not there is potential for revenue raising (e.g. grandfathering of tradable permits versus auctioning), and how precisely this revenue is recycled – for instance through reductions in different tax rates or earmarking of expenditures.

[8] Been and Gupta (1997) is one exception where the variable is not statically significant.

– The effects of environmental policies on employment markets, particularly in sectors which are directly affected by the environmental policy (see OECD, 2003a).

– The effects of environmental policies on related markets through changes in environmental quality. The impacts that local air pollution would have on the value of real estate in areas which are particularly adversely affected is an example.

Some of these channels are more important for particular environment-related income distribution issues than for others. They are examined below in more depth.

Direct effects through household expenditure patterns

An economy includes interrelated markets and a policy focusing on a particular market may also affect other markets, hence the distribution of income, in direct and indirect ways. The three layer analysis developed by Kriström (2003) progressively introduces such links, beginning with the simplest case of no repercussions ending at the complete general equilibrium model.

The direct effects are relatively easy to evaluate. Some goods and services which are common targets of environmental policies represent relatively more significant elements of lower-income households expenditure baskets than higher-income households. Examples of such goods and services might include electricity, potable water services and food. As such, any policy which targets such goods will appear to be regressive.

In other cases, goods and services which are frequent targets of environmental policies are more likely to represent a greater proportion of richer households expenditure baskets – i.e. demand is income-elastic. For instance, in some OECD countries demand for motor vehicles is income-elastic. In such cases, environmental policies are more likely to affect high income households relatively more than poorer ones.

Interrelated markets and effects on household income

While undoubtedly important, the direct effects of environmental policies on households' expenditures on those goods and services which are targeted directly are just the 'tip of the iceberg'. Thus, the financial cost of environmental policy for households cannot be only examined at the level of direct incidence of the policy. For instance, those goods and services which are targeted directly are purchased by other firms in other sectors as inputs into the production of other goods and services. Thus, the distributional impact of policies is likely to vary markedly once these indirect effects are recognised.

Similarly, the analysis must take into account the effect of environmental policies on households as taxpayers and not just consumers. Thus the role of public finance is key. Adopting such a perspective is sometimes needed to unravel the distributional consequences of environmental policy. This is in particular the case when assessing "winners" and "losers" from green tax-reforms. Thus, a carbon tax change can also affect the value added tax and other tax revenues. In principle, interdependence between tax bases can easily be handled within the general equilibrium framework.

Effects on labour markets may also be significant. For instance, the extent to which environmental policy affects employment[9] is of much relevance to households. Depending upon how employment in individual sectors is affected (e.g. transition impacts in vulnerable sectors such as heavy industries, change in employment characteristics), and the extent to which workers are able to adjust in the face of such changes, there may be important distributional impacts on particular groups.

9 See OECD (2003a).

Such a framework highlights the fact that environmental policy may have impacts, intended or not, in several markets not directly affected by a policy measure. When markets adjust and the impacts cascades throughout the economy, any policy measure may generate "winners" and "losers" in ways not always initially transparent. To map gains and losses from industries in a sector to corresponding financial impacts on households, one needs to see households as consumers, taxpayers and employees.

The case of the introduction of a tax on chlorine input to the pulp and paper industry discussed in Kristrom (2003), illustrates this clearly. Using the concept of "observed" demand curve makes it possible to represent all market repercussions into one single diagram, which depicts the demand quantities of a good. The results suggest that forest owners find it more profitable to supply more sawnwood, hence the increase of sawtimber volume. Pulpwood price is lowered essentially because of the lowered demand from pulp & paper mills while sawtimber price decreases as a consequence of increased supply. From this we conclude that forest owners profits will decrease and (owners of) sawtimber mills enjoy a higher profit.

This three-stage analysis can be merged into an overall framework based on a social accounting matrix. To take the view that there are important interactions between the environment and the economy, the framework suggests to expand a conventional social accounting matrix[10] (SAM) to include returns on environmental assets as well as ecological services. This takes the analysis beyond the financial distributional effects of environmental policy insofar as many important assets and services fetch no market price. It is to be noted that these ideas are consistent with recent advances in environmental economics.

Behavioural responses from households

While useful, a SAM is a static concept. The conceptual framework prepared by Kriström (2003) also highlights the importance of taking into account the behavioural responses from households when examining the distribution of financial effects of environmental policies. Possibilities for adjustment by different socio-economic groups in different markets are key to determining distributional impacts.

A particularly interesting dimension of this analysis is how households with different income respond to price-changes. Arguments cut both ways: lower income households may have more difficulties in adjusting to new environmental policies, at the same time an increasing income could be expected to lower price elasticities. Similarly, opportunities in labour markets in the face of policy shocks may be different for different socio-economic groups. For instance, there are often significant political barriers to the introduction of stringent natural resource management policies in fisheries, mining and forestry sectors due to concerns about employment impacts.

The cost for a household of environmental policy measures depends to a large extent on substitution possibilities. It is sometimes held that environmental policy imposes unequal burdens, because people in upper-income brackets have more options to adapt. This reinforces the regressivity of environmental policy. However, there are good reasons to think that this is not always the case. It is therefore useful in a distributional study to examine the price-sensitivity across income-groups. Unfortunately, the empirical evidence on this issue is relatively scant and does not allow a robust conclusion about how price elasticities vary across income groups in the case of environmental goods.

[10] A SAM is a way of consistently summarizing facts about the economic structure of a country (or region), the national accounts being a special SAM. We use an expanded version of a SAM here to underline two basic tenets of our analysis (Kriström, 2003).

The distributional effects vary with the instrument used

When examining at the distributional issues related to the use of environmental policies, the literature generally focuses on the possible regressive impacts of economic instruments, in particular taxes. As pointed out by Kriström (2003), empirical findings on cross-instrument comparisons are very scarce with almost no information on the distributional impacts of other environmental policies.

Concerns about the possible regressive impacts of taxes and permits can be attributed to the relative transparency of such impacts relative to other measures (i.e. direct regulation). However, this does not mean that the impacts are more severe. The distributional incidence of an environmental policy instrument will differ depending whether or not there is a potential for revenue recycling. This is the case in two contexts with economic instruments: when a tax is implemented and with a system of tradable permits where permits are auctioned. The potential for revenue recycling gives the government much greater leeway to address distributional impacts than other policies which do not raise revenue.

Environmentally related Taxes

The distributional implications of environmentally related taxes can arise from a variety of channels, as underlined in previous OECD work. The broad categories of distributional effects are:

- the direct distribution effects on households arising from the payment of the tax;
- the indirect distributional effects. For instance, in the case where the tax is directed at firms, the consumers pay a part of the cost of improving the environment through price increases which are passed on by firms. The indirect effects on households that can result for instance from the introduction of environmental tax reforms levied on certain factor inputs such as energy;
- the effects arising from the expenditure/use of environmental tax revenues; and
- the effects relating to benefits of environmental improvements.

Available evidence suggests that the direct effect of energy taxes tends to be income regressive but in general the degree of regressivity is weak, as will be further discussed in the next chapter. The empirical evidence also indicates that the degree of regressivity decreases once indirect effects are taken into account. This is particularly true of energy taxes, and arises from the fact that energy is an input into all other goods and services and as such the regressivity associated with the direct effects of tax on a good which is income-inelastic is partly attenuated once the effect on all expenditures are taken into account.

Tradable permits

The distributional effects of tradable permits can be similar to that of the taxes since, as noted by Kriström (2003), in a partial equilibrium perspective, the use of a tax is comparable to a tradable permits system where the permits are auctioned. The distributional implications will differ however with the grandfathering of permits where the rent is transferred from consumers to firms. The issue boils down to who should keep the rent. If for instance grandfathering of permits is used, the rent stays with those who are given the permits. With environmentally related taxes, the rent is returned to tax-payers.

The few analysis available underline how significantly the choice of the allocation of permits affects the distributional effects of tradable permits (auctioned versus grandfathered) as well as how the

revenue is recycled (see Markandya, 1998; Cramton and Kerr, 1999; Dinan and Rogers[11], 2002; Parry[12], 2004).

Thus, one great advantage of tradable permits is the apparent separability of equity and efficiency objectives through the initial allocation of permits. In this case, the pursuit of equity will not undermine efficiency objectives. Equity can be addressed in the initial permit allocation, and this will have no bearing on efficiency since efficiency is not affected by the way permits are allocated initially.

One argument sometimes put forward in the literature for the progressivity of emissions trading lies in the reduced control costs. This is likely to benefit lower-income households the most since control costs show a regressive pattern. However, this distinction relative to taxes surely reflects the differences in benchmarks used to evaluate emissions tax and emission trading programmes (OECD, 1994): emissions tax evaluations typically use the no-regulation baseline while emission trading evaluations use command-and-control benchmark and assume that permits are grandfathered and hence that no revenue will be collected.

Environmentally motivated subsidies

The conclusions on the distributional impacts of environmentally motivated subsidies[13] remain unclear in light of the paucity of empirical studies available. Examples of subsidies that could be used in an environmental policy include for instance energy savings subsidies or investments programmes to promote renewable energy. In the first case, at least, these policies are targeted directly at lower-income households. Thus, the subsidy is being used to address two objectives simultaneously – i.e. internalisation of the environmental externality and distributional objectives.

There might be significant potential to realise such complementary objectives, insofar as low-income households generally live in less energy efficient dwellings and may benefit the most from improvement in this area (Barker and Johnstone, 1993). However, in order for such measures to be economically efficient, it is important to ensure that they are designed to resolve market failures which particularly affect lower-income households (i.e. capital market failures for low-income households, split incentives through landlord-tenant relations, etc.) and they avoid problems of free-riding and adverse selection.

Moreover, just as it is important to examine public finance issues in the case of the application of environmentally related taxes and auctioned tradable permits, it is also important to examine such issues in the case of the application of subsidies. However, in the case of subsidies the distributional impacts will arise from the degree of regressivity or progressivity of the tax system used to raise the finance required to pay for such programmes.

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11 Examining the effects of a 15% reduction in US carbon emissions under different allocation mechanisms, Dinan and Rogers (2002) estimate that the lowest income households would be worse off under grandfathered permits while top income households would be better off. The low-income households would be better off if, instead, the permits were auctioned with revenues recycled in equal lump-sum rebates for all households.

12 In an assessment of the distributional impacts of tradable emissions permits for carbon, SO_2 and NOx in the US, Parry (2004) shows that grandfathered emissions permits can have a significant regressive effect as the rent ultimately accrues to shareholders.

13 It should be noted that some socially driven subsidies (e.g. coal) may be environmentally harmful (see OECD, 2003d).

Direct Regulation

Since the financial impacts of direct regulations are not as transparent as in the case of economic instruments, the distributional effects of direct regulation are less readily subject to analysis than the other instruments discussed thus far. However, this does not mean that they are less important. The literature on the distributional effects of command-and-control approaches is scant, but points out to no reason why such environmental policy instruments should be immune to distributional impacts, as noted by Kriström (2003).

The studies available suggest that the distributional consequences of direct regulation may not be the same whether the costs fall directly on the industrial sector or are passed-through to consumers. Assuming that the firms pass all abatement costs into prices for goods and services produced, the burden of direct regulation tends to fall disproportionately on low-income households (Robison, 1985).

In addition, the way the policy is financed (e.g. out of general revenue or dedicated sales tax increments) and the characteristics of these measures, has an incidence on the distributional impacts of direct regulation. Another element of significance in the analysis is the discount rate used, for instance when assessing the distributional effects of energy efficiency standards for appliances, as low-income households tend to have higher internal discount rates (see Sutherland, 2003 and 2004).

Liability for Environmental Damages

Liability for environmental damages can also have distributional implications. The distributional impacts of legal liability regimes are likely to vary widely depending upon the means by which damages are compensated in cases in which a firm (or other agent) is held responsible for adverse environmental impacts. In particular, the distributional impacts will not be the same whether damages are compensated on the basis of lost earnings or productive losses, or according to fixed criteria set regardless of households economic status. As such, civil law regimes and common law regimes are likely to have very different distributional impacts.

In short, all policy instruments have potential but different distributional impacts. To get a full picture of these effects, both direct and indirect channels through which they can arise are to be considered. Such an analysis tends to be easier to carry out in the case of taxes and auctioned tradable permits where the direct effects on households groups is generally more straightforward. However, even for taxes the case is complicated by the inclusion of indirect impacts and behavioural adjustments. The fact that the distributional implications of taxes are particularly highlighted is probably due to their greater "visibility" and should not be construed as an indication of their greater regressivity.

Looking at both benefits and costs

The conceptual frameworks developed by Pearce (2003) and Kriström (2003) converge to emphasize the need to look simultaneously at both costs and benefits when assessing the distribution of environmental quality, as well as the distribution of financial effects and environmental quality effects of environmental policies. Since changes in local environmental quality can have impacts on the overall financial impacts of environmental policies, both issues must be addressed.

A good example is that certain environmental impacts have important effects on existing markets, for instance the proximity to urban parks or hazardous waste facilities, on the real estate market. The analysis of the effect of the proximity to hazardous waste facilities on the housing value comes as an illustration to this mechanism. The study by Hamilton and Viscusi (1999) examining the populations surrounding hazardous waste sites slated for cleanup in the EPA's Superfund program indicates that the site-level mean house values for residents living within one mile ($98,590) or within four miles ($103,900)

were lower house values than the U.S. mean ($112,660). Along the same line, Sieg *et al.* (2001) show with an example from Los Angeles how environmental improvements affect the housing market.

As such, when looking at environmental-related distributional effects it is important to recognise that households are already receiving financial benefits or paying financial costs through such markets as real estate market or labour market. However, the extent to which they do so depends upon their status in the market. For instance, homeowners will benefit in terms of capital gains from improved local environmental quality, but tenants will (if markets are perfect) see such benefits reflected in increased rental costs.

1-5 What are the major methodological issues?

What are the main methodological issues for measuring the distributional effects of environmental policy? In addition to the definition of equity, a number of other elements have an incidence on the nature of the results obtained and their interpretation when measuring the distributional impacts of environmental policy. These include in particular the proxy used to measure wealth, the choice of the baseline and the unit of measurement or the choice of spatial unit and temporal scale. Some variables are likely to be more related to the distribution of environmental quality or to the distribution of financial effects of environmental policy.

Proxy used to measure wealth

As mentioned earlier, different criteria can be applied as "proxy" for wealth such as household current income or life-time income, household expenditures or expanded notions of wealth and each has its own limits when looking at distributional issue. The literature suggests that the definition retained may affect the results regarding the regressivity of environmental policy, as discussed in Kriström (2003).

In general, studies indicate that the regressive impacts of taxes are more limited in a life-time context.[14] For instance, taxes on gasoline appear less regressive when taken as a percentage of total consumption expenditures used as a proxy for life-time income (Porteba, 1991). In a similar way, looking at the distributional effects of a shift in motor vehicle emissions taxes, Walls and Hanson (1999) conclude that results heavily depend on the measure of income used and that the three types of vehicle emissions-based fees[15] examined are much less regressive when considering life-time income than on the basis of annual income. Smith (1992) notes however that this conclusion may depend on a number of factors and that, in the case of energy and carbon taxation in the U.K., the distinction makes little difference in distributional analysis

In short, conclusions about the distributional impacts of environmental policy will differ according to the concept of income applied. This conclusion is borne out by experience from the literature on the burden of taxation which suggests that “the choice of income measure clearly affects both the estimated distribution of taxes by income class and the effect of reform proposals.”[16]

The choice of the baseline

The choice of the baseline against which the distributional impacts are being measured stands as an important methodological issue when undertaking distributional analysis (OECD, 1994). The

14 A survey of studies using life-time income measures is in Metcalf (1999).

15 Fee based on annual vehicle-miles-travelled (VMT), fee based on emissions rates (in g/mi) and fee based on total annual emissions.

16 Atrostic and Nunns (1990).

distributional effects of a taxation system, for instance, will depend upon whether it is compared to a command-and-control alternative or judged against the status quo situation with a "no regulation" benchmark.

Moreover, if the environmental policy has impacts upon technological change, labour markets and other areas of the economy it can be difficult to assess what the baseline would have been in the absence of the policy. As such, every effort must be made to compare 'like with like' by ensuring that the full effects of the policy are compared with the counterfactual chosen.

Unit of measurement used

Different units can be used to measure the distribution of environmental quality as discussed by Pearce (2003). These can be broadly classified into the physical and the economic approach:

– The "Physical" approach relies upon measures such as emissions, exposure or risk. The measure of physical risks depends on the indicator retained. The literature distinguishes between the emission measure, which can be seriously biased, and more refined notions like the net emission concept (actual emissions minus exports of emissions), the indicator of exposure which allows for the behaviour of the population at risk and, the lastly, the measure of total risk. The latter indicator is the most sophisticated. It takes into account personal characteristics of those exposed at risk like nutritional status for instance.

– The "Economic" approach reflects personal preferences - e.g. environmental quality in different neighbourhoods is assessed according to the preferences of households with different levels of income. There is, of course, overlap and an economic approach may be – but not necessarily be – underpinned by physical measures.

