Ecological compensation of highway impacts; negotiated trade-off or no-net-loss?

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Chapter 1

Introduction

Introduction

The subject of this dissertation is the ecological compensation principle and its use as a means of addressing the impacts of road construction. More specifically, it offers a critical examination of how the principle has been applied in the context of the planning and construction of the Dutch national road grid, comprising motorways and other trunk roads. By way of introductory background this first chapter briefly reviews a number of basic issues, as follows:

- history of the ecological compensation principle in the Netherlands (1.1)
- development and significance of the compensation principle (1.2)
- ecological compensation: the international context (1.3)
- practical issues arising during implementation in the Netherlands (1.4)
- the questions and issues addressed in this dissertation (1.5)
- the issues *not* addressed in this dissertation (1.6)
- readers' guide (1.7).

1.1 History of the ecological compensation principle in the Netherlands

Prior to its implementation in the context of transportation infrastructure projects in 1993, the principle of ecological compensation had already been applied for a number of years in other policy areas in the Netherlands, notably forestry and land use. Under the Forestry Act (Official Gazette 1961), which seeks among things to prevent further decline of the country's total forested area (natural and plantation), any developer receiving approval for forest clearance on any scale has a statutory obligation to replant the same area of forest elsewhere. There are still no formal criteria for the requisite ecological quality of the new forest stand or stands, however. In the context of land use, too, recognition of the ongoing damage to nature due to agricultural optimisation led in the 1980s to the first efforts towards ecological compensation, with 'replacement' habitats being established elsewhere. This so-called re-allotment procedure was later formalised under the terms of the Land Use Act (Official Gazette 1985, MANF 1993). One very successful re-allotment scheme implemented under this Act was the 'Eschmarke' project, in the east of the Netherlands (MTPW 1995), the ultimate outcome of government plans for two road schemes announced in the early

1990s: the A35 motorway and the Enschede bypass, both of which were seen as posing a severe threat to local amphibian and reptile populations. Besides measures to mitigate the resultant impacts, in the form of fauna passages and adapted culverts, a coherent ecological compensation plan was drawn up involving extensive exchange of land (within an overall area of 1,100 hectares of farmland) and relocation of several farmsteads. There were even interventions in the landscape itself: ponds, streams with wooded banks and other new habitat were created and linear segments planted with natural vegetation (MTPW 1995).

During the same period, i.e. the 1980s and early 1990s, successive Dutch governments instigated further policies to address the ecological impact of development projects and outline appropriate conservation steps. Thus, one objective of the Second Transport Structure Plan (MTPW 1990) was 'to reduce habitat fragmentation in the long term and prevent it in the short term'. This goal was to be pursued by means of both mitigation and compensation, i.e., measures to reduce ecological impacts or compensate for them, respectively. This approach was bolstered up by several other key government policy documents, particularly the First National Environmental Policy Plan (MHPE 1989) and the National Nature Policy Plan (MANF 1990).

Ecological compensation was first formally adopted as a policy principle in the Netherlands in 1993, with its explicit incorporation in the National Structure Plan for the Rural Areas (*Structuurschema Groene Ruimte*; MANF & MPHE 1993). Noting the rapid decline in the quality and extent of undeveloped and rural areas in the Netherlands and the importance of such areas for, *inter alia*, nature and recreation, the Structure Plan seeks to afford them better protection. As one of a basket of policies towards this objective, the ecological compensation principle was now to be implemented in all development schemes projected to have an impact on any of several categories of designated area, principal among them the areas comprising the Ecological Main Structure. The document sets out a phased planning and decision-making procedure involving both the initiator of the project in question and the 'competent authority', in most cases the national of provincial government. The first procedural step involves weighing up the perceived need for the project and its anticipated benefits against the projected loss of ecological values. This phase is steered by the principle of 'no-unless' ('…there may be no development of protected areas unless other national (e.g.

