Working Paper

On Verifiability, and How it Could Matter for International Environmental Agreements

Owen Greene

WP-94-116
November 1994

IIASA

International Institute for Applied Systems Analysis] A-2361 Laxenburg Austria

Tel: (43 2236) 807] email: info@iiasa.ac.at] Fax: (43 2236) 71313

Preface

Hundreds or even thousands of international legal instruments on "the environment" are in existence. What happens to international environmental agreements once they are signed, and how does the process of implementing such agreements influence their effectiveness? These are the questions that motivate the IIASA project "Implementation and Effectiveness of International Environmental Commitments (IEC)". Research teams are examining these questions from many angles and with different methods.

One factor that influences whether some agreements are effective is the extent to which they may include provisions for verification of compliance. Although this has been a central issue in the analysis of arms control agreements, until recently verification of international environmental agreements has been relatively neglected. Yet many environmental agreements would probably be more effective if they included better provisions for determining whether a party is in compliance and for managing problems of inadequate performance and noncompliance.

In this paper, Owen Greene analyzes the factors that determine whether an environmental agreement is "verifiable". He decomposes the general concept of verifiability into its constituent properties; notably, he explores the intrinsic verifiability of different substances and behaviors. He suggests that proxies can be used in international agreements to improve the verifiability of the agreement by simplifying what must be verified and by tuning the terms of the agreement to indicators that are more easily measured and verified.

Greene also examines the ways that "verifiability" could affect the formation of international agreements as well as their implementation. Further, he shows how the verifiability of an agreement can change over time--either by design or due to changes, e.g., in technology or the cost of gathering and analyzing information. Throughout, he shows the many pathways by which verifiability might influence the effectiveness of an agreement.

This paper is part of IEC's work on international verification and review mechanisms. IEC is now sponsoring several case-studies related to these topics.

The context of this paper in the IEC project

This paper is one of several IEC working papers that survey the existing literature, place the project in a framework of prior research, and identify the major questions that deserve further study. At the outset, members of the project decided to prepare these papers to ensure that we were adequately aware of other research in the field and, especially, to ensure that we would be studying the most important questions in the proper context. The papers that play these roles are listed below, divided into each of the three areas of IEC's research program. Fuller descriptions of different parts of IEC's research program are available in the IEC project description (copies available from IEC) and in the prefaces and working papers listed below.

1. Historical case-study and comparative research

Most of IEC's research is directed at studying how international environmental agreements have been implemented historically through examination of case-studies and focussed comparisons among selected cases. Teams are studying domestic implementation as well as international and transnational processes. Eight papers review the relevant literature and establish the context and research questions:

Research on implementation at the domestic level in Western Europe and in the Eastern economies undergoing transformation:

- Steinar Andresen, Jon Birger Skjærseth, and Jørgen Wettestad, 1994, "Regime, the State and Society--Analysing the Implementation of International Environmental Commitments".
- Vladimir Kotov, 1994, "Implementation and Effectiveness of International Environmental Regimes During the Process of Economic Transformation in Russia".
- Elena Nikitina, 1994, "Domestic Implementation of International Environmental Commitments: a Review of Soviet Literature".
- Alexei Roginko, 1994, "Domestic Compliance with International Environmental Agreements: a Review of Current Literature".

Research on international and transnational processes of implementation:

- David G. Victor with Owen J. Greene, John Lanchbery, Juan Carlos di Primio and Anna Korula, 1994, "Roles of Review Mechanisms in the Effective Implementation of International Environmental Agreements".
- David G. Victor, John Lanchbery and Owen Greene, 1994, "An Empirical Study of Review Mechanisms: Report on Work in Progress".
- David G. Victor with Anna Korula, 1994, "What Is an International Environmental Agreement?"

- Owen J. Greene, 1994, "On Verifiability, and How It Could Matter for International Environmental Agreements".

2. Development of a database

IEC is developing a database that will consist of key variables related to the development and effective implementation of international agreements. It will allow systematic use of historical evidence from a large number of cases. The goal is to make possible the testing of hypotheses and the drawing of general conclusions about which variables are causally linked to "effectiveness". One paper reviews the major hypotheses related to the formation and effectiveness of international regimes:

- Marc A. Levy, Oran R. Young and Michael Zürn, 1994, "The Study of International Regimes".