The distinction is important since physical and economic approaches may yield very different results. For instance, if the total expenditures on all marketed goods and services of one socio-economic group are twice as great as those of another group, and if the local environmental conditions (i.e. air pollution concentrations, local environmental amenities, etc.) are marginally better, a physical approach may indicate that this distribution is regressive, while an economic approach would indicate that it is progressive.

The choice of the geographical unit

When looking at the distribution of environmental quality, more or less disaggregated levels of scale can be retained from census track[17], county level or even zip code areas[18] and this choice may affect the results obtained, as pointed out in the literature[19].

With the increase in data availability and the growth in the sophistication of spatial analysis, like geographic information systems (GIS), studies have evolved rapidly allowing for more disaggregated results. As an illustration, Hamilton (2003) shows that for the analysis on the distribution of exposure to hazardous waste facilities, research in the United States in the early 1990s focused on the state or county as the unit of geographic analysis. How risks varied by zip code area or census data tract was explored next.

17 See for instance Cutter *et al.* (1996).

18 See for instance the studies of Arora and Cason (1999) and Brooks and Sethi (1997) using information from Toxics Releases Inventory in the United States, or Kruize and Bouwman (2003).

19 See for instance Bae (2003). See also Lester and Allen (1999) and Hamilton (1995, 2003) for the importance of the geographical unit of analysis employed.

The ease of GIS analysis in the mid-1990s made explicit modelling of risks possible at plants and hazardous waste sites.

The methodology used

To examine empirical evidence on distributional effects of environmental policy, a broad range of methodological approaches can be used such as: micro simulation, economy-wide models, cluster analysis or modern cross sectional econometric methods. Also, when examining the distribution of environmental quality, some sophisticated tools can be used for spatial analysis like geographic information systems.

Methodologies have strengths and weaknesses that might affect the results in terms of distributional impacts and some trade-off have to be made when choosing methodological techniques. For instance, the micro simulation model used by Bork (2003) to analyse the distributional effects of the German Ecological Tax Reform on households has a very detailed description of public finance (expenditures and tax receipts) and disaggregated consumer expenditures across household type and commodity classification. On the other hand, this approach is less able to deal with behavioural responses and indirect effects than General Equilibrium modelling.

Some of the recent research on distributional effects uses sophisticated spatial techniques such as GIS analysis which generate useful results[20]. Hamilton (2003) shows that GIS technology has for instance allowed risk assessment to be conducted at the facility level for some types of hazardous waste sites. However, as pointed out by Bae (2003), micro-spatial analysis using GIS can provide a limited picture since little information is available on how adverse health outcomes diminish with distance.

Temporal scale

Distributional studies can consider evidence at a certain point of time or analyse changes over time, within one generation or between generations[21]; whether one perspective or the other is retained to examine the distributional effects of a policy will make a difference. Thus, Pearce (2003) distinguishes between the existence of disparities in the distribution of environmental quality, in the status quo conditions on the environment, and those arising in incremental changes to that status quo situation

Along the same line, Hamilton (2003) underlines that to determine the causation of possible disparities in exposure to potential risks, an approach going beyond the simple snapshot of who is exposed to hazardous waste facilities at a given point of time is required. As noted above, behavioural adjustments across different socio-economic groups can result in very different indications of distributional impacts.

This overview of some key variables having a possible effect on the results of studies examining the distributional impacts of environmental policy does not claim to be exhaustive and various additional elements may affect findings which can be issue specific. For instance, the findings of studies on exposure to hazardous waste facilities may differ according to the definition retained for such notions as risk[22], waste

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20 See for instance the papers presented at the Workshop by Kruize and Bowman (2003), Brainard *et al.* (2003) or Hamilton (2003). See also Brainard *et al.* (2002), McLeod *et al.* (2000) and Pye *et al.* (2001) for the distribution of air pollution in the U.K. or Sadd *et al.* (1999) for the use of GIS technology to study TRI releases in southern California.

21 Inter-generation distributional issues, which are out of the scope of this report, are for instance explored in the literature on climate change (Carraro, 2000).

22 Risks can be characterized in a number of ways. Some studies use a simple indicator variable approach, where a facility either does or does not handle specific wastes, is or is not in violation of rules, or contains or does not contain a particular type of environmental contamination. Risks are also proxied by function of facility, so that plants are categorized by whether they generate and manage their own hazardous waste or whether they receive shipments from

or facilities[23] as underlined by Hamilton (2003). Also, the results and comparability of case studies are affected by the nature and quality of the data available. As an example, analysing exposure to hazardous waste risks within a country requires data on waste facilities location, quantities of waste handled, and the demographics of surrounding[24].

other facilities and process the waste for a fee. In addition, some studies look at current risk while other can also consider potential or future risk (Hamilton, 2003).

23 Hamilton (2003) underlines that the definition of a "facility" offers numerous options: plants that generate hazardous waste, facilities that treat, store, or dispose (TSDs) of hazardous waste, or even sites now abandoned that once generated or managed these materials.

24 Such data may be available in some OECD countries, but differences in definition of hazardous waste and lack of consistent reporting would make it difficult to make comparisons across countries. However, as the use of Pollution Release and Transfer Registers (PRTRs) that record which facilities release particular types of pollution spreads across countries, more detailed environmental justice analyses will become available in the future (Hamilton, 2003).

CHAPTER 2: MAIN EMPIRICAL FINDINGS

This chapter examines empirical findings on the distributional implications of environmental policies across household according to economic status. Evidence on distribution of environmental quality and on the distribution of financial effects are both considered. The first section provides an general overview of the literature available in OECD countries while the other sections present the main findings of selected case-studies undertaken in the context of the OECD programme in the following areas: distributional effects of ecological tax reforms and of direct regulation; distributional impacts related to the provision of public water services; access to environmental amenities; and exposure to noise pollution and to hazardous waste facilities.

2-1 Overview on available evidence

When examining environment-related distributional issues, empirical studies generally focus either on the distribution of environmental quality or on the distribution of financial effects of environmental policies. This differentiation is used to review some of the available literature and main empirical findings. These two aspects of the discussion on income-distribution effects are, however, not addressed in a symmetric way in the literature and some bias exist as underlined below.

Empirical Evidence on the Distribution of Environmental Quality[25]

Making a distinction between the existing state of the environment - which can be progressively or regressively distributed, and the *incremental* change to that status quo - which can also benefit one group more than the other, Pearce (2003) notes that the former approach tends to be more widely studied.

The literature on the distribution of environmental quality is characterised by another bias. It tends to be unbalanced geographically, as most of the studies are coming from North America, in particular the United States. The evidence is very limited for Europe and almost exclusively coming from the United Kingdom, with a few studies from other countries (e.g. The Netherlands). Available evidence for the OECD Pacific region seems extremely scarce.

In addition, the literature mainly focuses on exposure to environmental hazards like toxic releases or hazardous waste sites, with very scarce studies on the distribution of exposure to environmental noise. Also, the distribution of access to environmental amenities (e.g. urban parks) has been rarely analysed.

Looking in more details at the U.S. literature[26] which is by far the more substantive on the issue, all the very early studies relate to air pollution[27] and generally conclude that the higher the damage the

25 This review of empirical evidence on the income-distribution of environmental quality draws on the report prepared by Pearce (2003) for the Workshop on "The Distribution of Benefits and Costs of Environmental Policies", 4-5 March 2003, as well as on other relevant material.

26 A review of early studies is provided in Cutter (1995), and of early and late studies in Bowen (2002). Hamilton (2003) gives an extensive review of empirical evidence on the distribution of exposure to hazardous waste facilities

27 Other than the Berry (1977) report which covered many forms of pollutant.

lower the income level[28]. These findings are however qualified by other work[29]. In the 1980s, focus shifted to hazardous waste sites, and in the 1990s coverage included toxic releases, waste sites and air pollution.

The correlation of exposure to environmental hazards with low income was established by a number of studies. Analyses providing evidence of income inequality for exposure to hazardous waste sites include Mohai and Bryant (1992), Yandle and Burton (1996), Hamilton and Viscusi (1999). Hamilton (2003) gives an extensive review of empirical work available in the North America and other OECD regions. Other studies have been carried out for exposure to TRI releases (see Burke, 1993; Brooks and Sethi, 1997; Arora and Cason, 1999; Millimet and Slottje, 2000), as well as for TSDF[30] sites (Anderson, 1994).

Findings on income inequality in exposure to environmental hazards are not always confirmed by other empirical work. For instance, Zimmerman (1993) shows that Hispanics and Blacks are correlated with hazardous waste sites, but finds no link to income and Been and Gupta (1997) find no correlation with poverty. The same way, Hite (2000) provides evidence of racial inequity but no evidence of income inequity when examining exposure to landfills. Other examples are provided by Boer *et al.* (1997) or Atlas (2001) who find no pattern of TSDFs (Transfer, storage and disposal facilities) or their risks being inequitably concentrated in disproportionately minority or low income areas. [31]

Evidence on the distribution of environmental quality in Canada is rather limited and inconclusive with early studies suggesting that income is negatively associated with air pollution (Handy, 1977) while more recent empirical work, relying on National Pollution Release Inventory, indicate that income is positively correlated with pollution (Jerrett *et al.*, 1997) or showing no association between releases, transfers and income (Harrison and Antweiler, 2002).

Empirical findings on the income distribution of environmental quality in Europe are more recent and scarce. They rest almost exclusively on data for the United Kingdom which indicate a positive correlation between air pollution and socio-economic deprivation (McLeod *et al.*, 2000; Pye *et al.*, 2001; Brainard *et al.*, 2002). European studies provide as well some interesting insights by examining issues which have been less analysed so far in the literature like the distribution of exposure to noise or the distribution of access to environmental amenities (e.g. urban parks). Evidence shows a positive but weak correlation between noise levels and low income groups (Brainard *et al.*, 2003) with different findings for aircraft noise as suggested by Kruize and Bouwman, 2003). For access to green space, studies conclude that income relationship is regressive (Brainard *et al.*, 2003a; Kruize and Bouwman, 2003). These results will be further discussed when examining in more details the findings of the case-studies presented at the Workshop.

Some of the recent evidence on the distribution of environmental quality across households in OECD countries is summarised in the table below (see Table 1). Overall, the main findings of the empirical literature available on the income-distribution of environmental quality indicate that:

– There are some forms of consensus in the literature that low-income household tend to be relatively more exposed to environmental hazards. This is in particular the case for exposure to TRI releases and proximity to hazardous waste sites with scarcer and more ambiguous results for exposure to noise pollution.

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28 Studies looking at pollutants such as TSP, SOx, or PM10 show that low income groups bear higher pollution (see Freeman, 1972; Zupan, 1973; Berry, 1977; Asch and Seneca, 1978; Harrison and Rubinfeld, 1978).

29 For instance, looking at the correlation of pollution (TSP and SOx) with income, Freeman (1972) shows that low income groups have higher pollution within cities, but relationship breaks down across cities.

30 Transfer, Storage and Disposal Facilities.

Table 1 - Summary table of empirical evidence on the distribution of environmental quality among household income groups

	OECD Country	Authors and Date	Main Findings
Exposure to environmental "bads"			
Air Pollution	Canada	Harrison and Antweiler (2002)	No association between releases, transfers and income (TRI releases-air, water and land pollution)
	Canada (Ontario)	Jerrett et al. (1997)	Income positively correlated with pollution, i.e. no inequity (TRI releases – air, water, land pollution)
	U.K. (Birmingham)	Brainard et al. (2002)	Poverty and ethnicity associated with pollutant emissions (CO and NO_2)
	U.K. (England)	Friends of the Earth (2001)	Polluting facilities primarily located in the most deprived wards (Carcinogen emissions)
	U.K. (England and Ireland)	Pye et al. (2001)	Weak positive correlation between air pollution and social deprivation
	U.K. (England and Ireland and Wales)	McLeod et al. (2000)	Pollution decreases as social index increases however once population density controlled concentration of pollutants higher in higher social class areas (NO_2, NO_2, PM_{10})
	U.K. (England and Wales)	Friends of the Earth (1999)	Most polluting industrial facilities disproportionately located in areas of below average income
	U.S. (National)	Atlas (2001)	No correlation with low income area (TSDF sites)
	U.S.	Millimet and Slottje (2000)	Substantial inequality (TRI releases)
	U.S. (Ohio)	Hite (2000)	No evidence of income inequity (Landfills)
	U.S.	Arora and Coason (1999)	Correlation with low income (TRI releases)
	U.S.	Hamilton and Viscusi (1999)	Mean household income lower in 0-4 mile ring than national average (Hazardous waste sites)
	U.S.	Been and Gupta (1997)	No correlation with poverty (Hazardous waste sites)
	U.S. (Texas)	Yandle and Burton (1996)	Correlation with low income (Hazardous waste sites)
			Mean household income lower in 0-4 mile ring than national average (Hazardous waste sites)
			No correlation with poverty (Hazardous waste sites)
			Correlation with low income (Hazardous waste sites)

Table 1 (continued) - Summary table of empirical evidence on the distribution of environmental quality among household income groups

	OECD Country	Authors and Date	Main findings
Exposure to environmental "bads"			
Air Pollution (continued)	U.S. (South Carolina)	Cutter at al. (1996)	Some indication of sites being in higher income areas (TSDF sites)
	U.S.	Hamilton (1995)	Expansion planned in areas with poorer populations and more minorities (TSDF sites)
	U.S. (National)	Anderton et al. (1994)	Income inequality (TSDF sites)
	U.S. (Los Angeles County)	Burke (1993)	Low incomes correlated with emissions (TSDF sites)
Exposure to Noise	The Netherlands (Rijnmond region)	Kruize and Bowman (2003)	Regressively distributed except for aircraft noise
	U.K. (Birmingham)	Brainard et al. (2003)	Very weak correlation between noise levels and socio-economic deprivation
Access to environmental "goods"			
Access to Urban Parks	The Netherlands (Rijnmond region)	Kruize and Bowman (2003)	Regressively distributed
	U.K. (Birmingham)	Bateman et al. (2003)	Income relationship regressive

- If there is some evidence that the *existing* distribution of environmental quality is distributionally biased against low income, the evidence on the distribution of benefits of environmental policies is undetermined: they may be progressive or regressive as underlined by Pearce (2003).

- However this consensus emerges in large part from U.S. studies and some caution must be exercised on the relevance of generalising the results to other countries given the existing geographical bias.

- In addition, the different approaches used result in different indicators of inequity which may affect the results. The importance of methodological considerations has been discussed earlier (see section 1-5).[32]

- Also, and this is a key point, the major part of the literature[33] makes no reference to any trade-offs in housing decisions by households. Risk may differ by social groups, but there is then no information on the possibility that those risks are offset by other location characteristics.

***Empirical Evidence on the distribution of Financial Effects of Environmental Policies*[34]**

Compared to the literature on the distribution of environmental quality, the geographical bias in favour of the United States is less marked for the literature assessing the distribution of the cost of environmental policy. There is a strong predominance of the literature focussing on the distributional impacts of economic instruments, and particularly environmentally-related taxes.

Most studies available on income distribution impacts of environmental taxes tend to focus on energy/carbon taxation. Brännlund and Nordström (2003), Cornwell and Creedy (1997), Symons *et al.* (1994) and Tiezzi (2001) are examples from Sweden, Australia, England and Italy of household studies. The Australian and Swedish study confirms the general view that carbon taxes are regressive while other analyses are more ambiguous.

As pointed out earlier, results on the regressivity of environmental taxation depend to some extent on how the tax revenues are returned to the economy. This point is discussed by Bork (2003) who concludes that overall, the effects of the German ecological tax reform are weakly regressive.[35] Thus, while gasoline taxes are found to be regressive in some studies (see Sipes and Mendelsohn, 2001), other analyses on gasoline tax suggest that lump-sum payments may actually make the tax-package progressive (West and Williams, 2002).

When studies of environmental taxation allow for market repercussions in economy-wide models, most of them conclude that such taxes are regressive[36]. Some studies suggest that there exist

32 For instance, the choice of the spatial unit is, as a number of studies point out, crucial with results being rendered invalid or less firm once spatial unit is changed.

33 Few studies suggest that such trade-offs occur (see Millimet and Slottje, 2000; Hite, 2000).

34 This review of empirical evidence on the distribution of financial effects of environmental policies among households according to economic status draws on the report prepared by Kriström (2003) for the Workshop, as well as on other relevant material, especially OECD work on the distributive impacts of economic instruments (OECD, 1994; OECD, 2001; OECD, 2001a; OECD 2002a).

35 See for instance the study by Symons *et al.* (1994) on carbon taxation of driving fuels.

36 The study from Ladandeira and Labeaga (1999) exploring the effects of a carbon taxation of Spanish households indicates that the impact is neutral.

options for reducing unwanted distributional impacts by targeted measures (Metcalf, 1999; Labandiera and Labeaga, 1999; Bovenberg and Goulder, 2002).

Evidence on distributional effects appears sometimes inconclusive – For instance, the comprehensive study by Klinge-Jacobsen *et al.* (2001) for Denmark concludes that gasoline taxation may be progressive, as well as registration duties for cars, while most other environmental taxes are found to be regressive. On the other hand, in their study of the distributional effects of taxes on transportation in Norway, Aasness and Larsen (2002) find that higher taxes on high pollution-pollution necessities such as gasoline have favourable environmental effects but increases inequality.