economic) interests are deemed more urgent and important'), and culminates in a basic decision on whether or not the project may go ahead. If on the basis of the information emerging in this phase approval is withheld, the formal procedure is concluded. If the project is approved, given its perceived overall benefits to society, and it is anticipated that the ecology of the area concerned will suffer in any way as a result, the procedure moves into its second phase. In all cases measures must then be taken to mitigate the ensuing damage and, to the extent that such steps are inadequate, measures taken to compensate for any remaining damage. Ecological compensation thus plays an important role in both key phases of project development (MANF 1995):

- in project planning and decision-making, through improved input of conservation interests,
- in implementation of projects that have received government approval.

This gives rise to a policy 'ladder' that in the course of project development seeks successively:

- to avoid ecological impacts,
- to mitigate any unavoidable impacts, i.e. reduce their severity, and,
- to compensate for any impacts that may then remain, aiming at a physical 'zero-sum' equation,
- financial compensation.

In other words, the more impacts can be avoided in the planning stages, the less mitigation and/or compensation measures will be required later. Similarly, if there is maximum mitigation of impacts, only a minimum of compensation will be needed.

The government's policy on rural areas laid down in the Structure Plan has been established via the so-called Key Physical Planning Decision procedure (*Planologische Kernbeslissing*). The government has thus committed itself to implementing the ecological compensation principle before it has actually been embedded in legislation. What the government has therefore pledged is to adhere to this principle in all projects where it itself acts in the role of either competent authority or project initiator. Neither is there much leverage available under civil law for moving parties to implement measures to compensate for ecological loss, in the form of compulsory purchase orders and the like. There is consequently

little alternative but to fall back on voluntary, i.e. 'amicable' land purchase and exchange, under terms freely negotiated by the respective parties. The National Structure Plan for the Rural Areas will soon be superseded by a new government policy document on Spatial Planning (MHPE *et al.* 2004), which is currently going through the final stages prior to national implementation at the moment. This Memorandum leaves unchanged the basis scope and objectives of the ecological compensation principle as described in the Structure Plan, and therefore has no great implications for the contents, conclusions and recommendations of this dissertation.

1.2 Development and significance of the ecological compensation principle

That economic progress and ecological conservation are frequently incompatible but at the same time fated to one another is now universally recognised and has been described elsewhere at length (see for the present context, e.g., Forman *et al.* 2003). The need to instigate ecological compensation in one form or another is most apparent in countries or regions where ecological values have suffered serious damage or loss as a result of economic development (Lynch-Stewart 1992, Torok *et al.* 1996). For years prior to introduction of such a principle, in the absence of effective national or federal policies and ditto environmental legislation, development projects were implemented in the absence of any proper decision-making procedure and without any serious attention being given to their likely ecological impact. One means of addressing this hiatus was by adopting ecological compensation as a formal policy principle, a process that proceeded in different ways in different countries and states (Allen & Feddema 1996, Bundesministerium für Verkehr 1996, Cowell 1996, Rundcrantz & Skärbäck 2003).

In the Netherlands the post-war period was characterised by rapid, large-scale development of residential, business and transportation infrastructure, generally accompanied by ecological damage and loss. It was not until the late 1960s that these issues were taken up the emerging environmental movement, but by the early 1970s their protests were becoming increasingly vociferous. Two of the projects singled out for particular criticism were the planned A27 road link between Utrecht and Amersfoort, scheduled to cut through a patch of woodland known as Amelisweerd, and the Leidse Baan, a provincial artery through the peat