3. Other research and policy activities

IEC researchers are applying their research findings to current and future policy issues as opportunities arise. The project is also sponsoring a major simulation-gaming exercise to explore issues of institutional design, implementation and compliance in international environmental agreements. Simulations can help promote creative thinking about political options for international management of climate change, identify potential pitfalls, integrate policy-relevant knowledge from a variety of domains, and identify important policy-relevant knowledge needs. One paper surveys the benefits of using simulation-gaming as a policy and research tool:

- Edward A. Parson, 1995, "Why Study Hard Policy Problems With Simulation-Gaming?"

The above list includes only the papers that the project has used in establishing the framework for its research activities. A complete list of publications and copies of papers are available from the IEC offices at IIASA.

SUMMARY

Verification and implementation review processes are potentially important factors in the effectiveness of environmental regimes, and yet until recently they have received relatively little attention. This paper examines one aspect of this issue area: the characteristics and determinants of 'verifiability', and ways in which it could affect the development and effectiveness of international environmental agreements. It aims to clarify and explore these issues, and to identify areas worthy of further research.

Definitions

The verification process involves monitoring national performance and then, on the basis of the information obtained, assessing compliance with international commitments. Since verifiability is the ability to verify compliance, it is thus a combination of *monitorability* - the ability to monitor the activities or substances covered by the commitment - and *assessability;* the ability to compare monitored performance with the standards set by the commitment. For the purposes of this paper, verification is not simply about *whether or not* a party is in compliance, but also about *the extent to which it is complying* with commitments. It is carried out by states or organisations other than the party whose performance is being assessed, implying that the monitoring or assessment processes involved should have some degree of independence from the party concerned.

Determinants of verifiability

The verifiability of a commitment depends partly on the extent to which the relevant activities or substances are already transparent to interested observers. In some cases, the processes of monitoring, data-gathering, information-exchange and review that exist independently of the treaty in question are already sufficient for at least some outsiders to be able to monitor parties' performance in relation to a commitment. Frequently, however, verifiability depends on the extent to which additional monitoring or assessment facilities are in place.

The determinants of 'monitorability' of the substances or activities relevant to compliance can roughly be divided into three categories. The first of these is the intrinsic monitorability, which depends partly on the physical or 'natural' characteristics of the activities or phenomena to be measured. It also depends on their social or economic characteristics - on the place they have in the societies involved in the agreement - and on the extent to which relevant natural and social sciences and monitoring techniques have been developed. On the basis of present scientific and technical knowledge, it is possible to develop a generic list of physical and social characteristics of 'Substance X' or 'Activity Y' that would determine their intrinsic monitorability. This could usefully clarify which types of commitments in a given environmental issue area are likely to prove verifiable, and thus the scope for effective environmental agreements in this area.

The second category of determinants relate to the extent to which an adequate 'infrastructure' of monitoring platforms, data-collection systems, and expertise already exists and is available for use. In principle, custom-built systems could be established for each treaty, but in practice the resources available for this are very limited. As is well known, the characteristics of the data-gathering systems and the institutions with which they are associated will typically affect the data they produce. This creates reliability problems which need to be taken into account,

and also problems of comparability of results between countries and regions. To a limited extent, these can be reduced by careful formulation of commitments

Thirdly, monitorability is determined by broader political, social or economic characteristics of the states involved, such as the extent to which states are open, pluralist, democratic, or strong domestically, or the character of their economic, cultural or social systems. The implications of these societal characteristics for monitorability depends on the extent to which adequate monitoring depends on data provided by the state concerned or on its cooperation (and whether the rules for such cooperation have been formally agreed).

Where verification issues are salient, there are likely to be doubts about the monitorability of commitments if it depends on self-reporting by governments, which could misreport in order to hide poor compliance. However, if the state's national data-gathering process is transparent, and outside observers have access to raw data or to the various government agencies or experts involved, then confidence in verifiability should increase. Appropriate transparency rules could be included in environmental agreements for this purpose. Nevertheless, parties may not accept some commitments to be monitorable unless national reports can at least be validated through independent inspections or compared with independently-collected data.

Where direct monitoring of the phenomena specifically governed by commitments is difficult, it may be possible to overcome the problem through indirect monitoring. Here, a methodology is used to calculate the phenomenon of interest using data on a set of relatively monitorable quantities. In this case, monitorability depends on the existence of an acceptable methodology, as well as on the ability adequately to measure each of the required data-inputs.

In addition to monitorability, the ability to verify depends on 'assessability'. This mainly depends on the formulation of the commitment: does it provide a standard against which a party's performance can be assessed? If the commitment is ambiguous, an assessment of a state's compliance would be difficult even if the information available on its performance were perfect. Assessability also depends on the ability to analyse the information obtained through monitoring, compare it with the commitment, and draw conclusions: some potential verifiers will tend to lack these capacities.