Empirical findings suggest that results vary according to the assumptions made such as the proxy used to measure wealth. This can be illustrated with the study by Walls and Hanson (1999) which concludes that emissions-based fees look more regressive than the current vehicle Californian registration fees system, both when using annual income and lifetime income, though much less so on a lifetime income basis.

The distributional effects of a tradable permits system, where the permits are auctioned, are similar to that of a tax. Available evidence on income distribution impacts of tradable permits is limited and some studies indicate a possible progressivity of the instrument like the survey by Markandya (1998) on permit markets in the U.S. which indicates that the instrument is beneficial for households in lower income brackets.

The literature on the distributional effects of direct regulation is scant compared to studies available on the impacts of economic instruments (e.g. taxes) but the issue is now receiving increased attention. Early studies examining the distribution of industrial pollution abatement costs indicate that direct regulations tend to be regressive (Robison, 1985). More recent studies on the income distribution impacts resulting from the imposition of appliances performance standards for energy efficiency (see Sutherland, 1991, 2003, 2004; and Stoft, 1993) suggest possible regressive effects since discount rates tend to fall with income levels. Energy efficiency standards will result for households in increased investments costs and lower operating costs. Evidence on the tendency of low-income households to have higher discount rates than high-income households has been revealed in purchases of energy-using consumer durables (see Dubin and McFadden, 1984; Train, 1985). In studies assessing the possible distributional effects of direct regulations to reduce mobile source pollution, mandated environmental equipment (e.g. smog emissions equipment) are also found to have a probable regressive impact since their cost varies little with the cost of the vehicle, as underlined by the contribution prepared by Bae (2003). On the other hand, analysis on the effects of performance standards (i.e. Corporate Average Fuel Efficiency Standard[37]) indicates that the resulting decline in the price of small cars could benefit low-income car-owners, and concludes on the progressiveness of the CAFE regulation (Goldberg, 1998).

There is also little empirical information regarding the distributional impact of information programs, let alone their relative efficiency. The same is true for voluntary agreements. But alternative policies, such as energy conservation programs (with indirect environmental benefits), may certainly be a burden to the less well off and benefit richer households. This, at least, is what Sutherland (1994) finds in his study of electric utility demand side management (DSM) programs.

Empirical findings across economic instruments tend be scarce as well (see OECD, 1994; Tietenberg, 1995; Markandya, 1998). So are cross-instrument comparisons looking at the differences in terms of distributional effects resulting for instance from the implementation of direct regulations and

[37] According the CAFE regulation which was enacted in 1975, every seller of automobiles in the U.S. had to achieve by 1985 a minimum sales-weighted average fuel efficiency of 27.5 Miles per Gallon.

economic instrument to meet the same environmental objective.[38] One of the few study available comparing the income distribution effects on households of tradable permits, taxes (emissions taxes and input taxes) and direct regulation (performance standards and technology mandates) demonstrates the potential importance of distributional considerations for the choice of grandfathered emissions permits.

Some examples of recent evidence on the distribution of financial effects of environmental policies across household available in OECD Member countries are reviewed in the Table 2.

Overall, this review of the literature available on the distribution of the financial effects of environmental policies suggests the following main findings:

– There is evidence that economic instruments tend to be regressive with a particular concern for taxes, with a weak to mild regressivity in general.

– However, when a revenue is raised – as in the case of taxes and auctioned tradable permits – these results depend on how the revenue is recycled.

– Whether repercussions on other markets and behavioural responses are taken into account or not will affect the results.

– Other assumptions like the proxy used to measure wealth - for instance, using life-time income rather than the annual income – can also affect the results.

– Alternative policies are by no means immune to such distributional impacts.

The literature review suggests that evidence on the distribution of environmental quality and on the distribution of financial effects of environmental is sometimes inconclusive and that some data gap exist. Also, there are some caveats about the possibility to generalize the findings as the literature on the disparities in the distribution of environmental impacts is quite unbalanced with most studies coming from the United States. In addition, the literature on the distribution of environmental quality mainly focuses on exposure to environmental hazards like toxic releases, with very scarce studies on the distribution of environmental amenities (e.g. urban parks) ; while the literature assessing disparities in the distribution of the cost of environmental policy concentrates on the distributional impacts of economic instruments, in particular carbon taxes.

[38] One can however mention Helfand (1999) where some empirical examples that support the notion that distributional concerns tend to favour the use of standards over taxes are discussed.

Table 2: Examples of evidence on the distribution of financial effects of environmental policies

	OECD Country	Authors and Date	Main Findings
Economic Instruments			
Taxes	Australia	Cornwell and Creedy (1996)	Carbon taxation - Regressive but transfer payment can be adjusted to compensate for the regressivity without decreasing total revenue
	Belgium	Mayeres (2001)	Transport instruments – Equity considerations do not have a large impact on the ranking of the transport instruments evaluated: peak road pricing, fuel tax and subsidies though the first continues to be preferred to the second
	Denmark	Klinge-Jacobsen *et al.* (2001)	Progressivity of tax on petrol of registration duties for car. Most other environmental taxes are regressive
	Germany	Bach *et al.* (2002)	Small regressive effects of the Ecological Tax Reform
		Bork (2003)	Ecological taxes (taxes on motor fuel) are regressive
	Italy	Tiezzy (2001)	Presumed regressivity of the carbon taxation not sustained
	Norway	Aasness and Larsen (2002)	Taxes on transportation - Higher taxes on air flights, taxis and automobiles together with lower taxes on bus rides, bicycles, and mopeds reduce inequality. Taxes on gasoline contribute somewhat to inequality. Railway passenger transportation seems to be neutral distributionally
		Halvorsen and Nesbakken (2002)	Electricity taxation – Most progressive tax schemes have better distributional properties than the proportional one when assuming that household cannot change their consumption. The positive distributional effects of the progressive alternatives are weakened when allowing for changes in household electricity consumption

Table 2 (continued): Examples of evidence on the distribution of financial effects of environmental policies

	OECD Country	Authors and Date	Main findings
Economic Instruments			
Taxes (continued)	Spain	Labandeira and Labeaga (1999)	Neutral effect of carbon taxation across Spanish households
	Sweden	Nilsson and Wadeskog (1998)	Negative distributional effects of a change in the carbon tax. Can be partly remedied with a compensation through a decrease in VAT
		Brännlund and Nordström (2003)	Regressivity of carbon taxation. Urban/rural dimension, rural households mostly affected
	U.K.	Symons *et al*. (1994)	Carbon taxation – Regressivity depends on how revenue is recycled. Study limited to taxation of driving fuels
		Smith (1995)	Cabon tax in Britain and Germany mildly regressive, more so in Britain than Germany. Taxes on petrol on the other hand are mildly progressive
	U.S.	Roberts *et al*. (1999)	Regressive impact of increased fuel duties in rural areas. (Scotland)
		Metcalf (1999)	Options for addressing distributional impacts of green tax reforms exist
		Walls and Hanson (1999)	Regressivity of vehicle-miles travelled (VMT) fee, fee based on emissions rates in grams per mile and annual emissions. Much less so on the basis of lifetime income compared to annual income. (California)
		Sipes and Mendelson (2001)	Regressivity of the gasoline tax
		West and Williams (2002)	Increasing the gas tax is generally regressive but the results greatly depends hoe the revenue is used. Lump-sum return may make the gasoline tax-package progressive
		Bovenberg and Goulder (2002)	Distributional impacts of carbon policy can be neutralized at low efficiency costs

Table 2 (continued): Examples of evidence on the distribution of financial effects of environmental policies

	OECD Country	Authors and Date	Main findings
Economic Instruments			
Taxes (continued)	EU	Barker and Köhler (1998)	Transport fuel tax could be weakly progressive for most European Union countries.
Tradable permits	U.S.	Markandya (1998)	Permit markets in the U.S. are beneficial for households in lower income brackets
Direct Regulation			
Standards	U.S.	Robinson (1985) Sutherland (1991) Stoft (1993) Sutherland (2003, 2004)	The distribution of industrial abatement costs across income classes is fairly regressive The costs of appliance standards falls particularly heavily on low-income households Possibility that the costs of appliances standards hurt particularly the poorest families The net cost of new minimum energy efficiency standards is borne disproportionately by low-income households
Other Instruments	U.S.	Sutherland (1994)	Regressivity of energy conservation programmes

2-2 Selected case-studies

The empirical studies discussed at the Workshop intended to address some of the biases identified.

The six case studies presented cover the following areas:

- The ecological tax reform in Germany (1) and the regulatory approaches to air pollution control in the United States (2) focussing on the distribution of the financial effects of environmental policies;

- The provision of public water services (3) to provide evidence on the distributional impacts of environmental-related public services; and

- Access to environmental quality in the Netherlands (4), exposure to noise pollution in the United Kingdom (5), and proximity to hazardous waste facilities in OECD countries (6) to analyse in particular the distribution of environmental quality.

The followings sections summarises the main findings of the case-studies which are presented in more details in the Annex.

2-2-1 Case-study on the German Ecological Tax Reform

The distributional effects of environmentally related tax reforms were examined by Bork (2003) in the light of the German Ecological Tax Reform implemented since 1998[39]. The reform consists of a gradual increase from 1999 to 2003 in tax rates imposed on fuels, heating oil, natural gas, and on electricity tax introduced in 1999. The revenue raised by the taxation system implemented has been recycled with an aim to address distributional concerns through the reduction of pension insurance contributions.

The empirical findings show slight distributional impacts of the ecological tax burden which vary according to the category of gross income considered. On average, these effects are weakly regressive.

However, most households are compensated by other reforms, although the government did not implement a reform specifically designed to correct for the distributional effects of the ecological tax reform. In particular, the increased child benefits partly offset the burden for households in lower income brackets. The income tax reform neutralises the burden of the ecological taxes in most cases. Only pensioners and some older people in lower income brackets are not compensated from other reforms.

2-2-2 Case-study on Air Quality Regulations in the United States

The empirical study prepared by Bae (2003) examines the distributional impacts of air quality regulations in the light of two cases: smog controls in Los Angeles and toxic air releases in Houston and Los Angeles.

The study concludes that the costs of air quality regulations tend to be regressive, but the benefits are progressively distributed. The high costs of air quality regulations are outweighed by the benefits in the

[39] On the distributional effects of the ecological tax reform, see also the paper prepared by Schwermer (2003) as the Germany's contribution to the Workshop on the "Distribution of Benefits and Costs of Environmental Policies", 4-5 March 2003.

form of favourable health effects and capitalized increases in house values. Low-income households are more likely to live in polluted neighbourhoods where air pollution is capitalized in low housing prices, and a surprisingly large percentage may be homeowners rather than tenants.

2-2-3 Case-study on the Provision of Water Services in OECD Countries

The case study prepared by Herrington (2003) focuses on the distribution of costs and environmental impacts of water services in OECD countries.

The study shows that the water charge burden tends to fall disproportionately on low income households in a number of OECD countries. The rate at which the burden declines as income increases to the highest group, however varies enormously. For instance failing from nearly 4% to 0.4% of household income, in the case of England and Wales, and from 0.66% to 0.33% in the US.

These disparities in the water charge burden among household income groups raise particularly significant concerns since many water uses are basic needs. Also, unit water prices have been increasing in real terms in most OECD countries in the last decade and will continue in the future.

2-2-4 Case-study on Access to Environmental Quality in the Netherlands

The distribution of environmental quality is examined by Kruize and Bouwman (2003) in the light of a case study carried out in the Rijnmond region, the Netherlands.

The results indicate disparities in the distribution of environmental quality. The main findings are that as income decreases, proximity to waste disposal sites increases as well as air pollution and noise above 50 dB, in particular for rail and accumulated noise, and access to public green areas decreases. The differences between income categories are more pronounced for air pollution than for noise with a reversed trend for aircraft noise.

The case study also showed that the perceived environmental quality by households is not always consistent with the actual environmental quality assessed using ‘objective’ indicators, particularly for noise.

2-2-5 Case-study on Exposure to Urban Noise in the United Kingdom

Some new insights on the distribution of noise pollution, for which very little evidence exists, are provided by a recent research undertaken by Brainard, Bateman, Lovett and Day (Brainard *et al.* 2003) in the city of Birmingham, UK.

Overall, the results showed weak disparities in exposure to noise pollution. The study indicated greater inequalities in noise exposure associated with deprivation than with racial or age. In particular, disparities were apparent for exposure to night-time noise for the combined sources. However, concerning exposure to road-noise, either at day or night levels, or in exposure to day-time noise for combined sources (road/rail/airport) no statistically significant disparities between income groups were found. There are many deprived areas without high noise levels and high income areas exposed to high levels of aircraft and motorway noise. These findings point out the existence of trade offs with some benefits, like improved mobility, that can compensate for higher noise exposure.

2-2-6 Case-study on Exposure to Hazardous Waste Facilities in OECD Countries

Empirical evidence on the distribution of exposure to hazardous waste facilities in OECD countries is provided by the study by Hamilton (2003).

Overall the review of the literature available in the United States and other OECD countries indicates that, in general, low income residents face the higher risks from hazardous waste facilities.

In the case of hazardous waste, there have also been analyses of the effect of political and social factors in the siting decision. For instance, it is commonly found that areas in which voter turnout is high are less likely to have hazardous waste facilities, even when the effects of other factors are taken into account. Similarly, in areas where the average level of education is high, hazardous waste facilities are less prevalent. Hamilton argues that both of these are attributable to the likelihood of firms facing collective action from the local community.

CHAPTER 3: POLICY IMPLICATIONS FOR DECISION-MAKERS AND CONCLUSIONS

This final chapter reviews some of the key issues and main challenges facing policy makers as they seek to design environmentally effective and economically efficient environmental policies, while ensuring that social aspects like distributional effects are addressed.

Government concerns about the distributional impacts of environmental policies generally arise when it is agued that an instrument is regressive, in the sense that its burden falls disproportionately on lower-income households. Taxes are generally perceived as being regressive and as a result are likely to face opposition from the public on these grounds. The public demonstrations that resulted from planned increases in energy taxation in several European countries in 2000 are an illustration. A more recent example is the strong reaction to charges for environmental services (i.e. waste collection) in Ireland (see Box 1). As such, addressing distributional effects can be a crucial element in the political acceptance of environmental policy (e.g. energy taxes).

Of course, all public policies are likely to have some distributional impacts of some kind. As such, the need to address distributional impacts (financial or other) associated with environmental policies arises when the impacts are significant. If the existing public policy framework (tax schedules, social security schemes, etc.) are thought to be 'fair' then the case for addressing distributional concerns only arises if: a) the policy has non-trivial distributional impacts overall and/or; b) for political economy reasons, perceptions of distributional impacts represent a significant barrier to the introduction of the policy.

Box 1. Examples of non-adoption of environmental measures for income distribution concerns

In **Ireland**, an inadequate consideration of income distribution concerns contributed to the abolition of domestic water charges during an election campaign in 1996. The water charges operating at that time were based on an unmetered system. It resulted in infrequent and large bills strongly burdening low-income households without standardised methods for dealing with vulnerable families. More recently, the population reacted strongly to the implementation of a new charge for municipal waste services (known as "bin tax') on the grounds that the option of the flat fee retained would be regressive, hitting lower-income families hardest.

In the **United Kingdom**, the government has excluded households from the climate change levy. The reason for its exclusion is related to the government's commitment to address fuel poverty.

However, various notions of what is a "fair distribution" can be retained as an objective when designing environmental policy relying on the different possible approaches of fairness. Concerning environmental quality, some of the concepts include: equality of environmental pressure, procedural fairness, "preference-based" notion of equity (see section 1.2). These goals tend to vary from one environmental concern to the other and to be country-specific. Also, experiences in OECD countries shows that distributional objectives are not generally stated beforehand when designing policies, but rather take shape within the policy process.

The first section examines the various frameworks that can be used to assess the distributional effects of environmental policies and their policy relevance (3.1). The wide set of measures available to policy-makers to deal with these impacts is then reviewed making key useful distinctions to characterise these options (3.2) and underlying the fact that policy options are guided by a number of parameters like the nature of the determinants of disparities (3.3) or the timing of intervention in the policy process (3.4) The following sections discuss the need to combine equity with other criteria for the evaluation of environmental policies like economic efficiency and environmental effectiveness (3.5) and the opportunity to use of a mix of policy instruments to address distributional concerns in order to tackle the complexity of the mechanisms involved (3.6). The last section explores areas of interest for future work (3.7).

3-1 Assessing environment-related distributional effects in their complexity

To address distributional issues, the possible adverse impacts of policy measures must first be assessed by governments, taking into account the variety of channels through which these effects can arise (e.g. direct, indirect) in order to reflect the complexity of the mechanisms involved which have been underlined earlier. When assessing distributive impacts, policy-makers may choose between different possible levels of analysis according to the nature of the most significant effects expected (e.g. mainly direct or also important potential impacts on other markets).