meadows between Leiden and The Hague. These protests were successful, leading to a rerouting of the A27 and reduced ecological damage, and cancellation of the Leidse Baan altogether, thus accompanied by zero ecological damage. In response to the protests of this era, the government passed legislation to improve the overall input of environmental and conservation interests in decision-making on new transport infrastructure projects. Two key items of legislation in this context were the Environmental Impact Assessment Act (*Besluit milieueffectrapportage*, Official Gazette 1987) and the Environmental Protection Act (*Wet Milieubeheer*, Official Gazette 1979), laying down among other things an obligation for project developers to identify a 'least environmentally damaging alternative' and outline measures designed to mitigate projected impacts. This was followed several years later by the Routing Act (*Tracéwet*, Official Gazette 1994), which sets out a phased planning and decision-making procedure for all major transport infrastructure projects, including national road-building schemes, complete with clear, mandatory deadlines, and enhances citizen rights by creating formal timetables for public participation and appeals. Part of the impetus for this legislation came from the European Union, it may be added, because of the duty to implement the EC Directive on Environmental Impact Assessment (EC/85/337) and other such European legislation at the national level.

Even with this new legislation in place, though, there still proved to be inadequate protection of ecological values. The populace, dismayed that at the end of the 20th century these values were still being sacrificed to economic development and seeing the substantial ecological damage often caused even after due implementation of 'mitigation' measures, continued to pressurise the government to guarantee better protection, by adopting the principle of ecological compensation, among other things. As already discussed in section 1.1, the principle was formally adopted in 1993, as one of the elements of the National Structure Plan for the Rural Areas. It is essentially an extension of the 'Polluter Pays Principle', anchored in the Environmental Protection Act and applied for many years in the context of effluent discharge permits, for example. A key feature of the compensation principle is that it is articulated according to the phases of project decision-making and explicitly identifies two actions to be pursued in tandem, as appropriate. First the envisaged benefits, perceived necessity and anticipated impacts of the project must be duly examined and weighed up. Only if planning approval is indeed granted is consideration (then)

to be given to elaborating the various kinds of conservation measures, including compensation. In principle, this prevents compensation becoming just another bargaining chip on the way to successful project implementation.

Although ecological compensation has been adopted as a policy principle in the Netherlands and elsewhere, the term has never in fact been adequately defined and in this respect the cited Structure Plan for the Rural Areas is no exception. When interpreting its terms in the context of concrete development projects, questions have inevitably arisen as to the precise scope and meaning of 'compensation' and the kind of measures actually envisaged in the real world. As experience has grown, though, practical guidelines have been elaborated, the result of methodical study and a 'learning-by-doing' attitude on the part of project initiators and others parties to specific projects. One factor that has proved especially important in this context is the nature and extent of local administrators' social networks (Glasbergen & Driessen 2002).

Based on the experience gained to date, ecological compensation can be defined as the substitution of ecological functions or qualities impaired by development projects. Such compensation aims to rehabilitate damaged areas and / or create new habitat of equivalent status, i.e., with similar ecological functions and quality attributes (Allen & Feddema 1996). This does not differ fundamentally from 'ecological restoration' or 'habitat creation' (Anderson 1995, Wyant *et al.* 1995), except that 'ecological compensation' specifically addresses the ecological impacts of development schemes. Dutch terminology on this point deviates from international convention, however. In the international literature 'mitigation' it take to signify any activity that avoids, minimises, rectifies, reduces or compensates for the effects of environmental damage (NEPA 1970, National Research Council 1992). In the Netherlands, though, and *in this dissertation* 'avoidance', 'mitigation' and 'compensation' are distinguished as three fundamentally different ways of addressing the impacts of development schemes. Here, then, 'mitigation' is a narrower concept than NEPA's, being restricted to impact minimisation, rectification and reduction and thus standing midway between 'avoidance' and 'compensation'.

The government strategy to adopt an ecological compensation principle has had two main consequences. In the first place, because some form of compensation is

required in every infrastructure project there is now even greater pressure on the scarce farmland available. For decades farmers have had to provide much of the land needed for road-building schemes and other development projects and now they must do so once more in the interests of ecological compensation. In this sense the agricultural sector feels it is bearing the brunt of the government's compensation policy (Siemes 1996). Nonetheless, in the years ahead farmers are likely to be involved increasingly in the implementation of compensation measures, with individual farmers benefiting financially.