The verifiability of a particular commitment will vary according to which actor would be doing the verification and which country or organisation is being verified. If the ability to verify compliance is significant for the implementation and development of international environmental agreements, the uneven distribution of such abilities amongst the actors involved can be expected to be important.

Verifiability and the implementation of international environmental agreements

The importance of verification issues, including verifiability, will depend on factors such as the patterns of interests, costs and benefits involved in an international environmental agreement, and the stringency of commitments. The possible ways in which the ability to verify compliance could affect implementation can be divided into interest-based and learning-based mechanisms and into mechanisms affecting the power and actions of states and of domestic and non-state actors.

The verifiability of commitments could affect the ways states calculate and pursue their interests. The extent to which states can (or believe they can) verify the compliance of treaty partners may affect their calculations of the costs and benefits of joining and implementing an agreement, and their confidence in its fairness and effectiveness. The ability to monitor and assess compliance could help to build mutual confidence. Furthermore, assessments by each state on how well other parties can verify its own performance could affect how it decides to implement its commitments. The more probable it is that good performance will be recognised and non-compliance will be exposed, the greater are the incentives to comply. Where a country lacks the capacity to implement properly, assessments of verifiability may affect the extent to which its government is prepared to admit difficulties and ask for exemptions or assistance. Moreover, the ability to verify compliance, and the ways it is distributed amongst parties, could affect power relations between states. Further, the ability of states to find and efficiently implement complex mutually-beneficial agreements partly depends on transparency, and thus on verifiability. So does the extent to which leaders can set political or commercial standards that others follow.

Verifiability is a measure of the ease with which states can learn about their interests by keeping abreast of the ways in which commitments are being implemented. It also relates to the potential for states to learn from the treaty partners implementation performance in a timely and effective way. The ability of international organisations or other parties to monitor relevant activities inside a state could be used to improve that state s capacity to implement its commitments. Such monitoring resources could also help parties to understand the environmental problems better.

Domestic and non-state actors are particularly important for the implementation of most environmental agreements. Verifiability can affect the cost-benefit calculations the government bureaucracies and domestic interest groups make about their interests in implementation of an agreement. International organisations could be empowered as a result of their monitoring or assessment capacity. Likewise, a state s ability to verify compliance could empower it in relation to domestic actors. Moreover, the ability to verify could empower particular government ministries, or change power relations between domestic actors.

The ability of non-state actors to expose poor compliance could strengthen them in their dealings with the state and other domestic actors. Moreover, as verifiability issues become salient, the states, organisations or experts who operate relevant existing monitoring systems or data-bases, or who have privileged access to them, could also be empowered. Since the ability to verify will depend partly on experts, they will be placed in a particular position of influence when verification matters.

The transparency associated with verifiability can facilitate learning of all types of actors. Moreover, international or independent monitoring, reporting and assessment systems associated with verifying a treaty provides governments, regulators, bureaucracies and non-state actors with information they may not otherwise have had. This additional information could help government agencies, regulators or companies to learn how to implement their commitments more effectively.

Where formal commitments are relatively unverifiable, a variety of informal indicators may be used to monitor or assess performance. The choice of such indicators is likely to be a political as well as a technical process and, since they may only be indirectly or loosely linked to formal commitments, their use has the effect of changing the standards by which compliance is assessed and thus shaping implementation. Notably, interested parties may use different informal indicators, according to their interests and monitoring capacities. The development and use of such indicators could increase the connections between international commitments and domestic implementation or international assistance programmes. The development and significance of such relatively verifiable informal indicators of performance is an important area for further research.

Verifiability and the formulation and negotiation of commitments

If verifiability issues could be important to implementation and to the power and learning of interested parties, then they are likely to be taken into account when commitments are being formulated or negotiated, and when decisions are being made about whether to join an agreement.

Perceptions of the *potential* verifiability of commitments in a given issue area could affect decisions about whether to try to negotiate agreements. Assessments of the *relative* verifiability of possible commitments could shape the formulation of agreements. Since the distribution of abilities to verify could affect power and interests (of both states and non-state actors), assessments of verifiability could affect parties negotiating strategies. Some governments may be unwilling to negotiate or join environmental agreements unless they believe the commitments are at least potentially verifiable. The design of an agreement, including the establishment of transparency or reporting rules and implementation review and monitoring systems, could be affected by a desire to make compliance more verifiable. The extent to which verifiability concerns have shaped the initiation, development, and design of environmental regimes, and participation in them, needs further research.