Looking at direct effects

As discussed previously, a first level of assessment of the distributional effects of environmental policy would consist in examining direct financial effects on households; this is mainly static and does not take into account indirect impacts. Direct effects can be analysed by looking at the percentage of income (expenditure) spent on different goods and services directly affected by the adoption of, for instance a tax, making use of data collected through household expenditure surveys.

Focussing on direct effects can give a good picture of the most important distributional impacts arising from the implementation of certain types of environmental policy instruments. This may be the case, for example, with taxes on final products (e.g. gas guzzler tax applied to cars) or mandated environmental technology for final products (e.g. catalytic converters). This approach can however provide a misleading picture and accounting for indirect effects as well as adopting a dynamic perspective may be necessary to grasp the complexity of distributional effects involved. These other possible frameworks of analysis are successively examined.

Taking into account indirect effects

A static framework may also be used to assess the indirect financial effects resulting from the implementation of environmental policy. This approach may be of particular relevance to determine the distributional impacts of policy instruments targeting goods and services that serve as inputs to the production of other goods and services. These can arise from both direct forms of regulation and economic instruments. For instance, irrespective whether or not the impacts of air pollution emissions from refineries take the form of technology-based standards or tradable emission permits, there will be downstream implications on the cost of fuels used by households.

Carbon taxes aiming at reducing carbon dioxide emissions are another example. The carbon tax would affect prices faced by households both directly, for fuels, and indirectly for manufactured goods. The price of goods increases in proportion to their carbon content. Such effects can be accounted for when using input-output tables which provide data on inter-industry flows. They allow for the determination of the sectors in which the price increases are the greatest, and the distributional implications most important.

Taking into account such 'indirect' effects can have important implications for the assessment of the distributional implications of different measures. For instance, the analysis of the distributional impacts of a carbon tax in Australia suggests that the regressivity of the tax results notably from the high price increase in the fuel and power sector, combined with relatively large price increases in the food and tobacco sectors, which also form a relatively high proportion of the budget of lower income earners (see Cornwell and Creedy, 1996).

Considering again the example of a carbon tax, some of the interrelated mechanisms involved can be disentangled as follows (see Kriström, 2003): companies with increased costs will shift some of these costs onto the buyers of their products. If agriculture uses a significant amount of fossil fuels and experiences a carbon tax increase, parts of this will be shifted towards slaughterhouses and others that demand agricultural products. The cost of distributing the goods on roads will also increase, with an impact on households.

Taking into account behavioural response

Assessments based upon input-output tables are essentially static in nature. No account is taken of potential substitution between different factors of production. For instance, if environmental policies targeted at steel production result in greater cost and substitution of other materials (i.e. in motor vehicles, housing, etc.), the apparent distributional effects arising from assessments which take production technologies as given will be misleading.

Moreover, substitution possibilities at the level of the household are important. In particular, all households may not react in a similar way to the adoption of a policy. Taking into account these differences across households may prove important when undertaking the distributional analysis. An approach accounting for households' behavioural changes allows, for instance, for the assessment of transitional impacts. These can be substantial for some households as lower income households may have fewer substitution possibilities to adjust to the policy in the short term. In effect, they will have lower price elasticities compared with higher income households.

Accounting for effects in related markets

The three levels of analysis mentioned above focus on the distributional implication of environmental policy on households taken as consumers. Yet, households are also tax payers, workers and residents. Thus, the effects on associated markets may be significant and factoring them into the distributional analysis may be necessary to get a full picture of the mechanisms involved.

Firstly, some distributional effects may arise through the channel of public finance. This might be the case, in particular, when the proceeds raised by economic instruments – such as taxes or auctioned tradable permits – are recycled. The distributional implications will not be the same depending upon how the revenue is redistributed (e.g. reduction in payroll taxes for employers, in income taxes, in VAT rate). For instance, Kriström (2003) notes that, should the proceeds from the carbon tax be used to cut labour taxes, it is reasonable to expect that goods which are relatively "labour-intensive" will fetch a relatively lower price. Prices on haircuts and consulting services may therefore fall. Such reductions will end up in the hands of the households, much in the same way as households, in the end, must pay higher taxes. With this perspective, it is again clear that the distributional implications of environmental policy can be rather subtle.

Distributional effects may also arise through the channel of labour markets. On the one hand, some environmental policies may disproportionately affect some households, as workers, for instance because of competitiveness concerns in energy-intensive industries that may result from the adoption of

environmentally-related taxes. On the other hand, for deprived household groups such as low-income households, the proximity to active labour markets might be seen as compensation for increased exposure to environmental hazards (i.e. noise, air pollution).

Other trade-off may exist as well, such as proximity to transport networks, or housing markets. For instance, distributional impacts may arise through the real estate market. As local environmental quality affects the housing market, some households may receive financial benefits (i.e. if a park is sited nearby) or pay financial costs (i.e. if a hazardous waste facility is sited nearby) through the real estate markets. Also, the distributional effects resulting from an improvement or a deterioration of this environmental quality will not be the same whether households are homeowners or tenants. Besides, distributional concerns might not be the same whether disparities arise for instance as a consequence of siting decisions, or following the siting decision as a result of falling property values which will induce lower income earners to move in.

In order to handle these complex interactions, computable general equilibrium models can be useful (see Kriström, 2003) as they allow treating revenues and expenditures of different agents in a consistent way. This approach also sheds light on the interaction between different tax bases. A carbon tax change can also affect the value added tax and other tax revenues.

Thus, when assessing distributional effects of environmental policies on households, policy-makers may choose between different frameworks of analysis according to the nature of the main distributive effects expected to arise from the implementation or tightening of a policy. With some instruments, focusing on the direct effects might give a good picture while with others, accounting as well for indirect effects and households' responses may be necessary. In other cases, examining only the distributional effects on households as consumers might provide a misleading picture and adopting a wider perspective where possible impacts on households as tax payers, workers and residents may be required to grasp the complexity of the mechanisms taking place.

Recapitulative tables of possible distributional effects of measures and policy relevance to adopt different assessment frameworks are provided below (see Tables 1 and 2). There are, however, two areas in which there is clear need for further methodological refinement. The first is with respect to 'adjustment' costs. The full distributional impacts of some measures can take time to manifest themselves. For instance, a measure which appears to have very regressive impacts in the first instance, may be less regressive once all affected markets (e.g. labour markets) adjust. The converse can also be true. The second, and related area is with respect to the modelling of economic-environment interactions. For instance, for local public goods, changes in environmental quality impact (at least partly) on changes in the quality and thus prices for associated goods (e.g. real estate). Models which account for changes in the 'quality' and not just the price of affected commodities might lead to very different results than simpler models.

Table 1 – Frameworks to assess distributional effects – Recapitulative table

Type of assessment framework	Static framework to assess direct effects	Static framework to assess indirect effects	Dynamic framework to assess indirect effects
Type of distributional effects			
Direct financial cost on households taken as consumers	X		
Indirect financial costs on households as consumers		X	
Effects on households as tax payer (channel of public finance)			X
Effects on households as workers (channel of labour market)			X
Effects on households as home owners or residents (channel of real estate market)			X
Methodological tools	Household Expenditure Surveys (HES)	Input-output Tables	General Equilibrium Models (GEM)

Table 2 – Policy relevance of using one assessment framework according to the degree of importance of expected distributional effects – Recapitulative table

Assessment frameworks	**Static framework to assess direct effects**	**Static framework to assess indirect effects**	**Dynamic framework to assess indirect effects**
Examples of scope of policy relevance for using a framework	Policies targeting final products (e.g. taxes or performance and technical standards for final products)	Policies targeting goods and services that serve as inputs to the production of other goods and services, capital equipment involved in manufacturing and management of waste	Policies in which there are likely to be important impacts on other markets (e.g. public finance, labour market, real estate market)
Examples of measures	- *private vehicle taxes (e.g. registration, one-off import)* - *motor fuel tax (e.g. leaded petrol, diesel)* - *water consumption charge for households* - *tax on household electricity consumption* - *catalytic converter* - *energy efficiency standards for household appliances*	- *heavy fuel tax* - *coal and sulphur tax* - *charge on industrial waste* - *sulphur emission trading* - *performance or technical standards to reduce acid deposition* - *technology standards for waste incinerators*	- *ecological tax reform embedded in broader tax reform*

3-2 Measures to address distributional concerns: key distinctions

Some useful distinctions that can be used to characterise the range of possible options that can be applied by governments to deal with the possible adverse impacts of environmental policy on income distribution:

Mitigation and compensation measures

Measures can be taken "upstream" to factor in distributional issues at the level of the decision-making process. Once the decision is made to implement a policy, two sets of options usually considered are either mitigating the impacts on low-income households ex-ante or compensating them ex-post (see OECD, 1994). Over time, a certain shift in policy options from "downstream" to "upstream" approaches can be noticed as pointed out by Hamilton (2003) with the increasing involvement of local communities in the hazardous waste siting processes. The range of options available to decision-makers to deal with distributional issues according to the timing of policy intervention is further discussed in section 3.4.

Measures related to environmental quality / financial effects

In an analogous sense, a distinction can be made between policy intervention related to the distribution of environmental quality (e.g. exposure to environmental disamenities and access to environmental amenities) or the provision of environment-related services (e.g. water, energy), and those more targeted towards the distribution of the financial cost of environmental policies. These different policy options are examined in more detail later.

Direct and indirect measures

When looking at policy options to address distributional concerns, a distinction can also be made between measures targeted directly at low-income households, and more general measures that are likely to benefit them disproportionately because of their place in the market or because of the nature of their demand.

These measures may be taken in the field of environmental policy like tightening environmental policy to reduce exposure to environmental hazards which particularly affect low-income households. Ensuring that households are able to make informed housing-related and work-related decisions with respect to the degree of exposure to environmental hazards, and to express their demand for environmental quality is another illustration. Examples of measures include facilitating access to environmental information, consultation and public participation in political decision-making, as well as access to courts in environmental matters.

If a large spectrum of policy options is available to deal with environment-related income distribution effects at the policy level, the choice of decision-makers with respect to one instrument or another will depend on a number of elements that will be discussed in the next sections.

3-3 Accounting for the determinants of disparities in policy choice

Policy options available to decision-makers may prove more appropriate than others according to the specific determinants of the disparities associated with a given environment-related distributional concern to be addressed. Some disparities may arise because of the existence of market failures and barriers (e.g. information asymmetries, limited access to credit markets) or because of policy failures (e.g. restrictions on possibilities to express preferences) and this is likely to affect the choice of the instruments to be used, as discussed in this section. These determinants will differ, depending upon whether the

primary concern is related to the distribution of environmental quality or the distribution of the financial effects.

If the environmental good (or bad) affected is a local 'public' good (or bad), this has to be addressed in a very different way from pure public goods for which exposure and access are non-excludable and non-rivalrous. The case of hazardous waste or public park siting is illustrative. Even if the government takes measures to 'equalise' exposure and access to such facilities across income groups, this is unlikely to be possible in practice since there will be a degree of "sorting" through real estate markets, with low-income households gravitating toward (away from) neighbourhoods where hazardous waste facilities (parks) are located. Policy measures must recognise the importance of this phenomenon for all local public goods.

In addition, there will be differences between the effects of similar policies depending upon whether they target purely private marketed goods like petrol tax, or services involving public investment in infrastructure as in the case of wastewater treatment facilities. For instance, the provision of environmental-related services provides illustrative examples since the flexibility to design tariff structures to meet equity objectives (e.g. use of increasing-block tariffs, arrears forgiveness for low-income households) may differ again according to the type of private participation involved (e.g. public management and ownership, privately run but publicly owned, ownership transferred to private interests).

Addressing information problems

As underlined by Boyce (2002) distributional concerns may result from imperfect information and this can be due either to the lack of knowledge about the effects of pollution or to a lack of knowledge about their causes. Right-to-know legislation can help address the first problem, while the second can be improved by environmental education.

Policy actions that governments may take to remove information failures and barriers contributing to possible disparities in the distribution of environmental quality include the provision of information on exposure to environmental hazards to individuals and the facilitation of access to information publicly available, with the introduction of specific programmes or policies targeted at low-income households.

By providing environmental information to the public**,** governments can contribute to reductions in the exposure (improve the access) of individuals to environmental disamenities (amenities), in general. As noted above, this may be of particular value to disadvantaged groups such as low-income households. Measures taken to release public information on specific installations allow, in particular, a more informed choice concerning the choice of private housing according to the risk of exposure to environmental hazards.

The principle of right of access to environmental information by the public has been gradually adopted by almost all OECD countries through domestic legislation and/or of international legal acts. At the national level, such instruments include constitutional provision concerning the right of access to information, and law and regulations specifically dealing with environmental information. At the international level, initiatives include acts such as the 1998 Aarhus Convention on access to environmental information and public participation; the 1998 OECD Council Recommendation on Environmental Information; and the 1990 North American Agreement on Environmental Co-operation. At the European

Union level, several directives contain requirements for the disclosure and dissemination of environmental data[40] (OECD, 2001d).

The right to environmental information includes general issues such as providing legal basis for the right to information, informing the public on its right to environmental information, helping the public to obtain information, accessibility and quality of the information, informing the public on emission from specific installations. The latter aspect, on the promotion of public access to information from specific installations, appears to be of particular relevance when considering distributional issues.

In many OECD countries, legislation to develop public access to environmental information is already in place or is being prepared. Some examples of recent country initiatives to promote public information on specific installations are provided by Japan and Mexico. In Japan, the 1999 Law Concerning Access to Information held by administrative organs went into force, and the Law Concerning Access to Information held by independent administrative institutions was passed. In addition, under the 1999 Law for a pollutant release and transfer register (PRTR), data from specific companies can also be disclosed to any party upon request, and the government can publish aggregate data concerning quantities of chemical substances released and transferred in various areas (OECD, 2002d). The reform underway in Mexico to implement environmental right-to-know legislation is another example of current initiative in this direction. In 2001, a reform was passed calling for the creation of a mandatory Pollutant Release and Transfer Register (PRTR) system, such as the ones used in the United States since 1986, and requiring public access to information. In Canada, the National Pollutant Release Inventory (NPRI) [41] and Canadian Information System for the Environment both contribute to public access to information on exposure to environmental hazards (Dostaler, 2003).

The promotion of provision of specific environmental information to the public, allowing in particular households to know the level of environmental risk they are exposed to by local industry could contribute to reducing exposure to environmental 'bads' in general by increasing demand for environmental quality, and hence also among disadvantaged groups such as low income households. However, it will only have disproportionate effects on that group if they are more exposed to this type of environmental hazard. In addition, these measures can have a lesser impact on disadvantaged groups since they can be expected to be less aware of the availability of this information and to have more difficulty to access it if specific actions directed to them are not taken. In addition, even if low-income households are more exposed to this type of hazard, chances are that even if they are aware of the existence information on environmental hazards and have access to such information, in some cases they may not be able to change behaviour because of constraints in related markets (i.e. real estate).

Specific programmes or policies can also be introduced by Member counties to facilitate access to environmental information, with some actions specially targeted at low-income households including: the distribution of booklets presenting how to find available information which can be specially directed at low-income households; the availability of facilities to search for this information (e.g. computer facilities in municipal offices, etc.) and the provision of assistance for vulnerable persons, like low-income households; as well as free access to information through a toll-free numbers rather that information only available via written and paid request.

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40 The most important one is the 1990 EU Directive on Freedom of Access to Information on the Environment (90/313/EEC) that is being revised to implement the Aarhus Convention.

41 The NPRI Communities Internet Portal has been launched by Environment Canada in 2004 as a new tool to help the public better understand and access the national and local information about pollutant releases.

Addressing barriers and failures in associated markets

Besides policies that can be implemented by governments to facilitate access to environmental information, allowing low-income households to make an "informed decision", actions can be taken to address other possible determinants of disparities like barriers and constraints in associated markets. As noted earlier, characteristics of both the housing market and the labour market may for instance contribute to the disproportionate exposure of low-income households to environmental hazards by limiting their mobility. For instance, environmental improvements may affect the housing market (see Sieg et al., 2001). This has distributional implications, e.g. low-income tenants will have to pay a higher rent induced by the environmental improvement while richer property owners accrue the capital gains, as noted by Kriström (2003). Over the long-run, this often changes the distribution of income in a certain area, as low-income earners can no longer afford the increased cost of living caused by environmental improvements.

Thus, a policy aiming at reducing disparities in exposures to environmental hazards in a given area, for example, by restricting the siting of polluting activities in that zone, may be an inefficient way of reducing disparities in the longer term. It would be useful to factor in this type of possible side effect at the decision-making level. In such cases, policies targeted at low-income areas may be less efficient than more general policies associated with land use planning, which ensure that all households have acceptable levels of exposure to environmental bads and reasonable levels of access to environmental goods.