In the second place, the focus on *ecological* compensation has meant that the landscape impacts associated with development schemes have been neglected in comparison, in two respects. First, there is no parallel obligation to compensate for impacts on the structure or visual character of the landscape. Second, ecological compensation is itself a development activity that may impair the landscape in one way or another, as there is always a risk of conservation measures being implemented in a manner breaching the constraints and character of the landscape in question. However, this is intrinsic to the current policy framework of ecological compensation.

1.3 Ecological compensation: the international context

As mentioned earlier, there is already a fair amount of policy experience with the ecological compensation principle in other countries. This is now briefly reviewed, not with the aim of providing any kind of comprehensive survey but to give a representative idea of the conventions and policy umbrellas under which compensation principles have been operationalised over the past few decades.

1.3.1 International

At the international level the compensation principle has been formally adopted within the framework of two conventions: the Ramsar Convention on Wetlands (1971) and the Bonn Convention on the Conservation of Migrating Wild Animal Species (1979). The countries that have ratified these conventions have committed themselves to protecting areas deemed of major international importance, in particular key waterfowl habitats (Ramsar) and populations of designated species migrating across one or more national frontiers (Bonn). These conventions place

restrictions on the kind of (economic) activities that may be undertaken in such areas and require that in cases where a project does receive approval and will lead to loss or impairment of ecological functions there is due compensation of such impacts. However, neither convention provides any precise description of what is to be understood by 'compensation measure'.

1.3.2 North America

In the United States the principle explicitly tying development schemes to compensation measures is the 'no–net-loss' principle, complying with Section 404 of the US federal Clean Water Act (1972). This Act, integrated with the Fisheries Act and The Nontidal Wetlands Protection Act, obliges project initiators to compensate for losses of wetland area and functions. In the short term the no-net-loss principle aims to achieve a steady state for wetlands, i.e. with losses and gains in balance, and in the long term an expansion of total wetland area, via compensation ratios greater than unity, i.e., greater than one (Sifneos *et al.* 1992).

Specifically, developments associated with the destruction, filling and dredging of wetlands are authorised under the Act. In the 1990s projects were approved on a year-by-year basis, with no-net-loss of area or quality being sanctioned in any given year (Abbruzzese & Leibowitz 1997). Measures are usually aimed at restoring hydrological and soil characteristics, vegetative cover and wildlife use of wetlands (Brinson & Rheinhardt 1996, Wilson & Mitsch 1996). However, the authorisation process appears to give little consideration to the problems of habitat isolation and noise load resulting from infrastructure developments (Torok *et al.* 1996, Nash & Cotten 1997).

In projects receiving authorisation the goals for achieving no-net-loss are often specified as a replacement or compensation ratio, i.e. the ratio of replaced to lost area (Allen & Feddema 1996). This ratio varies from state to state according to the severity of the impacts, the succession stage of the lost wetland, as a 'quality indicator', and the location of the compensation site relative to the development (Lynch-Stewart 1992). The ratio usually lies between 1:1 and 4:1 (Zedler 1996).

The Canadian government has established a similar policy, specifically for impacted wetlands on federal land, which commits federal land managers to the

same goal of 'no-net-loss' (Rubec 1994). Mitigation and compensation measures are embedded in the Canadian Environmental Assessment Act (1992). However, there are no strong legislative measures in place such as Section 404 of the US Clean Water Act and compensation may in practice be implemented under several different articles of legislation.

1.3.3 European Union

In the European Community, now the European Union, the 1979 Directive on the Conservation of Wild Birds (79/409/EEC) and the 1992 Directive on the Conservation of Natural Habitats and Wild Fauna and Flora (92/43/EEC) together formulate a 'no-net-loss' principle. In the first place, these directives oblige Member States to identify protected zones (79/409/EEC) and natural habitats for species of national interest (92/43/EEC). Secondly, in cases where implementation of a high-impact develop-ment scheme is held to represent a vital and urgent public interest, they oblige states to implement compensa-tion measures to maintain the integrity of the European Ecological Network *Natura 2000*. Among the measures cited are restoration of designated habitats and creation of new habitats.