Verifiability and the development of environmental regimes

Environmental regimes are dynamic, and their development continues after initial commitments have been agreed. Verifiability could also be significant in shaping the further development of both the commitments and the institutions of the regime.

Where existing commitments are deemed inadequately (or excessively) verifiable by at least some interested parties, or where the ability to verify compliance brings problems to light, it may generate pressures to reformulate existing commitments or negotiate new ones. It may also lead to the adoption of a variety of informal verifiable indicators of performance, as discussed above. This can amount to an informal development of commitments, since such indicators can effectively change the standards by which parties compliance is assessed. Verifiability is also an important factor in the effectiveness of unilateral confidence-building measures or pledge and review processes, which are important for many environmental regimes and particularly for framework conventions.

Verifiability issues may similarly affect the institutional development of environmental regimes Measures to improve independent monitoring facilities may strengthen or shape international organisations, implementation review procedures, or transparency rules associated with an agreement. Alternatively, if compliance with commitments is relatively

transparent, the demand for implementation review procedures and international monitoring or assessment facilities will be reduced. The development of clusters of informal indicators of performance could generate demand for highly developed implementation review mechanisms. The relationship between the verifiability of commitments and the development of implementation review mechanisms is worthy of further research. So are questions relating to developing and regulating the shared use of monitoring facilities, including environmental monitoring satellites, for verifying several conventions.

Changes in verifiability and regime dynamics

The verifiability of a given environmental commitment is likely to change over time. This may be done deliberately, but verifiability will also change as a result of relatively independent processes. Changes in intrinsic monitorability, due to scientific, technical or social developments, can be expected, as can changes in monitoring infrastructures and the political or economic systems of the states involved. Because verifiability affects interests, power and learning processes, these relatively autonomous changes could affect the implementation and development of environmental regimes.

Moreover, answers to the question how much verifiability is enough not only varies between interested parties, but also over time. If assessments change on whether existing commitments are adequately verifiable, there is normally scope for achieving substantial improvements in parties verification abilities, either unilaterally or multilaterally. However, such changes in standards could also lead to demands for changes in regime rules and commitments.

Conclusions

Improved awareness of the character and determinants of verifiability and of its potential significance would inform research on the implementation and development of international environmental agreements in potentially important ways. A number of issues that are particularly worthy of research include:

- the extent to which verifiability has affected the formulation of environmental commitments and participation in them;
- the determinants and characteristics of monitorability, especially of the intrinsic monitorability of activities or substances covered by commitments;
- the relationship between verifiability and the development and effectiveness of review mechanisms;
- the role and development of relatively-verifiable informal indicators of national performance in regime implementation and development;
- the relationship between changes in verifiability and regime development and implementation;
- the development and management of, and regulation of access to, environmental monitoring facilities (such as satellites) which are important to the verifiability of several international environmental conventions.

Table of Contents

ON VERIFIABILITY, AND HOW IT COULD MATTER FOR INTERNATIONAL ENVIRONMENTAL AGREEMENTS

August 1994 (revised Nov 1994)

Owen Greene*

1. INTRODUCTION

Verification issues are potentially important in all international agreements where the policies and actions relevant to the agreement of some or all of the participants depend to some extent on the behaviour of other members. More specifically, verification issues are potentially significant when the benefits of participating in an agreement depend to some extent on the compliance of other members with its main rules and commitments. Processes by which performance can be monitored and reviewed can affect behaviour and shape the development of agreements. In some cases, perceptions of verifiability of an agreement could affect the extent to which states are willing to participate in an agreement at all.

Processes for verifying how well partners are complying with their treaty obligations may even be important for states that could benefit from implementing their commitments irrespective of other parties' performance. States may decline such benefits if they suspect that partners think that they can take them for a ride, in order to avoid setting undesirable precedents for future agreements or to encourage (potential or actual) treaty partners to change their general approach towards compliance. Moreover, domestic politics being what it is, uncertainties about compliance can be used by domestic interest groups opposed to the agreement or some of its obligations to block implementation.

Effective verification processes can have an important confidence-building role, encouraging broader participation and further regime development. By contributing to timely information-exchange between the parties, verification and review processes could help countries to optimise the effectiveness of their collective action. They can deter non-compliance and thus

---

* Owen Greene is a Principle Investigator in the Implementation and Effectiveness of International Environmental Agreements project at IIASA, and also Senior Lecturer, International Relations and Security Studies, at the Department of Peace Studies, Bradford University, UK.