If there are concerns about the efficiency of home finance markets, policy-makers may in particular adopt measures to facilitate access to capital markets for low-income households who may face significant constraints in home finance or consumer credit. These measures may include preferential loans schemes targeted at low-income households. For instance, investment in energy conservation measures can be facilitated through such schemes. As a matter of fact, poor families tend to live in dwellings with a low level of energy performance. Premium loan schemes targeting low-income households have for instance been implemented in Germany for improving the energy efficiency of existing buildings (OECD, 2003c). Capital subsidy programmes targeting low-income households may also be implemented by governments to address capital market failures that could contribute to distributional concerns. The U.S and the U.K. (see the New Home Energy Efficiency Scheme–HEES) have adopted large scale capital subsidy programmes aimed at low-income households.

One drawback of these programmes is that they do not have a significant effect on rented housing where many low-income households live (OECD, 2003c). Moreover, if the programmes are not well-designed they can be costly. For instance, there is significant potential for 'free-riding' if efforts are not made to ensure that beneficiaries would not have undertaken the measures themselves in the absence of the programme. More generally, it can be difficult to set the level of benefits precisely at the point at which the 'marginal' decision to undertake a given investment is made. The information requirements can therefore be considerable, particularly when the beneficiaries are a heterogeneous group.

Addressing policy failures

Policy failures such as limited access of low-income households to the decision-making process, be it at the individual or collective level, are another determinant which may be related to possible disparities in the distribution of environmental quality (see 1.3).

To deal with these concerns, policy measures may be adopted by Member countries to promote access to political decision-making like encouraging the active representation of disadvantaged interest groups, such as low-income households, to siting decision of environmental disamenities (e.g. hazardous waste sites, airports). If differences in propensity to initiate collective action give rise to disparities, authorities may take steps to increase involvement such as technical assistance grants to communities

involved in siting or information provision. In a similar way, policy initiatives may be taken to facilitate public participation to decision process for the location of environmental amenities or protected areas (e.g. green belt, watershed zone). Along this line, one of the key lessons with the Korean policy on the restricted development zone (Green Belt) was the importance of public participation at an early stage of the policy process (Jeong and Nam, 2003). Policy Improvement Councils were set up consisting of representatives from the green zone residents, media and NGO's, academics and government officials, which lead in particular to the implementation of compensation schemes for the residents. Similarly, when designing the public policy on the designation of special watershed zones in Korea, a consultation process involving the different social groups concerned took place to help minimize the adverse effects on some groups.

The nature of the environmental liability regime and possibilities of access to courts in environmental matters may also have an incidence on the exposure of low-income households to environmental hazards, even though measures are not directly targeted at them. Firstly, tighter liability regimes tend to increase possibilities to sue firms responsible for the exposure of local communities to environmental "bads". The evolution in the field of environmental liability from a fault-based to a strict liability principle, and the principle of the reversal of the burden of the proof are examples. Access to court in environmental matters may also be facilitated by extending access to justice to environmental groups, just like in the New Finnish Environmental Protection Act which came in force in 2000.

In addition, measures may be taken by governments to address the adverse distributional effect on low-income households that may result from the system of compensation adopted when a firm (or other agent) is held responsible for adverse environmental impacts, as it is for instance the case when damages are awarded on the basis of lost earnings or productive losses. Monetary compensation that is sometimes proposed *ex ante* to communities to compensate for the negative externalities imposed by an activity[42] may also be designed to take into account possible related distributional concerns.

3-4 Timing of policy action and options available

Measures to deal with distributional concerns may be taken by governments at different stages: during the process of coming to a policy decision and/or once the decision is taken, at the stage of policy implementation.

In this section the range of measures available to decision-makers is presented in a descriptive manner. The important question of the possible adverse effect of some policy options on environmental effectiveness or economic efficiency will be discussed in section 3-5.

Taking into account distributional concerns when designing and/or assessing policies

Distributional effects have been specifically tackled by Governments when designing and/or assessing environmental policies (e.g. environmentally-related taxes) in a number of OECD Member countries including the Netherlands (i.e. energy tax), Germany, Denmark or the United Kingdom as will be discussed in further details in this chapter.

In order to factor distributional considerations "upstream", into the decision-making process, Member countries can take a number of measures such as adopting specific institutional arrangements or providing guidance to include issues related to distribution when assessing environmental measures.

[42] "Host community compensation" or "host fees" paid by the developer for the right to site a landfill within a community is an example (see Jenkins *et al.*, 2002).

Setting-up institutional arrangements

To account for possible adverse effects of policy measures on distribution, countries may adopt specific institutional arrangements such as providing a legal basis for addressing distributional aspects or setting up specialised working groups or committees either in an *ad hoc* way or on a more regular basis (see Box 2).

Box 2. Examples of institutional arrangements to account for distributional concerns

In the **United States**, distributional issues have been embedded in the policy making through a series of institutional arrangements since the early 90's. It appears to be one of the only countries where a compulsory legal framework has been adopted to address distributional effects. The U. S. Environmental Protection Agency (EPA) set up an internal working group, in 1990, to study the links between minority and low-income populations and exposure to environmental hazards. In 1992, an "Office of Environmental Justice[43]" (OEJ) was also established by the EPA to integrate environmental justice concerns into the environmental programs of the agency. A federal advisory committee was then created in 1993, the "National Environmental Justice Advisory Council" (NEJAC), to provide independent recommendations to the U.S. EPA. In addition, the 1994 Executive Order 12898 established the Interagency Working Group on Environmental Justice (IWG) to enhance coordination between federal agencies, requiring them to formally address issues of environmental hazards in low-income and minority communities and to develop 'environmental justice strategies'.

Denmark has set up a committee to assess the distributional impacts resulting from the implementation of the green tax reform in 1998 (particularly arising from household electricity consumption) and to evaluate options to address them (OECD, 2002a).

Providing guidance on environmental policy appraisal

More generally, policy-makers may factor social matters like distributional incidence "upstream", in the design and/or *ex post* evaluation of policies, plans or projects, by formalising guidance frameworks accounting for such impacts and by allowing for participatory procedures in the decision process. Distributional incidence of environmental policy may be factored in by decision-makers in the design and/or *ex post* evaluation of policies by formalising guidance frameworks accounting for social impacts such as distributional effects in policy appraisal.

A broad range of assessment methods are available to decision-makers to factor in social aspects like distributional considerations when gauging projects or policies (see Box 2). Some evaluation can be undertaken with special consideration for social aspects (e.g. distributional effects) and may be used more systematically when significant distributional concerns are expected to be attached to a project or a policy.

Social aspects can be included in Environmental Impact Assessments (EIA) which are generally carried out to appraise initiatives for large-scale facilities and infrastructure (e.g. hydroelectric projects), likely to cause significant environmental impacts. They may also be incorporated into Strategic Environmental Assessment (SAE) as illustrated by SAE applied in the United States or Canada[44].

43 Originally named the Office of Environmental Equity.

44 One of the most recent SEA legislation in Canada was passed in 1999.

Besides, certain approaches explicitly address social concerns like Social Impact Assessment (SIA) where impacts can be appraised according to socio-economic indicators like household income level. The Social Impact Assessment (SIA) is a method aiming at gauging the consequences to human populations of projects, programmes and policies with the following bottom-line question: "who benefits and who loses?". The method is usually applied to large infrastructure projects, but can also be applied to projects at urban scale. In the United States, the National Environmental Policy Act (NEPA) of 1969 is generally regarded as the legislative mandate for most SIA. An explicit legal basis for social impact assessment can also be found in EU countries such as Finland.

In addition, appraisal methods focusing on the economic evaluation of policy, such as cost-benefit analysis (CBA), can allow for the incorporation of distributional considerations by assigning weights to the various gains and losses for different socio-economic groups. In the U.K., for instance, the Treasury Green Book on the use of evaluation in central government (HM Treasury, 2002) provides guidance on how distributional impacts can be brought into the cost-benefit analysis by using distributional weights (see Box 3). A benefit or cost accruing to a relatively low-income family would be weighted more heavily than one accruing to a high income family. The possibilities to factor the distributional impacts of environmental policies into decision-making by using distributionally-weighted CBA are discussed in further detail by Pearce (2003). This approach has some limitations, like the difficulty of obtaining the relevant information, and raises some questions such as whether or not an individual project should be used for correcting wider distributional concerns (DETR, 1998). Also, equity is a multi-dimensional concept and there are a variety of criteria that might guide burden distribution.[45]

Projects and policies may also be assessed in frameworks aiming at covering simultaneously economic, social and environmental impacts and looking at their possible interactions. Such an integrated approach generally referred to as "Sustainability Impact Assessment" (SIA) explicitly addresses distributional impacts. This methodology is currently being considered in a number of countries as well as at the EU level. The Netherlands Commission for Environmental Impact Assessment has recently been drawing up a standard format for this approach, and in the United Kingdom an Integrated Policy Appraisal (IPA) is being developed and tested. The proper contours of this methodology are still being debated, raising questions such as how to link it with other existing evaluation methods (e.g. EIA, Strategic Environmental Assessment[46] (SEA), Regulatory Impact Assessment (RIA)) and where it can be applied. Many support the view that the different instruments should be integrated into an Integrated Assessment (IA) tool requiring a more integrated approach of policymaking.

Social aspects like distributional impacts may also be addressed at an early stage, in the analysis of future projects, by allowing for public participation in the decision-making procedures, an approach which has been examined in previous OECD work (OECD, 2002b; OECD, 2001c). Thus, the involvement of potentially affected groups is considered as a key principle in some project assessment methods like Social Impact Assessment. The case of noise pollution is illustrative with the organisation of public hearings over airport noise to determine how aircraft takeoffs and landing may affect the residents living in the airport area. In the United Kingdom, for instance, the government held a consultation in 2003 for the design of the future airport policy in London and the South East of England over the next 30 years. Another example is provided by the recent consultation organized by the British government on the potential for using economic instruments to improve household energy efficiency, and where distributional issues were considered as key in the choice of the instrument (Davies and Dunn, 2003).

Specific guidance documents may be prepared by policy-makers to provide a framework to address distributional issues "upstream" of the implementation of a project or a policy, at the international,

45 See chapter on "Equity and Cost Benefit Analysis" in OECD (2004a).

46 See for instance the SEA Directive (2001/42/EC) adopted by the EU in 2001.

national, or regional level like the guidelines prepared by the U.S. EPA to tackle issues of 'environmental justice' (see Box 3).

Box 3. Examples of guidance on policy appraisal addressing distributional issues in OECD countries

At the **European Union** level, the Commission established a new integrated framework for impact assessment with the objective to ensure that social aspects like distributional issues are considered for each policy proposal, together with environmental ad economic impacts. One of the potential social impacts highlighted is the "distributional implications such as effects on the income of particular sectors, groups of consumers or workers etc". This extended impact assessment is to be performed for major proposals from 2004 onwards (COM(2002)276).

The **United Kingdom** has formalised central government advice on how to take account of distributional implications in policy appraisal in the new edition of the Treasury Green Book (HM Treasury, 2002). This guidance applies also to the retrospective evaluation of a policy, programme or project and its completion or revision. According to the significance of the distributional incidence across different groups, including income groups, action may be required to modify the policy in question (Davies and Dunn, 2003).

In the **United States**, the guidance documents for incorporating environmental justice considerations into developing environmental impact statements (EIS) or environmental assessment (EA) issued by the Environmental Protection Agency (EPA) are being implemented.

Addressing distributional concerns at the stage of policy implementation

Once the decision is made to adopt a given environmental policy that might have distributional impacts on low-income households, two types of actions distinguished earlier are available to governments to address distributional concerns: mitigation and compensation measures[47]. Mitigation refers to reducing the impacts of the programme *ex ante*, so that potential distributional impacts do not occur. Compensation refers to aid to particular groups, low-income households in our case, *ex post* so that they are (at least partly) "made whole" (OECD, 1994).

It should be noted that the scope of options available to policy makers to deal with possible distributional impacts will not be the same according to the type of instrument used, and in particular whether or not the instrument used generates a revenue to distribute or not, as in the case of economic instruments such as taxes or auctioned tradable permits.

Distribution of environmental quality

To address concerns more specifically related to disparities in the distribution of environmental quality, mitigation measures may be introduced by governments such as the adoption of spatial restrictions on the siting of sources of pollution and waste in order to reduce the exposure of lower-income to environmental hazards. Measures may also be taken to involve the community in the permitting decisions. An example of spatial restriction is provided by the United States where the environmental justice bills, including the "Environmental Justice Act" of 1992, the "Environmental Equal Rights Act" of 1993, and the

47 The previous publication (OECD, 1994) was focussing on mitigation and compensation measures when examining the policy option to address the distributional effects of economic instruments.

"Public Health Equity Act", include provisions to prohibit or strongly discourage industrial and waste facilities from operating in certain low-income areas (Lambert and Boerner, 1997).

Compensation measures may also be taken, *ex-post*, to deal with distributional concerns. To address possible disparities in the distribution of environmental quality, technical or financial assistance can be provided to low-income households to reduce exposure to environmental hazards (e.g. air pollution, noise), like for instance to support the installation of double glazing against noise in dwellings. Financial support might also be given to compensate for possible economic losses arising from the siting or expansion of hazardous facilities in a given area. An illustration is provided by Korea where, under the law enacted in 1995 to consider the distributional issues arising from the operation of waste treatment facilities, financial assistance is provided to compensate residents which varies according to the distance from the site (Jeong and Nam, 2003).

Distribution of financial effects of environmental policies

Different options are also available to governments to deal with possible disparities in the distribution of financial effects of environmental policies. For instance, to alleviate the burden of environmentally-related taxes for low-income households, mitigation measures would include tax exemptions. However, such measures might affect the economic efficiency and environmental effectiveness of the policy as will be discussed in further detail in section 3.5.

When the implementation of an environmental policy is likely to generate revenue, as is the case with the use of economic instruments such as environmentally-related taxes or auctioned tradable permits, compensation measures may be taken "within" or "outside" the instrument. In other words, distributional impacts may be addressed using the revenue generated by the instruments itself for direct financial assistance or tax refunds directed at low-income households or benefiting particularly to such groups. An example of this later option is provided in Switzerland with the taxes on VOC and on the sulfur content of heating oil which are refunded to households on a per capita basis (OECD, 2001).

However, potential effects may also be addressed through other channels which are not related to the point of incidence of the policy. Examples include the reduction of other taxes or the provision of direct financial assistance. Norway provides an illustration of tax shift with two-thirds of the increased revenue resulting form the households electricity taxes increases in 2000 being transferred back to customers through increased standard allowances and minimum allowances in income taxation (OECD, 2001). As underlined earlier, the distributional effect of the measure will much depend on the regressivity of progressivity of the income tax structure.

Box 4. Examples of measures to address disparities in the distribution of financial effects of environmental policies in OECD countries

To account for possible income distribution concerns resulting from the implementation of the **German** Ecological Tax Reform, the reform was embedded in a comprehensive Federal Government tax reform providing in particular for a reduction of pension insurance contributions and an increase in child benefit payments.

To compensate for the doubling of the energy taxes in 1999-2001 in the context of a general tax reform in the **Netherlands**, a whole set of compensation measures were provided to households through changes in personal income tax.

In **Denmark**, the increase in the energy taxes decided in the framework of the tax reform phased in from 1998-2002 was introduced alongside reductions in the personal income tax for lower and medium incomes as well as compensation.

Distribution of the provision of environmental public services

To account for distributional concerns associated with the provision of environmental public services (i.e. water, energy or waste services) policy options to mitigate possible disparities will include tariff-related measures designed to meet equity objectives (e.g. increasing-block tariffs or capped tariff) by means of subsidies, tax reductions or exemptions (e.g. VAT rates). Australia provides large rebates on water bills to low-income households through the concessions schemes funded at state government level (Herrington, 2003). The possible adverse impact of this type of measures on efficiency and effectiveness will be addressed later (see section 3.5).

Other possible options include demand-side management programmes with, for instance, measures for water conservation specially directed at low-income households which are adopted in various countries like Australia, the United Kingdom or the United States. Programmes to curb energy consumption directed at low-income households can also be developed. Such initiatives are found for instance in the United Kingdom[48], the United States, or Belgium where Wallonia grants a subsidy to low-income households for energy efficiency improvements (OECD/IEA, 2001b). Countries may also oblige public utilities to promote the energy efficiency of domestic consumers with a special focus on low-income households, as is the case in the United Kingdom under the Utilities Act which imposes such obligations on electricity and gas suppliers from 2002.

Policy options available to decision-makers to compensate possible distributional concerns related to the provision of environmental services include direct income support measures, service vouchers, payment assistance in the form of rephrasing and easier payment plans, special loan facilities and arrears forgiveness. An example is provided by the Slovak Republic where since 2000, under the Act of Housing Benefit, the government can contribute to the payment of all housing-related expenditures, including water charges, for low-income households (OECD, 1999).

Box 5. Examples of recent measures to address possible disparities in access to environmental services

In **Italy**, the electricity reform which entered into force in 2003 provides a special tariff to low-consumption households (OECD/IEA, 2003a).

A new "social tariff" has been introduced in **France** in 2004 for electricity. According to the decree, the electricity bill of low-income households (i.e. annual resources below 5.520 euros) will be reduced by 30 to 50% for the first 100 kW/h on a monthly basis.