Several EU countries including Belgium, Denmark, Germany, the Netherlands, the United Kingdom and Sweden, as well as Switzerland, have adopted a regulato-ry approach to the compensation principle, encompassing similar practices to those mentioned in the two European directives. In Germany the principle was elaborated in some detail many years ago. The 'Intervention regulation' (*Eingriffsregelung*), introduced in 1976 and applied within the framework of Environmen-tal Impact Assess-ment (INN 1991), is embedded in the Federal Nature Conservation Act (*Bundesnaturschutzgesetz*). It requires project initiators to follow a three-step procedure, first seeking to avoid projected impacts, then to mitigate them and subsequently to compensa-te for any remaining (i.e. unavoidable or unmitigated) impacts. Under this Act a development may be given conditional approval if suitable mitigation measures are deemed feasible. Final permission may be granted only after conservation interests (incl. compensa-tion measures) have been duly weighed up against other, wider (i.e. socio-economic) interests associated with the development (Von Kiemstedt *et al.* 1996).

After introduction of the *Eingriffsregelung* at the federal level, some fifteen implementational frameworks for compensation were elaborated in the respective German states, all fairly similar. With respect to species conservation, these procedures emphasise the impacts of habitat destruction and deterioration; with respect to habitat fragmentation, guidelines for no-net-loss are formulated in qualitative terms only (Bundesministerium für Verkehr 1996). Each year sees new projects authorised under the *Eingriffsregelung* (Bauer & Kleinschmidt 1991).

1.4 Practical issues arising during implementation in the Netherlands

As already discussed, with its National Structure Plan for the Rural Areas the Dutch government committed itself to applying the ecological compensation principle in all development projects in which it acts in the capacity of project initiator or competent authority. As soon as it was introduced in mid-1993, then, the principle at once became a key policy element for the Ministry of Transport, Public Works and Water Management, responsible for the construction, operation and maintenance of the Netherlands' national transportation infrastructure, i.e. the national road, rail and waterway grid. The same held automatically for the Directorate-General of Public Works and Water Management (*Rijkswaterstaat*), the government agency responsible for implementing ministerial policy in many key areas and itself frequently acting as project principal in government-commissioned development schemes.

The decision-making procedure in force for national infrastructure projects, including national road schemes, as defined above, is laid down in the Routing Act (*Tracéwet*, Official Gazette 1994), which came into force some six months after publication of the Structure Plan. Expectations were that application of the compensation principle in the context of national road schemes would show up immediately in the various phases of the planning and decision-making process (the first consequence of the principle). After incorporation of the principle in the Routing Act, general in scope, and the Routing Decision (*Tracébesluit*), covering the details of project implementation, it was thought that actual mitigation and compensation of the ecological impacts of national roads (the second consequence) would be guaranteed. This proved to be only part of the story, though, for introduction of the compensation principle confronted *Rijkswaterstaat* with a number of problems.

In the absence of Dutch experience or expertise in this area, ecological compensation had to be incorporated from one day to the next in a series of ongoing national road schemes. As *Rijkswaterstaat* grappled with its new task, a range of issues came into focus. With regard to the first consequence of the compensation principle, it became clear that answers must be sought to the following key questions: (a) How is the principle to be integrated in planning and decision-making on national road schemes? (b) In practice, is the 'no-unless' principle really effective as a means of preventing interventions in ecologically vulnerable areas? (c) How often are national roads actually rerouted in the early planning stages in order to minimise ecological impacts? (d) What issues of substance need to be studied before the ecological compensation principle can be implemented in properly scientific fashion? (e) What kinds of ecological data are required in the various phases of planning and decision-making? (f) How are the various parties – local and provincial authorities, interest groups, other organisations – likely to respond to use of the compensation principle in road schemes implemented by *Rijkswaterstaat* and how cooperative, or otherwise, are they likely to be?