Acknowledgments

The stimulus for me to write this paper came from an early meeting of the researchers and advisors for the IIASA project on implementation and effectiveness of international environmental agreements. There it was suggested that a 'thinkpiece' exploring the determinants and potential significance of the verifiability of environmental commitments would usefully complement and develop our work on the role of verification and implementation review processes, and aim to identify areas for further research. An initial outline was developed after discussions with David Victor, and subsequently John Lanchbery, Juan Carlos di Primio, David Victor and Gene Skolnikoff provided valuable suggestions and comments on a draft paper. I gratefully acknowledge their help.

encourage parties to implement their commitments properly and to report accurate information. Effective verification processes would bring evidence of non-compliance to the attention of members of an agreement in a timely way, enabling them to act to help with capacity problems impeding implementation, to protect their interests, or to take appropriate measures to persuade or enable laggards or poor performers to change their ways and implement their commitments more fully in the future.

By improving transparency, verification processes can shape on-going assessments by the parties and other relevant actors of their interests and the ways they choose to pursue these. In addition to providing information about compliance, they can promote learning about: the environmental problems themselves; the problems, constraints and opportunities confronting regime partners; and the effectiveness of different implementation measures.

Moreover, increased transparency can increase the capacity of environmental groups and other non-state actors to play an effective role in improving national environemtnal performance (both at home and abroad) and promoting regime development, by directly or indirectly influencing government policies or by changing the behaviour of other non-state actors. Transparency may bring new actors into the fray, as people and organisations become aware of the significance of the regime for them and of their interests in its development and implementation. Further, to the extent that non-state actors (non-governmental organisations, international organisations, expert groups and such like) acquire some standing in the verification process, their capacity to shape the development of other aspects of the regime may be enhanced.

This is not to suggest that verification, implementation review or transparency processes necessarily help to promote formation, development and effectiveness of international environmental agreements. On the contrary, it is possible to identify a variety of circumstances in which they could be damaging. For example, some countries may be unwilling to join an agreement if verification and implementation review issues are prominent during the negotiation phase or if the agreement contains what they believe to be unduly intrusive or expensive provisions for monitoring their performance. Concerns about verifiability may shape commitments in ways that limit the potential for the agreement to achieve its main goals. Similarly, some transparency or implementation review processes could empower groups that are opposed to the agreement or undermine its supporters. Some verification systems could raise undue suspicion about compliance, or make it difficult to resolve implementation problems in the most effective ways.

Nevertheless, for better or worse, verification and implementation review issues could be a major factor in the initiation, negotiation, establishment and development of international environmental agreements, and in determining their effectiveness. Their important role in arms control and disarmament agreements is well-known and relatively well-studied[1]. To an extent, their role in agreements in other issue areas such as trade (e.g., GATT) and human

[1] There is a large literature on verification in the arms control and disarmament context. See for example, articles and references in the annual VERTIC yearbook - most recently J Poole and R. Guthrie (eds) Verification Report 1994: Yearbook on Peacekeeping, Arms Control and Environmental Agreements, Brassey's, London, 1994 - and S.Sur (ed), Verification of Current Disarmament and Arms Limitation Agreements: ways , means, and practices, Dartmouth Publishing Co., Aldershot, 1991.

rights has also been studied. However, their role in international environmental agreements has until recently been the subject of relatively little research[2].

It is an important part of the aims of the IEC project on the implementation and effectiveness of international environmental agreements to correct this, and to develop understanding of the role and significance of verification and implementation review issues for international environmental agreements. This paper aims to explore an aspect of this issue: the potential significance of 'verifiability' in the development and effectiveness of environmental regimes. Thus, it aims to provide an initial discussion of verifiability - what it is, and how it could matter - and to identify some potentially important areas for future research.

Verifiability is the ability to verify. Thus this thinkpiece only discusses one aspect of the relationship between verification issues and environmental agreements. Clearly the significance of *actually establishing and using* verification and implementation review systems is a larger and potentially more important question. This broader question has been initially examined elsewhere (Fischer (1991); Ausubel and Victor (1992); Greene (1993)), providing at least a starting point for further research within the IIASA project and elsewhere. In contrast the potential significance, and even the characteristics, of verifiability in this context have not yet been properly addressed, thus motivating this initial review.

The next section discusses the potential ways in which verifiability may relate to the development and effectiveness of environmental agreements. This is followed by an examination of the characteristics and determinants of verifiability. The next section after that outlines the ways in which changes in verifiability may relate to the dynamics of regime development and implementation. Throughout each section, the aim has been to identify potential areas for further research as they arise in the discussion. Nevertheless, some of the main research issues raised are outlined in the concluding section.