In the **United Kingdom**, under the Warm Front launched in 2000 to replace the former Home Energy Efficiency Scheme (HEES), financial support is provided to low-income households for home insulation and heating improvements. The government has allocated over £600 million to the scheme up to 2004 (OECD/IEA, 2003b).

The distinctions made in this section can be useful to review possible policy options available to deal with the possible adverse impacts of environmental policy on income distribution though they do not draw exclusive categories and there can be some overlap when examining measures taken by OECD countries. For instance, when adopting an environmental tax, the introduction of a tax exemption for low-income households can be characterised as a mitigation measure addressing directly income distribution concerns within the instrument.

[48] Measures taken in the framework of the New Home Energy Efficiency Scheme adopted in 2000 (OECD, 2002c).

3-5 Addressing equity while ensuring economic efficiency and environmental effectiveness

As mentioned previously, equity is only one criterion for appraising environmental policy among others such as environmental effectiveness, economic efficiency or administration and compliance costs (see OECD, 1997). When addressing distributional concerns associated with the implementation of environmental policies, decision-makers may take into consideration the various possible interactions between distributional effects, environmental effectiveness and economic efficiency, which may both contradict and reinforce one another. As noted earlier, a different approach may consist in considering that equity and efficiency objectives should be treated entirely separately (see section 1.2).

Addressing distributional concerns while preserving economic efficiency

There is no necessary link between the need to keep the marginal incentives the same (for reasons of economic efficiency and environmental effectiveness) and interventions designed to mitigate adverse distributional impacts. Indeed, measures to address distributional concerns of environmental policies may have three types of potential effects in terms of economic efficiency and environmental effectiveness: (i) keep the marginal incentives the same – for instance by implementing a tax and paying a lump sum to low-income households; (ii) keep the incentive but change its modalities (e.g. escalating block tariffs); or (iii) remove the incentive altogether. In terms of efficiency, the first option is the best, but may not be politically acceptable. The third option can never be efficient, is very often not effective and is inconsistent with the Polluter Pays Principle (PPP).

The last two types of effects (ii) and (iii) may result from the adoption of various mitigation measures which, as noted earlier, incorporate a reduction in the distributional impacts of the instrument on low-income households by provisions in the legislation itself (e.g. tax exemptions and rebates, changes in tariff structure[49]). The first effect (i) corresponds to the use of compensation options (e.g. reducing other taxes, introducing payment transfers) which are to be preferred over mitigation measures, because the incentives are maintained (OECD, 2002). Well designed tax refunds are a typical compensation measure which does not affect incentives associated with the rate or structure of the taxes. [50]

Addressing distributional concerns while ensuring environmental effectiveness

Policy options taken to deal with possible income-distribution problems associated with the implementation of an instrument may have an adverse effect on the environmental effectiveness of the measure. This might be the case, in particular, with the adoption of mitigation options to alleviate the burden on low-income households like tax exemptions and rebates. The reduction of the tax rate applied in Germany to particular heating systems, which has been socially motivated, has negative environmental impacts, for instance.[51] Similar mechanisms can arise from compensation measures. The case of the German ecological tax reform is illustrative as the heating allowance provided to lower income households to compensate distributional effects resulting from the sharp increase in heating oil prices is likely to lower the incentive for energy efficiency, and hence to have counter-productive effects from the environmental perspective (Schwermer, 2003).

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49 For resources pricing (e.g. water), tariff structures may be designed to meet distributional objectives while keeping some incentive, though changes compared to the normal structure of the tariff. An example would be the use of increasing-bloc tariffs in which the marginal price for a cubic meter of water increases with consumption, which is for instance applied in Italy, Greece, Spain, Portugal and Belgium.

50 The measure taken by the German government with the entry into force of the ecological tax reform provides an illustration with the granting of a one-time financial support of DM 5 per square meter of leaving space for low-income households (OECD/IEA, 2001a).

51 The reduced-cost night-time electricity heating systems targeted by the measure consume much more primary energy than oil or gas heating systems due to the transformation loss while electricity is generated (Schwermer, 2003).

Addressing distributional concerns related to resource pricing may also affect the environmental effectiveness of measures. Herrington (2003) shows that the use of minimum charges can seriously affect any water conservation message. In Ireland, the domestic water charge was abandoned altogether. Examples of charge exemptions are provided by the Belgian experience where families in receipt of a minimum income in Flanders are exempted completely from charges for the domestic discharge of waste water. In a similar way, the Dutch system allows the exemption of low-income households from municipal waste collection and sewage taxes (OECD, 2001). Conversely, policies aiming at developing the use of individual water metering which allow for the measurement of individual water consumption promote a more rational use of water than flat-fee system, but can have distributional incidences.

Addressing distributional concerns while limiting administrative costs

Some tensions can also exist between equity objectives and the administrative and compliance costs of the policy. Thus, pursuing distributional goals may call for a targeting of policy measures on some very specific household groups; a process that is likely to entail significant administrative costs.

Changes in environmental quality, which could stem from the implementation of measures aiming at preserving environmental quality in a given area, or on the contrary result from the siting of polluting activities, may have different financial effects among household groups. This effect is in particular likely to vary according to whether households own or rent their dwellings. In the case of an improvement in environmental quality, the owner can benefit from capital gains, while he is likely to face an increase in rents in the second case. Timing aspects are also significant and the financial effects will not be the same if households move to the area before or after the change in environmental quality. In the former case, lower rents or prices in the housing market can be regarded as a form of compensation for lower environmental quality. The usefulness to target policies on specific households groups when dealing with distributional concerns is provided by the Korean experience. Data on the percentage of property-owning residents in the area versus residents renting their dwelling, provided useful inputs for the revision process of the regulation on Restricted Development Zone[52] (RDZ) that took place in 1999, and where it was decided that owners only would receive financial benefits (Jeong and Nam, 2003).

In other cases, it might be relevant for governments to target measures addressing distributional concerns on other variables such as the occupational status of households. An example is provided by the German ecological tax reform, where an assessment of the effects of the reform according to social status or age of households indicates that pensioners and some older people in lower income brackets have not been compensated by other reforms (see Bork, 2003). Targeting policy measures according to the size of the household may also prove to be useful, as suggested by analysis on the equitable pricing of water services (see Smets, 2003).

So, while it may be relevant to target policy measures dealing with distributional effects taking into account the various expected effects of the policy according to different household groups characteristics (e.g. occupational status, age, home owners or rented, size of the household), significant administrative costs can be associated with the design and implementation of well-targeted policies.

[52] The concept of Restricted Development Zone was borrowed from the "Green Belt" in the UK. The policy was first introduced by the Republic of Korea in 1971 to contain urban sprawl and to protect the natural environment around urban areas.

3-6 Using policy mixes to tackle distributional concerns

The combination of environmental policy measures to reduce a specific environmental damage or preserve a given natural resource is of common use in OECD Member countries though generally little studied[53]. To tackle distributional concerns associated with environmental policy, three broad types of options are available to policy-makers: using environment-related policy instruments, implementing instruments pertaining to other public policies, or adopting a "mixed" approach combining environmental policies and other public policies. The various combinations of instruments available to governments to tackle distributional implications of environmental policy are successively examined.

Mixing environmental policy instruments

When introducing an economic instrument generating revenue such as an environmentally related tax, government may address distributional issue within environmental policy by, for instance, using the proceeds to adopt environment-related financial support measures targeted at low-income households or benefiting them particularly. Some measures adopted by the German government to deal with the possible distributional effects associated with the ecological tax reform are illustrative. The programmes funded from the recycling of the eco-tax revenue comprise for example a financial incentive provided to consumers to facilitate the switchover from reduced-cost night-time electricity heating systems to environmentally safer heating systems which is expect to benefit low-income households more specifically. In addition, some compensation measures to overcome the sharp increase in mineral oil prices have been introduced like the Act on kilometre allowance[54]. In addition, income support measures have been taken, with the granting of a one-off heating allowance[55] to households in need, to compensate for the tax rises (Schwermer, 2003).

Distributional impacts may also be addressed outside the instrument but within the scope of the policy that can potentially cause distributional concerns. These adverse effects may for instance arise from the implementation of a direct regulation so that measures must be financed through general revenue. Another example is the case of resource pricing where tariff measures may be used to address affordability problems, such as capped tariff rebates or increasing-block tariffs for water, but where targeted income support measures (e.g. water coupons) can also be introduced. This option might be chosen in a situation where the government would not trust other channels to address distributional concerns as could be the case with the provision of a basic good like water.

Mixing environmental policy and other public policies

When considering policy mixes, a wider perspective can be retained, looking at the combination of environmental policies and other public policies. Distributional concerns can be addressed within the instrument but outside of the policy that has caused the concern (i.e. environmental policy); in this case, the revenue generated by the instrument may be disbursed through measures which are not related to the environment. To improve the distributional effects of the ecological tax reform, in addition to using environmental policy instruments, a range of measures have been taken by the German government such as

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53 Recent OECD wok on voluntary approaches and tradable permits (OECD, 2003b; OECD, 2004) have examined the use of these instruments in combination with other instruments and highlighted that more detailed analysis of the case for the use of policy mixes was clearly required.

54 The kilometre allowance so far valid only for employees to travel in motors cars was replaced in 2001 by a kilometre allowance valid for all means of transport. This transition is expected to have positive distributional effects since public transport tends to be used more frequently by low-income households (Schwermer, 2003).

55 The allowance amounts to €2.56 per square meter of living space.

the use of tax revenues to reduce pension insurance contributions. Direct income support measures to low-income households are another example.

Distributional concerns may also be addressed both outside of the instrument and outside of environmental policy. For instance when tackling distributional implications of a direct regulation by adopting measures outside of the scope of environmental policies. These measures may pertain to a wide range of other public policies, sometimes closely related to environmental policy, such as: housing policy, land-use policy, liability policy, information policy or credit policy (see section 3.3).

The implementation of a combination of instruments related to different areas of policy making to address environment-related distributional issues may imply the co-ordination of a variety of administrations representing separate ministries and intervening at different geographical levels (local, regional, national, international). Ensuring that these policy packages are effective, and that there is coherence between policy and institutional frameworks, comes along with setting up of appropriate institutional arrangements.[56]

However, if policy mixes may, in some cases, complement weaknesses of existing policies, there are also possible drawbacks associated with their use and some conditions exist for the economic efficiency and environmental effectiveness of policy mixes which need to be examined (see OECD, 2003b). This holds true when combining policy instruments to address distributional concerns.

3-7 Concluding remarks

This synthesis report has highlighted three main conclusions. First, all environmental policies are likely to have distributional impacts. While these effects have a greater "visibility" in the case of economic instruments which are often found to be regressive, they can also arise when using direct regulations (e.g. energy efficiency standards). Second, though the distributive burden of environmental policies is generally assessed with a focus on direct financial effects, taking into account indirect effects may have significant implications on the results. These indirect impacts may for instance result from input-output linkages (e.g. effect of a carbon tax on the price of manufactured goods) or revenue recycling effects (e.g. through the channel of public finance). They may also take place through associated markets like the labour market (e.g. transition impacts in some sectors) or the real estate market (e.g. changes in the quality of the environment reflected in the price of housing). Third, policymakers confront important choices when considering how best to respond to these equity concerns. In particular, they need to consider simultaneously how different groups of individuals will be affected by the financial burden of environmental policies and a change in environmental quality (directly and indirectly through associated markets like real estate market); and, when introducing measures to mitigate these distributive impacts, they need to retain the incentive effects of the environmental policy.

The report points to a number of areas where additional insights would represent considerable advance for the formulation of policy recommendations to address the distributional effects of environmental policy. It highlights, in particular, the importance to consider the differences in responses across households when designing environmental policies. It is important not to see households as a homogenous group. Improving the understanding of individual household behaviour in key areas of consumption such as energy, food, water and waste generation would significantly contribute to better integrate the social, environmental and economic pillars of Sustainable Development in the future.

[56] For instance, in the case of Korea, to address distributional concerns related to the designation of Restricted Development Zone, the government integrated the Law on the Management of Land Use and the Law on Urban Planning into the Law on the Planning and the use of Land (Jeong and Nam, 2003).

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ANNEX – DETAILED CASE-STUDIES

1. Case-study on the German Ecological Tax Reform

The distributional effects of environmentally related tax reforms were examined by Bork (2003) in the light of the German Ecological Tax Reform implemented since 1998[57].

Objective and background

The analysis concentrates on the financial first order effects of the reform on private households. The changes in the burden of the ecological taxes and the social security contributions are analysed. In addition, the distributional effects of a major reform in the income taxes, including increased child benefits, are examined.

In the study, a tax is said to be regressive if the average tax rate falls with income. It is proportional if the average tax rate is constant and it is progressive if the average tax rate rises with income.

The reform consists of a gradual increase from 1999 to 2003 in tax rates imposed on fuels, heating oil, natural gas, and on electricity tax introduced in 1999. The revenue raised by the taxation system implemented has been recycled with an aim to address distributional concerns through the reduction of pension insurance contributions. These transfers allowed reducing the contribution rates to the pension system from 20.3 per cent to 19.5 per cent of gross income in 2003.

To assess the dimension of the increase in ecological taxes since 1999, the analysis concentrates only on the changes between 1998 and 2003.

The methodology used

A microsimulation model is used. The model is capable of analysing direct taxes, indirect taxes and social security contributions and transfers simultaneously.

The direct tax module consists of patterns for the income tax, the property taxes and the tax on cars. Value added tax, gasoline tax, electricity tax, tobacco tax, insurance tax and taxes on alcoholic beverages are parts of the indirect tax module. The social security contributions module contains the designs of the old-age insurance, the health insurance, the unemployment insurance and the nursing care insurance. The module for transfers covers child and housing benefits, education benefits, social aid and old-age benefits.

The strength of the microsimulation model is to provide comprehensive data on public expenditures and tax receipts with, for example, information about exemptions and deductions to compute the German income tax quite exactly, as well as on consumer expenditures. For instance, data are available

[57] On the distributional effects of the ecological tax reform, see also the paper prepared by Schwermer (2003) as the Germany's contribution to the Workshop on the "Distribution of Benefits and Costs of Environmental Policies", 4-5 March 2003.

on consumer expenditures of natural gas, diesel, petrol or electricity to calculate the ecological taxes for each household.

In contrast to macroeconomic models behavioural effects derived from the equations of supply and demand are not included in the microsimulation model.

Distributional effects

The microsimulation study analyses first the distributional effects of the German environmental tax reform. The impact of the ecological tax burden shows a high variation within different income groups, especially in the low income bracket for gross income up to annually 50, 000 Euros.

The main finding (looking at average changes in tax burden of the ecological tax reform by type of tax) is that the tax on electricity[58], on natural gas and on heating oil have clear regressive effects. On average, the tax burden of each ecological tax does not exceed one per cent of disposable income. For taxes on motor fuel the result is different. Up to the income bracket 25,000 to 30,000 Euro there is an increasing tax burden in per cent of disposable income. With gross annual income higher than 30,000 Euro, the relative tax burden decreases.

In addition to changes in ecological taxes, the use of the revenue is taken into account in a second stage. The impacts of the reform are measured across different dimensions such as the distribution of households over income, among different household types, depending on the social status, households residing in rural and in urban, and between different generations.

Distinguishing between the sizes of the households, nearly all of them are – on average – confronted with a regressive effect of the reform. Only for the two-person households, there is a small progressive effect from the lowest to the second income bracket[59]. When looking at the impacts of the reform depending on the social status, results appear contrasted. Workers and employees with a gross income between 20,000 Euro and 100,000 Euro are on average less affected by the ecological tax reform than all the other groups. In this case, the reduction of the social security contributions mitigates the higher tax burden. Also, there is a clear picture of the impact of the ecological tax reform across family types with the average burden of the reform rising across almost all income brackets with the number of people living in the household. Besides, considering the impacts by residential area, the study shows that households in a city face the lowest burden from the ecological tax reform. Lastly, examining the effects of the ecological tax reform by the age of the households, the study concludes that the age does not have any influence on the distributional effects due to the ecological tax reform in the income brackets between 25,000 Euro and 40,000 Euro. In this range almost all households face, on average, the same weakly regressive effect while for the income brackets up to 25,000 Euro, the results differ. The relative burden increases with the age of the head of the household. The group of households whose head is more than 65 years does not seem to profit from the reduction of the social security contributions.

Looking at the impacts of the ecological tax reform, in per cent of disposable income, the study shows that, in most cases, households face the regressive effects of the reform even when the reduced social security contributions are considered. Nearly all households are negatively impacted with only 8.8 per cent of all households gaining from the reform. The maximum gain is 0.8 per cent of disposable

[58] By abolishing the tax rebate for storage heaters, the burden from a tax on electricity would rise especially for households in lower income brackets. This rebate mitigates the impact of taxes on electricity for about ten per cent of all households who have storage heaters.

[59] In this case, the progressive effect of motor fuel taxes predominates the effects of other types of ecological taxes.

income. The maximum loss is about 10 per cent of disposable income. Hence, gains are much smaller than losses. But, on average, the loss is small (0.7 per cent of disposable income).