When it came to the second consequence of the compensation principle, there were also questions to be answered, principal among them the following: (g) How exactly are mitigation and compensation measures to be implemented? (h) How much will they cost in practice? (i) Can such measures be implemented concurrently with realisation of the road scheme in question? (j) To what extent should compensation plan implementation and road construction be organised under one and the same procedural umbrella? (k) How can it be ensured that ecological compensation does not simply boil down to execution of standing policy, with compensation measures therefore leading to no net gains at all? (l) Does full implementation of all scheduled compensation measures necessarily guarantee that the damage they sought to address is effectively countered? (m) To what extent can the compensation principle – as presently articulated for road projects – be applied to other types of development project (e.g. railways, housing developments, plantation forests) and extended beyond ecology? (n) Where several (science-based) options are available for designating compensation measures, what are their respective advantages and drawbacks?

1.5 The questions and issues addressed in this dissertation

At *Rijkswaterstaat* there was thus an urgent need to develop unambiguous as well as practicable answers to these and related questions. At the same time, the agency's responsibility for implementing the compensation principle required a major change in organisational culture, for its brief had always been limited to the administration of (national) roads and immediately adjacent areas, including responsibility for fauna tunnels, ecoducts, fauna fencing and other such mitigation measures (Canters 1997). As compensation measures are not usually implemented in the direct vicinity of the road in question, however, the agency's traditional area of work was clearly to be extended in a very literal sense. The question, then, was how this organisational move could best be planned.

When it came to everyday implementation of the compensation principle in ongoing road schemes, then, difficulties were anticipated right from the start. There was a clear need for a preliminary analysis of the anticipated problems and *Rijkswaterstaat* was eager to find solutions, one obvious reason being that it is in the transport ministry's interest to minimise delays in implementing its own infrastructure plans; smooth, scientific and effective practical elaboration of the ecological compensation principle would be a major contribution in this respect.

Against this background, the present dissertation – written more than a decade since the ecological compensation principle was introduced in the Netherlands – seeks to answer five specific questions regarding use of the principle in the context of national road-building schemes:

1. What consequences has the ecological compensation principle had for planning and decision-making at *Rijkswaterstaat*, the Directorate-General of Public Works and Water Management? (cf. questions a-f above)
2. How are compensation measures actually implemented and how effective are they? (cf. questions g-l)
3. To what extent can ecological compensation, as articulated for road projects, be more widely applied? (cf. question m)
4. What are the advantages and drawbacks of the main options for (science-based) compensation measures? (cf. question n)
5. What problems are encountered in practice and what options are available for addressing them? (cf. first half of this section).

1.6 The issues not addressed in this dissertation

This dissertation does *not* consider implementation of the European Bird Directive (79/409/EC) or Habitat Directive (92/43/EC) in the Netherlands, nor any influence these directives may have had on Dutch legislation. Although the Bird Directive was already finalised in 1979 and the Habitat Directive in 1992, it was not until the year 2000 that either were effectively implemented in the Netherlands. Areas protected under these two directives enjoy a higher status of protection than those protected under the National Structure Plan for the Rural Areas (restricted basically to the Ecological Main Structure). The key focus of this dissertation is, rather, the experience gained by *Rijkswaterstaat* in planning and implementing compensation measures in accordance with the aims and terms of this Structure Plan. However, this experience may well prove useful in any future ecological compensation schemes to emerge from the two European directives and may even provide an operational model for doing so. For even if the European directives do in principle afford designated areas greater protection, if a development is still approved after due consideration of all relevant interests, there will still be a need for mitigation and compensation measures. It may be remarked that here, too, there is very little legal leverage available in the Netherlands for realising pre-conceived compensation measures.
A second restriction of scope is that this dissertation does not address the impact of the ecological compensation principle on Dutch rail and waterway projects, even though these are now subject to the same statutory obligations. One practical reason for this is that when the compensation principle came into force in 1993 a relatively large number of road projects were already at the planning stage or midway through decision-making, making them a convenient object of study amenable to real-time monitoring. In the period during which the research for this dissertation was conducted this was not the case with rail and waterway projects.