Before proceeding further, however, it is necessary to clarify what we mean by some of the key terms used in this paper.

Verification is the process of assessing compliance with the commitments in an agreement, or of comparing national performance with agreed standards. The verification process includes monitoring and assessment. More specifically, it includes: monitoring, data-collection and information exchange; analysis of the information gathered or generated; and on the basis of this analysis, assessments of compliance or performance in relation to commitments. It is carried out by parties or groups other than the party whose performance is being assessed, implying some degree of independence from this party in the monitoring, auditing or assessment processes involved.

For our purposes, verification is not simply about *whether or not* a party is in compliance, but also with *the extent to which* it is complying with commitments.

---

[2] There has, however, been a growing literature on this recently, much of it by researchers involved in Module 3 of IIASA's IEC project and their close collaborators, and a significant part relating to climate change. See the following references for initial examinations of verification issues and environmental agreements : W. Fischer (1991); Ausubel & Victor (1992), Greene (1993); and also J. Poole & R. Guthrie (1992, 1993, 1994).

Verifiability is the ability to verify; that is, the extent to which commitments in an agreement are amenable to effective verification. It is a combination of *monitorability* - the capacity to measure or monitor the activities or substances covered by a commitment - and *assessability* (the ability to compare monitored performance with a commitment).

The determinants and characteristics of monitorability and assessability are examined further in section 3, where the question of what we mean by verifiability is also explored in more detail. However, we begin by discussing the mechanisms by which verifiability may affect the development or effectiveness of international environmental agreements.

2. HOW COULD VERIFIABILITY RELATE TO THE EFFECTIVENESS OF INTERNATIONAL ENVIRONMENTAL AGREEMENTS?

2.1 Introduction

The definition of *effectiveness* of environmental agreements is itself contested (see, for example, Young, (1992, 1994); Levy (1993); Haas et al (1993)). The extent to which an international agreement works well can be assessed according to a number of criteria - whether: it helps to tackle the environmental problems it was established to solve; its goals are actually achieved; it changes behaviour of actors along the lines of its agreed standards or commitments; its provisions are adopted in domestic law; it is efficient, fair, sustainable or robust. In this section, we mostly adopt a behavioural understanding of effectiveness (asking how the verifiability of international commitments could affect behaviour relating to the implementation or development of such commitments). But not exclusively so: we also consider mechanisms by which verifiability may relate to other dimensions of effectiveness listed above.

Verifiability is a necessary condition for effective verification processes, which in turn are closely related to (or overlap with) implementation review mechanisms. Therefore, many of the ways in which verifiability could relate to regime development and effectiveness are bound to be closely associated with the mechanisms by which verification and implementation review could be important, which are discussed in Victor et al (1994) and in Fischer (1991), Ausubel and Victor (1992) and Greene (1993). The following discussion aims to build on this understanding (or, at least, mapping) of the potential roles of implementation review and verification, to identify the particular roles that verifiability issues might play.

There are some issues or themes that are important throughout the subsequent discussion. One relates to the fact that verifiability is the ability to verify rather than the actual use or results of verification processes. This means that perceptions or calculations of verifiability will tend to be particularly relevant. Beliefs about the ability to verify will depend upon understandings about monitoring or assessment capacity, and these could turn out to be mistaken.

Moreover, assessments of verifiability will depend on assumptions about the additional resources that would be available actually to carry out verification, or about the economic, political or social costs that might be acceptable. The additional resources available are likely to be limited, and different participants may make different assumptions about negotiable or acceptable additional costs for verification purposes.

In this context, verifiability depends partly on the existence of broader monitoring systems and infrastructures, and of relevant transparency and consultation processes, which will provide a basis on which verification systems could be built. Transparency processes are thus related to verifiability.

Such existing monitoring infrastructures and transparency processes will have their own characteristics, and will vary from country to country. Combined with the fact that different actors will typically have differing access to resources and expertise, this implies that the ability to verify will be unevenly distributed amongst the actors involved. This distribution can be expected to have some stable or structural characteristics: some states' environmental performance is more transparent than others' across a range of issue areas, and some actors have a relatively great overall capacity for environmental monitoring and assessment. Nevertheless, the distribution of capacity to verify is bound to depend in detail on the precise commitments involved.

The verifiability of a particular commitment will thus vary according to who would be doing the verification and which country or other actor is being verified. To the extent that verifiability is important, one would expect that such differences between actors' ability to verify the same commitment could be significant in the development, implementation and effectiveness of regime commitments.