The study also examines the effects of the income tax reform. This includes, in particular, a large reform of the income tax from the year 2000 with a net relief for the households. In addition, the government increased significantly the child benefits between 1998 and 2003 for the first and second child. These reforms were not designed to compensate households which are negatively affected by the ecological tax reform, but this is embedded in a comprehensive tax reform package.

Embracing the income tax reform into the analysis changes completely the picture of the distributional effects. Only households in the income brackets up to 20,000 Euro face a burden from the ecological tax reform in spite of the income tax reform. Above these incomes brackets, all households have to pay less taxes than before the reform.

When including the increased child benefits into the observation, the results show that, on average, only households with a gross income up to 15,000 Euro are burdened by these two tax reforms, but only with less than 0.5 per cent of their disposable income. Examining the total distributional effects of the German reforms according to social status reveals that only some pensioner households, as well as a few unemployed, students and other non employees face on average a higher burden after all reforms. Self-employed, civil servants as well as workers and employees face on average a higher disposable income after considering all the reforms. At last, differentiating by age of the head of the household, the study concludes that middle aged heads of households (from 30 to 45 years) gain over the whole income scale from the reforms. Especially in the lower income brackets the increased child benefits more than compensate the burden of the ecological taxes. If the age of the head of the household is between 45 and 65 years, the relief of the reform is usually smaller than the relief of middle aged heads of households due to a lesser number of children in these households.

Concluding remarks

The empirical findings show slight distributional impacts of the ecological tax burden which vary according to the category of gross income considered. On average, these effects are weakly regressive, less regressive than the German added value tax for instance. However, the tax on motor fuel is progressive in lower income brackets.

The reduction of the social security contribution increases the regressive effect as the measure mainly benefits the middle and upper income classes. When examining the effects by distinguishing between social status, type and size of households as well as the residential area or the size of the head of the household, more examples of progressive effects are given. It is to be noted that the regressive effects of the ecological tax reform might be overestimated in general in the result provided by the microsimulation since the behaviour response of households are not taken into account.

However, most households are compensated by other reforms, although the government did not implement a reform specifically designed to correct for the distributional effects of the ecological tax reform. In particular, the increased child benefits partly offset the burden for households in lower income brackets. The income tax reform neutralises the burden of the ecological taxes in most cases. Only pensioners and some older people in lower income brackets are not compensated from other reforms. These people usually do not pay income taxes and do not profit from the child benefits. But, due to the variance of the effects, there is no guarantee that no one will be burdened by the ecological tax reform, although some reforms have net reliefs.

2. Case-study on Air Quality Regulations in the United States

The empirical study prepared by Bae (2003) examines the distributional impacts of air quality regulations in the light of two cases: smog controls in Los Angeles and toxic air releases in Houston and Los Angeles.

Distributional Impacts of Environmental Policy Instruments

The paper reviews the possible distributive effects of selected measures to reduce mobile source pollution. Direct regulations such as mandated emission equipment (e.g. smog emissions equipment) have a probable regressive impact since their cost varies little with the cost of the vehicle. However, the distributional consequence of mandated equipment will not be the same when the costs of mandated environmental technology fall directly on industry. In addition, the way the policy is financed, for instance out of general revenue or dedicated sales tax increments and the distributional characteristics of these measures has an incidence on the distributional effects of direct regulations. For instance, with the regressive nature of sales taxes and a probably regressive tax system, the use of environmental direct regulation appears to be almost invariably regressive in the US. The expected regressivity of various incentive-based measures such as emissions charges or road pricing has been highlighted too with a stronger impact for the former because of the propensity of low-income households to drive older and less well maintained cars; also whether it is an emission fee uniform per mile or a one-time emission fee paid upon purchase proportional to lifetime emissions affects the impact. The regressivity/progressivity of gasoline taxes depends for instance on how fuel consumption varies with income or the way the instruments has been designed and implemented. The possibilities to address distributional concerns through revenue recycling have to be taken into account as well.

Air Quality Regulations in Southern California

The first case-study examines the distributive effects of regulations to control smog in Los Angeles. This empirical study provides interesting insights since distributional studies on exposure to environmental hazards generally focus on point sources pollution, which have a local impact, and only a few look at exposure to ambient air pollution for which measures to improve region-wide air quality have to be implemented.

Southern California has been the most aggressive region in the United States for direct regulation of air pollution, especially after the late 1980s when a successful Federal lawsuit galvanized the Air Quality Management District into a much tougher stance. The result was stronger regulations and much higher control costs than elsewhere in the United States. NO_x reductions in Southern California were for instance five times more costly[60] than the national average (Lee, 2002). The State of California applies stronger automobile emission controls since the early 1970s, and still leads the way with CO_2 controls to be imposed soon. In general, the burden on the poor may be expected to increase as the costs of compliance rise.

The study looks at the aggregate cost and benefits of air regulations, an approach on which available data tend to be scarce, incomplete[61] and outdated. The methodology used involves estimating a Net Welfare Impact (NWI) function for individual households that added up the benefits and costs of air

60 At $25,000 per ton.

61 The estimate on the aggregate costs and benefits of air quality regulations made by AQMD (1988) in the specific case of Southern California refers only to the direct regulatory control costs incurred by industry. These tend to swell as pointed out by Gordon and Richardson (1988) when taking into account other costs like indirect and induced impacts of the control costs, the administrative costs, the burdens on consumers in terms of restricted choices and most important, the congestion costs.

quality improvement by income group, location and race. The NWI function is calculated taking into account health benefits, housing impacts, visibility benefits, unemployment risk, price impact and tax changes.

One of the key finding of the study is that low-income households, and especially homeowners gain most. Health benefits and, for homeowners, the windfall property value gains, swamp the costs of higher prices and taxes and the unemployment risks.

The price impacts of air quality regulations are regressive, however, varying from 5 percent of income for household with a gross annual income of $25,000 to about 3.1 percent for the highest household income group. The price impacts ripple through the local economy, but the transportation expenditures are the most drastically affected.

The tax incidence are also potentially significant, although less burdensome because many of the air quality regulations are self-financing. Assuming that tax requirements are evenly split between sales taxes and a higher gasoline tax, the tax incidence would vary from 3.5 percent for the $25,000 household to 1.75 percent for the highest household income group. Most of these revenues would be for transport-related air quality controls, such as public transit investments.

In conclusion, the costs of air quality regulations tend to be regressive, but the benefits are progressively distributed. The high costs of air quality regulations are outweighed by the benefits in the form of favourable health effects and capitalized increases in house values. Low-income households are more likely to live in polluted neighbourhoods where air pollution is capitalized in low housing prices, and a surprisingly large percentage may be homeowners rather than tenants. Also, gains in higher property values are more important than the unemployment risks associated with pollution control costs. It should be noted however that Los Angeles is an extreme case, and all the estimates would be lower in other U.S. metropolitan areas. Also, even in Los Angeles, the estimates would be much lower today because of significant improvements in air quality in recent years.

Toxic Air Releases in Houston and Los Angeles

The second case-study compares the distribution of exposure to toxic air releases in Houston and Los Angeles which rank among the most polluted cities in the United States.

The results show that in Houston, TRI sites are found disproportionately in low-income Zipcodes. In Los Angeles, on the other hand, the results are different. Household income is again a significant predictor of exposure as in Houston but with a much higher degree of predictive power. Minority population shares and income levels are more closely correlated than in Houston. When both minority population shares and median household income levels are introduced in the same equation, the result remains the same in Houston (only income is significant), but in Los Angeles County only the minority population share is significant. The results join the debate in the literature whether race or income is a better predictor of proximity to environmental hazards.

Concluding remarks

The study shows that the costs of air quality regulations tend to be regressive. On the other hand, the benefits are progressively distributed since, given their location, lower income households experience the largest improvements in air quality. The analysis also confirms that toxic air releases have regressive equity impacts.

3. Case-study on the Provision of Water Services in OECD Countries

Distributive concerns can arise in the provision of environmental-related services such as water services, residential energy services or waste collection services. The case study prepared by Herrington (2003) focuses on the distribution of costs and environmental impacts of water services in OECD countries. It builds on the results of the project on Social Aspects of Water Pricing undertaken under the guidance of the Working Party on Global and Structural Policies (OECD, 2003).

Objective

Looking first at whether affordability is perceived as a concern in OECD countries, the study then presents data relating to the burden of piped water charges across the income distribution in eight countries. Secondly, the distributional implications of present commonly-used means of financing piped services in OECD countries are examined, before reporting on the use of tariff-related and income-support measures to address affordability questions.

Perception and Measurement of Affordability

An exploration of affordability perception suggests that household water affordability is regarded as a significant issue in less than ten countries out of the 22 for which it was possible to obtain a tentative view. Mapping the results against whether specific measures or tariff structures to address affordability problems are in place shows that those countries with perceived affordability problems have all taken mitigation measures.

Using micro-affordability measurement techniques, water charges burdens are measured across income groups in eight OECD countries. Average household water charges are expressed as a proportion of household income, usually disposable income. The results suggest that the percentage of water charges burden on households declines significantly as we move up the income scale, as would be expected for a utility service where basic water uses continue to predominate, and for which the array of possible luxury demands remains relatively narrow. However, the rate at which the burden declines as income rises varies enormously. The case of England & Wales and Mexico (falling from nearly 4% to about 0.4% and 0.7% respectively) can be compared with those of Hungary (from 2.5% to 1.25%), the Netherlands (2.4% to 1%), or the US (from 0.66% to 0.33%).

The influence of the volume of consumption in the measurement of inequality is underlined as public water supply demanded by most households in higher-income countries must meet a mix of essential or 'social' services (satisfying basic needs) and 'private' services often of a luxury nature (e.g. pressure washers, swimming pools, sprinklers). This dichotomy suggests that affordability policies should target the basic needs of the poor; hence, this has potentially profound implications for tariff design as well as the equity of charges considered above.

Distributional Implications of Financing Water Services

Traditional methods of charging for water services in single family houses (SFHs) in OECD countries vary widely: *no domestic charges* (Ireland and Northern Ireland), through *flat-fee* charges, which mostly prevail in the northern and southern regions of OECD (Iceland, UK - especially Scotland, Norway, New Zealand and parts of Canada); *varied volumetric tariffs* (the rest of Canada, Australia, Luxembourg and the United States); the familiar *two-part tariff* (fixed charge + single volumetric rate) in most of OECD Europe; a *single volumetric charge* alone (eastern Europe); and finally *increasing-block tariffs* (IBTs) of one form or another (OECD Asia, Belgium, the Mediterranean countries and Mexico). The most noteworthy changes over recent years are the spread of domestic metering and, within measured charging, a move away from decreasing and towards increasing block tariffs (DBTs and IBTs).

Flat fees have often been assumed to be broadly in accordance with ability-to-pay. This stems from their connections with the householder's residence – owned or rented. Two-part measured tariffs, on the other hand, are considered as generating possible inequity for households consuming low volumes of water.

Increasing block tariff structures (IBTs) are sometimes applied for affordability reasons, arguing that the poor use less water, and therefore a cheaper first block or two of water (and wastewater, if the two service tariffs are linked) will benefit the poor most. However, this argument makes no allowance for the problems faced by the larger poor household, and, similarly, does not recognise the existence of the well-off small household, which may end up paying far less per m^3 for its water services than its large poor neighbour. Put another way, IBTs may permit the targeting of relatively poor small households, but in doing so (i) ignore larger poor households and (ii) catch some well-off ones as well. The targeting is therefore inefficient.

Some pricing structures policies have been rethought in attempts to lessen the burden on low-income large households. For IBTs, some of these amendments include gearing the first free block to the size of the household (Belgium) or giving special treatment to larger households (Spain, Greece). Other ways of influencing affordability via tariff adjustments range from central government subsidies, to tariff arrangements, either reserved exclusively for particularly vulnerable groups, or directed at broader consumer groups in which low-income households are expected to be significant. In Hungary and the Slovak Republic, large subsidy programmes have been used as policies to influence household affordability. Other than Malta's Social Assistance tariff, the only policies directed at vulnerable groups are in England & Wales. Examples of restricted tariffs for broader groups, in which lower-income households may be important, exist in Spain and, again, in England & Wales.

A large range of income support measures which address affordability problems have been identified in OECD countries: capped tariff rebates and discounts; direct income assistance or water services vouchers from government; water utilities, or other private or charitable sources; payment assistance in the form of re-phasing and easier payment plans, special loan facilities and arrears forgiveness; and other hardship initiatives providing assistance directly to households. No fundamental conflicts between environmental and social objectives seem to arise in the use of income-support measures.

Main conclusions

The study shows that the water charge burden tends to fall disproportionately on low income households in a number of OECD countries. The rate at which the burden declines as income increases to the highest group, however varies enormously. For instance, failing from nearly 4% to 0.4% in the case of England and Wales and from 0.66% to 0.33% in the US.

These disparities in the water charge burden among household income groups raise particularly significant concerns since many water uses are basic needs. Also, unit water prices have been increasing in real terms in most OECD countries in the last decade and will continue in the future.

Implementing individual household water metering leads to a better management of water resources as well as economic efficiency gains. Depending on the 'original' un-metered charges paid, however, there may well result in sizeable financial problems for low-income households, especially – according to empirical modelling exercises comparing un-metered and metered tariffs – for larger families.

Changes in measured tariff structures for already-metered households give rise to more complex analysis. Shifts into IBTs probably generate environmental gains, but their traditional equity rationale is

undermined by the possibility that small well-off households could end up in lower-priced tariff blocks than large poorer families.

Amended IBTs such as the Flanders tariff, necessarily associated with considerable cross-subsidisation within the household sector, can assist greatly in meeting affordability problems. But they only work well with regularly updated information on individual household occupancy.

Income-support measures generally show no important conflicts between environmental and social objectives, but their use is frequently constrained by government expenditure limits. Recent initiatives in England & Wales, Belgium and France show income-support schemes, incomplete in coverage, being funded from outside the public sector.

In areas with significant gaps in service provision, standard solutions introducing high-level service quality for all may not be the best way forward. Differentiated services, responding to local circumstances, based in the local community and sometimes embracing alternative technologies, should be seriously considered.

4. Case-study on Access to Environmental Quality in the Netherlands

The distribution of environmental quality is examined by Kruize and Bouwman (2003) in the light of a case study carried out in the Rijnmond region, the Netherlands.

Objective and background

The objective of the study was to assess the socio-economic distribution of access to environmental quality and to examine the determinants of possible disparities. The case-study considered a wide variety of measures of access to environmental quality (while most studies generally look at one environmental indicator only). This gives a more complete insight, but, more importantly, it offers the possibility to analyse the accumulation of environmental impacts for a certain neighbourhood and for a certain population group. The case study also intended to provide new insights by combining objective measures of access to environmental quality with perception based measures.

The Rijnmond region was selected for the case study based on the fact that is highly industrialised. The largest industrial harbour in the world is located in this area as well as the city of Rotterdam with a dense transportation network. Industrial activities, agriculture and traffic are an important source of pollution in this region. Also, this area consists of both heavily urbanised areas as well as rural areas. This potentially results in a higher variety in socio-economic groups and environmental quality than in case one would focus only on the city of Rotterdam, for example.

Methodology

Three categories of indicators were used: environmental indicators, socio-economic indicators (income) and so called ‘additional indicators’. In the case-study, these additional indicators were social indicators (e.g. age, ethnicity, educational level, age) and physical indicators, such as dwelling characteristics (rental/private, building period, type of dwelling), urbanisation degree, and type of living environment. They were selected as aspects from the local environment having both a relation with the outcome (environmental impact indicator) and the socio-economic indicator ‘income’. This selection does not claim to be unique and exhaustive.

The broad definition of environmental quality indicators retained to examine the distribution of environmental quality includes: air pollution (NO_2), noise (road, rail, aircraft, accumulated), soil quality, safety risk contour of specific companies, presence of waste disposal facilities, as well as access to public

green areas (e.g. parks, forests). The definition of environmental indicators was also determined by the distinction between environmental 'good' and 'bads'.

Quantitative data were collected on the selected environmental indicators from recent existing national and regional databases. The lowest possible spatial scale was retained, preferably the household level, the 6-digit zip code level (about the size of a street) or the 4-digit zip code level (size of several neighbourhoods) otherwise.

In addition to objective environmental indicators, perception-based measures of access to environmental quality are examined like the perception of environmental quality in the neighbourhood or the perception of availability and quality of green areas. These 'subjective' environmental indicators are based upon responses to a survey, with a limited number of observations in some cases.

The spatial distribution of objective environmental quality and income was analysed using Geographical Information System (GIS) maps. The socio-economic distribution, including for perceived environmental quality, was assessed based on statistical analysis such as descriptive statistics and regression analysis.

Main results

Results on the distribution of objective environmental quality according to income groups are available on different spatial levels (6-digit and 4-digit zip code) to examine possible differences. Also, they are partly weighted for the number of inhabitants in order to account for areas where more people are affected by the present environmental quality. Unweighted results might differ to a great extent leading to different conclusions.

In general, higher income categories have a better access to environmental 'goods' than lower income groups, while environmental 'bads' are more often present in lower-income areas than in higher-income areas.