Finally, as stated earlier, the principal focus of this dissertation is compensation of *ecological* values. No consideration is therefore given to compensation for any form of damage to landscapes, in terms of structure or visually (by restoring or enhancing 'heritage' features or characteristic land use patterns, for example). Although in several Dutch provinces developers are now obliged to undertake this kind of 'landscape compensation', no policy to this end has yet been adopted at

the national level and these issues are not therefore addressed in the present study. This restriction to *ecological* compensation also means that no consideration has been given either to compensation for impairment of recreational or agricultural values, for example. Obviously, though, compensation of development-related impacts in terms of both ecological values *and* landscape integrity will always be the best option, the landscape being the abiotic substrate of those values and therefore ultimately determining the conditions available for successful development of compensation sites.

1.7 Readers' guide

Following this introductory chapter, Part 2 reproduces the various articles that have already been published in national and international journals between 1996 and 2003 as part of this ongoing dissertation project.

Chapter 2 describes the design and development of the ecological compensation plan for the A50 road link between Eindhoven and Oss. This was the very first scheme in which the compensation principle was applied and came to be the longest-running project ever, both for *Rijkswaterstaat* and for the Netherlands as such. It also set the tone and starting point for all subsequent compensation plans undertaken in the context of national road schemes. In preparing the compensation plan for the A50, two issues predominated: the methodology for deriving compensation measures and the opportunities available to the various parties for critically appraising the ensuing draft compensation plan.

Chapter 3 reviews the ecological compensation principle as it is applied in various countries around the world and sets out basic guidelines for application during the planning, decision-making and implementation phases of national road schemes. First the basic policy framework of the compensation principle is described. Then, moving on to the practicalities of compensation, the main types of choices facing project initiators are considered: 'in-kind' vs. 'out-of-kind' compensation, 'on-site' vs. 'off-site' compensation and the instruments employed to actually implement the measures.

Chapter 4 analyses and describes how the compensation principle has affected planning and decision-making for six road schemes deemed representative of the

Dutch situation. Each scheme is evaluated against four criteria: How successful was the compensation principle in preventing ecological impacts? How were descriptions of projected impacts used to derive compensation measures, with respect to both quantitative scale and ecological quality? What were the estimated costs of compensation? And what was the input of the various parties to the compensation plan?

Chapter 5 essentially repeats the exercise of the previous chapter, using the same evaluation criteria, but now for nine compensation plans established for *national* road schemes in the Netherlands.

Chapter 6 describes how implementation of the A50 ecological compensation plan discussed in Chapter 2 was proceeding seven years after initial finalisation. The main focus of this interim assessment is how actual implementation compared with the targets set in the plan, in terms of size, quality and location of the compensation sites as well as financial cost.

Chapter 7, finally, considers the kind of ecological data that is required in the various phases of the Dutch planning and decision-making procedure for national road schemes and the actual availability of such data. To this end the respective phases of the Routing Act planning process are reviewed and an appraisal made of the detail required in each with respect to basic ecological data and impact prediction. The chapter concludes with some suggestions on how mitigation and compensation measures should ideally be dovetailed into the various phases of the procedure.

Chapter 8 presents a summary of the results of this dissertation, drawn from the findings of Chapters 2-7 of Part 2.

Part 3 draws the various threads together. Chapter 9 discussed the ecological compensation principle as it is actually implemented at present and identifies a number of unresolved issues requiring further clarification. The general conclusions resulting from Part 2 and the discussion lead to recommendations as to how the ecological compensation principle might be more effectively applied in the road-building context in the Netherlands. The chapter closes with a series of summarising conclusions.

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