In discussing the ways in which verifiability issues may relate to the effectiveness and implementation of environmental agreements, it is possible to distinguish between two broad levels of analysis. First, there are possible mechanisms by which verifiability issues could affect how 'unitary' states interact, which policies such states choose to adopt, and how they implement them. Second, there are ways in which verifiability could affect domestic or non-state policies or processes in ways that could impact on the development, implementation and effectiveness of environmental commitments.

In each case, verifiability may relate to: actors' assessments of their interests and of the best way to pursue these; the potential for effective and sustained cooperation; learning processes; capacity-building processes; and the ability to affect the policies and implementation practices of other actors. The following sections aim to outline each type of mechanism in turn, beginning with the policies and interactions of unitary states. Potential areas for further research are indicated as they arise.

2.2 Verifiability, interstate interactions, and effectiveness of international environmental commitments

2.2.1 The assessment and pursuit by unitary states of their interests

Potential mechanisms linking verification processes and effectiveness:
Verification and implementation review processes can affect the development, implementation and effectiveness of international agreements through their effects on the ways in which states calculate their interests and choose policies to pursue these interests. The main mechanisms by which they may do this is: (i) to make the extent to which each party is complying with its commitments more transparent to treaty partners and to others, and (ii) to provide a framework within which regular assessments can take place, political pressures for

improved performance can be exerted, and responses to non-compliance can be formulated and coordinated.

By increasing the risks of exposure, potential 'laggards' or free-riders may be encouraged to comply with agreed commitments. To the extent that other states' believe that the benefits of participating in an agreement depend on the compliance of other members, verification and implementation review systems can provide information and re-assurance that implementation is in their interests, and thus help to maintain and build confidence in the regime.

By increasing transparency, verification systems may help parties to identify and sustain complex bargains that allow all parties to benefit. In principle, they could have this effect whether the parties were primarily concerned about their 'absolute' costs and benefits or about their relative positions compared with their competitors. In the latter case, verification and implementation review processes can at least re-assure each party that it is not losing out unacceptably.

How important these interest-based mechanisms are for the development and effectiveness of a given agreement depends on the underlying patterns of power and interests involved (the 'strategic' situation, or 'game'). Classically, one would most expect verification to be important where states perceive themselves to be in a 'collaboration game', where the benefits of complying with commitments depends upon the compliance of other states, and where there are incentives for some states to cheat (see, for example, Stein (1990)).

However, it is possible to envisage a range of other types of 'games' where transparency of national compliance and performance could help or hinder states in finding and maintaining effective environmental agreements. Parties that, even without an agreement, would have independently planned to implement policies consistent with their commitments cannot be expected to be greatly affected in their domestic implementation policies by the existence of verification systems. However, they could be encouraged to 'over comply' if they receive information confirming that other parties are meeting their commitments. Moreover, where the benefits to them are increased by widespread compliance, such 'leading' states may nevertheless want verification systems, to use them to exert pressure on more reluctant states to comply.

The actual importance of these mechanisms can also be expected to vary according to the stringency of the commitments. Whatever the underlying patterns of interests and incentives (or 'game structure'), verification issues may have little salience if the potential costs and benefits of non-compliance are small. Moreover, interest in verifying the performance of treaty partners can be expected to be relatively low if it seems clear that most of them do not find their commitments to be stringent and will find it easy to comply, since verification would probably have little impact on their behaviour in such circumstances.

The importance of these mechanisms by which verification could affect behaviour also depends on the willingness of parties to use them. For example, in some cases, parties may be quite inclined to establish and use verification systems to monitor a particular state's performance and to pressure it to comply fully, even if they suspect that this may only have a marginal impact on its behaviour or if its performance in meeting its commitments barely directly affects their interests in the agreement. The same parties may prefer to turn a blind

eye to the inadequacies of another states' performance. This may be because they are more worried about the possibility that it might leave the agreement or retaliate if challenged, or because of broader considerations of power and foreign policy.

Verifiability of commitments, by definition, is a necessary condition for effective verification processes. Thus the extent to which states have an ability to verify commitments will be a major factor in determining the extent to which any of the mechanisms outlined above may operate.

Moreover, the particular characteristics and distribution of verification capacities in a specific issue area may have qualitative effects on the ways in which such mechanisms operate and on their effects. Some commitments are more verifiable than others and, for each commitment, abilities to verify will be unevenly distributed amongst states. Variations in verification abilities may thus shape states' calculations of interests as they decide how to operate within an agreement and how to implement their commitments.