On the 6-digit zip code level, these differences are particularly strong for exposure to air pollution, with the levels of NO_2 decreasing with income; for access to public parks (the higher the income, the higher availability of public green areas), and for presence of a waste disposal site in the surroundings (the higher the income, the lower the chance of having a waste disposal site in the surroundings). For exposure to noise pollution, differences are clearer when considering noise levels below 50 dB(A) than noise levels above 65 dB(A). The difference is also more pronounced for railroad traffic noise and accumulated noise (road, aircraft, rail). An exception is found for aircraft noise, for which the opposite is true. On the 4-digit zip code level, the relation between income and the environmental indicators is generally confirmed, with again the strongest relation between air pollution (NO_2 levels) and income, and no clear relation between the percentage of dwellings within a safety risk contour and income.

When considering the distribution of accumulations of 'goods' or 'bads' among income levels, instead of looking at the distribution of various environmental impacts separately, the case study shows that although the general trend is not very clear, it shows that the lower the income, the higher the percentage of accumulation of 'bads'. However, these differences were small. The differences in accumulation of 'goods', however, appeared to be larger. These results clearly show that the higher the income level, the higher the percentage with accumulation of environmental 'goods' in the surroundings.

For the perceived environmental quality, higher income groups perceive air pollution, malodour and traffic-related environmental problems more often as the largest problem, compared to lower income categories. Lower income groups are more often dissatisfied with the amount and quality of green areas in their neighbourhood and annoyed by noise than higher income households.

Finally, when exploring the combination of the 'objective' and the 'subjective' environmental quality indicators in the Rijnmond region, the results indicate that the association between the two indicators is not very strong, except for the amount of available public green areas Unexpectedly, the households most annoyed by noise are no the ones exposed to the highest levels of aircraft, road traffic or accumulated noise.

However, these results are only indicative and need to be taken with caution because of the small amount of data available, and the fact that 'objective' environmental data were aggregated with only a limited number of respondents at the level of boroughs.

Concluding remarks

The results indicate disparities in the distribution of environmental quality when examining two spatial scales (4 digit and 6 digit zip codes). The main findings are that as income decreases, proximity to waste disposal sites increases as well as air pollution and noise above 50 dB, in particular for rail and accumulated noise, and access to public green areas decreases. The differences between income categories are more pronounced for air pollution than for noise with a reversed trend for aircraft noise.

The case study also showed that the perceived environmental quality by households is not always consistent with the actual environmental quality assessed using 'objective' indicators, particularly for noise.

5. Case-study on Exposure to Urban Noise in the United Kingdom

Some new insights on the distribution of noise pollution, for which very little evidence exists, are provided by a recent research undertaken by Brainard, Bateman, Lovett and Day (Brainard *et al.* 2003) in the city of Birmingham, UK.

Objectives and background

Whilst there is substantial evidence of the deleterious effects of environmental noise exposure on human health, there is rather less evidence available on the distribution of different populations'exposure. This case study examines whether inequities in exposure to noise pollution are apparent amongst such population groups in a large English city.

The work is grounded with the context of European developments and legislation on noise control. The city of Birmingham was involved with the European Union level discussions on noise reduction from an early stage and was subsequently chosen as the trial site for noise mapping in the United Kingdom. Hence the work undertaken in the city has been subject to a considerable amount of empirical effort and is of both national and European significance.

Methodology

The study uses data from the Birmingham noise mapping project to assess possible inequities in noise exposure between different population groups. Using a Geographical Information System (GIS), a methodology is developed whereby measures of noise exposure and socio-economic characteristics are calculated for neighbourhoods in the city. Information on socio-economic characteristics of households such as indicators of poverty, age and ethnicity were derived from the 1991 UK Census records. Since there was no explicit income question in the Census, a number of variables, such as levels of unemployment or car ownership, were considered as proxy indicators of relative affluence or deprivation. These were used to calculate "Carstairs Deprivation Index" (Carstairs and Morris, 1989), a composite measure of social deprivation in the city of Birmingham.

Estimates of road and rail noise levels were made using established sound propagation models and combined with data on noise generated from the city's airport. Both day and night-time noise levels were considered. In order to use the noise exposure estimates to predict population dose, it was necessary to obtain a detailed estimate of the spatial distribution of the population of Birmingham. A dataset that was derived from the 1991 UK Census of Population was employed.

Descriptive statistics including the calculation of means, median, percentages, and quartiles were used to determine how the estimates of exposure were distributed across the different population groups in combination with Kolmogorov-Smirnov tests. The statistical analysis was undertaken using S-Plus 5 and SPSS 10 software packages.

Some analytical limitations and caveats must be pointed out. In particular, the estimates are based on modelled rather than measured noise levels. Also, it was not possible to examine individual exposures to noise. Furthermore, the analysis assumed that noise levels across the place of residence of populations was the sole contributor to the dose they received which is of course a simplification. Besides, the most recent information source available was from 1991, however, there is no reason to believe that these characteristics have changed strongly over the relatively short time between the Census and the period for which the noise estimates were made.

Main findings

Cumulative proportions of populations in different deprivation categories were compared to estimated noise exposures, and Kolmogorov-Smirnov (KS) statistics were calculated to assess the magnitude of any disparities in exposure between these groups. These statistics showed no statistically significant disparities for the road-only noise map data, either at day or night-time levels. Furthermore, no significant differences in exposure were apparent between the deprivation groups for daytime noise from the combined source map. However, some discrepancies were evident in estimated exposure to night-time noise from the combined sources. At night, the least deprived (most affluent) areas experience (estimated) noise levels lower than those in the most deprived. The observations suggest that there are some disparities for the most deprived areas In particular, the higher night-time noise levels observed in the most deprived areas, compared to the more affluent, may be associated with the absence of aircraft noise during the night. This may especially be the case given that the airport is located in more affluent areas of the city. However, this observation aside, the results provide no clear evidence of an overall trend in the relationship between deprivation and noise levels.

The study shows that most of districts with high levels of deprivation do not appear to experience particularly high noise exposure. The map suggests that noise levels are quite variable between high deprivation areas. Similar results were obtained for different racial groups. Moreover, there are sizeable areas of land near the motorway and city airport that do not have significantly deprived populations according to the Carstairs index, but do experience high noise levels. Hence it seems that, in the absence of the motorway and the airport, inner city exposures would predominate and the deprivation related disparities in noise exposure would be much greater than those observed here.

Results on the distribution of noise exposure based upon ethnicity and age profile were also provided. Poverty was found to be closely associated with ethnicity, making it difficult to discern the independent effects of the two factors. Although only 4.8% of white populations reside within the top 10% of deprived enumeration districts, 34.2% of Asians, and 23.0% of blacks live in these areas. The case study suggests that greater ethnicity associated disparities in median noise exposure are apparent than is the case for age, with the Asian subgroups tending to experience somewhat lower exposure than the city average, and blacks somewhat higher levels. For road noise alone, during the day or at night, no statistically

significant difference in modelled exposure between racial groups is found. However, there is some weak evidence of disparate experiences with regard to emissions from combined sources.

In addition, the study suggests that the benefits of living near modern transport links can compensate for high noise pollution. There is evidence of comparatively affluent populations exposed to high levels of aircraft and motorway noise. Amongst these groups, the improved mobility offered by these facilities may outweigh any disamenity associated with higher noise exposures. Furthermore, research attempting to measure preferences (as *willingness to pay*) for noise reduction, as reflected in the purchase price of properties, showed that the impact of noise levels on property prices varied between housing markets of different levels of affluence in Birmingham. Inequities in the housing market leading to differential residential environmental exposures amongst population groups were found to be arguably a key consideration from an environmental equity perspective.

Concluding remarks

The study showed greater inequalities in noise exposure associated with deprivation than with racial or age. In particular, disparities were apparent for exposure to night-time noise for the combined sources. However, concerning exposure to road-noise, either at day or night levels, or in exposure to day-time noise for combined sources (road/rail/airport) no statistically significant disparities between income groups were found. There are many deprived areas without high noise levels and high income areas exposed to high levels of aircraft and motorway noise. These findings point out the existence of trade offs with some benefits, like improved mobility, that can compensate for higher noise exposure.

Overall, the results of the study showed weak disparities in exposure to noise pollution. However the fact that some ethnic groups and more deprived communities appear to be exposed to higher noise levels than the rest of the population is a cause for concern.

6. Case-study on Exposure to Hazardous Waste Facilities in OECD Countries

Empirical evidence on the distribution of exposure to hazardous waste facilities in OECD countries is provided by the study by Hamilton (2003).

Objectives

The study reviewed the nature of the data available and the comparability of studies on hazardous waste facilities within and across OECD countries. The focus was on the distribution of potential risks by demographic group, including different income groups, within a given country. The report compared the results from the United States where the majority of the studies on hazardous waste facility siting and operation available are conducted with those studies published in English available in other North American countries, Europe, and Asia. The literature on the distribution of hazardous waste facilities was reviewed as well as the studies on the determinants of exposure to hazardous waste facilities.

Methodology and data

Methodologies used to assess the distribution of exposure to hazardous waste facilities across households income group rests on technologies such as Geographic Information Systems (GIS) which allow to link exposures with populations at the facility level. The radius of risks generated by a plant is generally defined through modelling involving assumptions about the dispersion of air emissions, for instance, or the likelihood of groundwater contamination. An alternative methodology used in some studies of hazardous waste sites draws on epidemiology. The health of residents living around a site is monitored and calculations are made to determine whether higher than expected levels of disease are noted. The multiple sources of risks make it difficult to isolate the separate effect of a plant's operation on residents,

however[62]. The turnover in residents may also make it difficult to detect effects through epidemiology, since there may be a long lag time between the exposure and the onset of cancer.

Another way to analyze the disposition of hazardous waste is to examine the flow of hazardous materials across borders. This analysis takes the country as the unit of observation and explores how trade in waste varies with differences in income levels and environmental policies across states.

The studies dealing with the distribution of exposure to hazardous waste facilities are conducted for different geographic units (e.g. national level, city, county, or site level) and use data such as company self-reported pollution figures from the U.S. Toxics Release Inventory or information on environmental cleanups in the U.S. Superfund program. The expansion plans of hazardous waste facilities provide another way to look at potential exposure by demographic group. EPA national survey of TSD capacity plans can be used and facility decisions can be matched with census data on the zip code neighbourhood surrounding a plant.

Main findings

The main findings of U.S. studies suggest that low income and minority populations are often exposed to a greater risk arising from the siting and operation of hazardous waste facilities, as illustrated by the work of Hamilton and Viscusi (1999). Site-level mean household incomes are lower at the one mile ring around Superfund sites and the four-mile ring than the mean household income for the nation as a whole. The mean household income steadily increases as one moves from one-mile to four-mile to ten-mile rings. The results indicate that as distance from a site increases, the mean household income for the populations potentially exposed increases, the mean housing values increase, and the percentage of highly educated residents increases. However, on a population weighted basis, residents within four or ten miles of Superfund sites have higher mean household incomes and greater housing values than those for the United States as a whole. Such income differences may arise because of the high concentration of sites in urban areas, where both incomes and housing values are higher.

Less detailed information exist in other OECD countries, though the evidence suggests that in some countries disparate exposures may exist by income, in part because of job opportunities and compensation programs in siting procedures. The most complete non-U.S. studies are from Canada and the United Kingdom.

Using Canada's National Pollutant Release Inventory (NPRI), which contains self-reported facility emissions similar to that collected in the U.S. Toxics Release Inventory program, Jerrett et al. (1997) aggregated 1993 facility air, water, and land emissions to the county level in Ontario and model the county emissions total as a function of four county characteristics: median income per household, average dwelling value, total population, and manufacturing employment. They found that the coefficient on median income per household is positive and statistically significant (as are the population and manufacturing variables) and that the housing variable is negative and statistically significant. They note that the positive relation between income and pollution may arise if high wages are part of compensation for pollution exposure. Harrison and Antweiler (2002) examined at the facility level on-site releases (i.e., air, water, land, and underground injection) and off-site transfers, using Canadian NPRI as well, and found no significant correlation between community income and the current releases or changes in releases over time.

[62] If residents close to a plant have lower incomes, for example, higher rates of illness may come from poor diet, inadequate health care, and exposure to toxics from a facility.

An analysis of the distribution of 156 plants in England emitting more than 1,000 kilogrammes of carcinogens in 1999 found that the polluting facilities were primarily located in the most deprived wards. 66% of carcinogen emissions are in the most deprived 10% of wards; 82% of carcinogen emissions are in the most deprived 20% of wards; only 8% of carcinogen emissions are in the least deprived 50% of wards (Friends of the Earth, 2001). A previous study concluded that, all across England and Wales, the poorest families (reporting average household income below 5,000 £) are twice as likely to have a polluting factory close by than those with average household incomes over 60,000 £ and that overall, almost two-thirds of the most polluting industrial facilities located in areas of below average income (Friends of the Earth, 1999).

Three other studies focus on the exposure to particular air pollutants by demographic groups in the United Kingdom. Brainard *et al.* (2002) use modeled emissions from vehicles and measured emissions from monitoring sites to estimate exposures to carbon monoxide (CO) and nitrogen dioxide (NO_2) in Birmingham, England. Using GIS technology and 1991 census data at the enumeration district level, the authors conclude that "both ethnicity and poverty are associated with pollutant emissions in Birmingham, with the highest emissions being recorded for populations with the highest proportions of minority ethnic groups and impoverished residents." McLeod *et al.* (2000) used monitoring data on sulphur dioxide, nitrogen dioxide, and fine particulates to estimate exposures at the local authority district level in England and Wales in 1994. Using a regression analysis, they find that pollution decreases as the social class index increases. Controlling for population density, however, they find that "the concentrations of all three air pollutants are higher in higher social class areas." Pye et al. (2001) use data on air pollution, GIS technology, and demographic data at the ward level conclude that: Greater London, Birmingham City District and Greater Belfast in Ireland show a positive correlation between air pollution and social deprivation, with higher pollutant concentrations of NO_2 and PM_{10} in areas exhibiting higher levels of deprivation. Cardiff City Council in Wales does not appear to show any significant relationship between air pollution and social deprivation.

The importance to determine the causation of possible disparities among household groups was strongly emphasized beyond providing a snapshot of who is exposed to potential risks from hazardous waste facilities at a given point in time. The different approaches used to examine what causes exposures to risk to vary across demographic groups include: analyzing what communities are targeted by firms when they plan to expand hazardous waste capacity; how regulators respond to communities as they cleanup hazardous waste sites; the impact of neighbourhood characteristics on the reduction of carcinogenic air emissions by facilities; the change in area demography over time as plants locate; the response of housing prices to changes at waste sites, and the reported reactions of individuals when they are asked about siting hazardous facilities.

The literature in the United States dealing with the determinants of disparities can be summarised as follows:

- In expansion plans of commercial hazardous waste facilities, zip code areas targeted for expansion had lower voting rates, fewer people, and higher percentage of renters (Hamilton; 1993, 1995).

- The more plants reduced emissions the greater the expected cancers generated by the facility and the higher the voting rate around the plant- a proxy for collective action (Hamilton, 1999).

- When cancer risks are low, more stringent cleanups of hazardous waste sites are chosen if surrounding residents are more politically active. (Viscusi and Hamilton, 1999).

- When Treatment Storage and Disposal (TSD) facilities were originally sited, they were not located in areas with high concentrations of the poor or African Americans (Been and Gupta, 1997).

- Mixed evidence on whether TSD facilities sited in poor areas originally or whether poor residents moved to areas after plants were located (Lambert and Boerner, 1997); Pastor et al., 2001).

The literature that explains siting patterns for hazardous waste facilities in OECD countries other than the United States focuses on individual level survey data or case studies of particular siting mechanisms. The main finding can be summarized as follows:

- Acceptance of a nuclear waste repository located in a resident's community declined as perceived risks or negative economic impacts were larger. Compensation offers in the survey reduced willingness to accept the nuclear waste site. Compensation offers can crowd-out a feeling of civic duty (Frey and Oberholzer-Gee 1996, 1997; Frey et al., 1996).

- Compensation facilitates siting of energy plants in Japan (Lesbirel, 1998).

- Approval of siting of hazardous waste treatment plant in Alberta, Canada, linked to early local plebiscite on accepting siting, regional government's provision of funds for local community to hire experts to analyze plant impacts, government's provision of compensation for infrastructure costs and more experts, and formation of local committee to monitor plant operation (Fisher, 1995)

- Role of compensation, unemployment and public participation in explaining the approval of siting of hazardous waste facilities (e.g. Sjoberg et al., 1999; Schneider and Renn, 1999; Coenen, 1998)

Conclusions

Overall the review of the literature available in the United States and other OECD countries indicates that, in general, low income residents face the higher risks from hazardous waste facilities.

In the case of hazardous waste, there have also been analyses of the effect of political and social factors in the siting decision. For instance, it is commonly found that areas in which voter turnout is high are less likely to have hazardous waste facilities, even when the effects of other factors are taken into account. Similarly, in areas where the average level of education is high, hazardous waste facilities are less prevalent. Hamilton (2003) argues that both of these are attributable to the likelihood of firms facing collective action from the local community.