Verifiability and the shaping and negotiation of commitments

In the 'rational actor' paradigm we are temporarily adopting here, if the mechanisms relating verification processes to effectiveness outlined above are likely to be important in a given agreement, our 'unitary' states can be expected to take them into account when they are considering whether to enter into such an agreement, and when they negotiate commitments. At this stage in the development of an agreement, assessments by states of their potential abilities to verify would be relevant rather than the verification process itself.

Thus, understandings about verifiability may be an important factor in decisions about whether to join an agreement and about the formulation and implementation of commitments. States which calculate that participation or implementation is only in their interest if others also comply may be unwilling to enter into negotiations where potential commitments appear unverifiable. Conversely, states seeking merely symbolic agreements may not want to risk being manoeuvred into verifiable agreements.

For similar reasons, concerns about verifiability may shape commitments, and thus the overall design of the international regime. For example, the Montreal protocol is primarily concerned with limiting concentrations of chlorine and bromine in the stratosphere, and thus with limiting emissions of ozone depleting substances such as CFCs. However, commitments focus on consumption (defined as production plus imports minus exports), partly because this is more monitorable (it is also more amenable to effective government regulation).

Governments which believe that they can use verification systems to promote their interests will tend to try to shape commitments accordingly, to ensure that they, at least, are able to monitor and assess performance. Moreover, it is possible to conceive of situations where states will want to negotiate verifiable agreements which nevertheless lack effective verification systems. They may believe that their interests are best served by an agreement in which non-compliance cannot easily be detected at the beginning of the regime, with the option of being able to develop effective verification systems later. They may, for example, want to defer full compliance themselves. Alternatively, they may believe that this is the only way to win broad agreement to sign up to a desirable agreement, and hope to improve its effectiveness later. These states will have an interest in shaping commitments so that they are "verifiable" but deferring the establishment of effective verification procedures.

A variant of this approach would be negotiate commitments so that one aspect of verifiability was in place, but not the other. For example, commitments could relate to monitorable activities, but be formulated ambiguously so that compliance cannot be objectively assessed. States could then, for example, hope to be able relatively rapidly to refine the commitments or standards to make them more specific when the time was judged to be right.

The extent to which assessments of verifiability have actually shaped the negotiation or formulation of international environmental commitments, or affected decisions about whether to participate in an agreement, is unclear and a potentially important subject for empirical research. From the foregoing discussion, one would expect the salience of verifiability to depend upon: perceptions of the patterns of interests or pay-offs that an agreement would involve (i.e. the strategic situation or game states perceived themselves to be in); the extent to which states were concerned with relative advantage rather than absolute cost-benefit calculations; the stringency of commitments; and the extent to which there were significant differences in the verifiability of the types of negotiable commitments. In cases where verifiability issues seem to have been salient, a number of ways in which states may aim to affect verifiability in pursuance of their interests were indicated above (such as varying the specificity of commitments), and it would be interesting and potentially important to trace which of these were used and with what effect.

Efficiency of joint effort

In our review of the role of implementation review mechanisms (IRMs) may play in the effectiveness of international environmental agreements (Victor et al, 1994), an interest-based process is identified by which IRMs can, through information gathering and exchange, reduce the transaction costs of finding and maintaining international agreements which states enter into in order to benefit from efficiencies gained by performing some functions jointly. In this context, the verifiability of activities or phenomena in a given issue area could directly correlate with the prospects that states will achieve such joint actions. To the extent that relevant activities are relatively easily or reliably monitorable, it may be easier for governments to identify opportunities for cooperation and to establish efficient common standards.

The correlation between verifiability and transparency is potentially important here. If the relevant activities and concerns of each potential partner are relatively transparent to the others, governments are more likely to be able to identify and negotiate such cooperative agreements. Once joint action is agreed, transparency will make it easier to maintain and develop the cooperation.

Moreover, the partners may decide to establish implementation review mechanisms (IRMs) or improve their monitoring capabilities to increase the efficiency of their cooperation, and thereby improve verifiability as a side benefit. However, to the extent that the relevant activities are already adequately verifiable (or transparent) using national means or existing information exchange systems, there may be less demand to establish new IRMs. This indicates one of many ways in which verifiability could shape the demand for, and design of, IRMs in an agreement.

Within an established international regime, there may also be many situations where some or all parties could benefit from performing some functions jointly and where verifiability may be relevant. For example, groups of parties may be able to benefit by jointly implementing policies to meet commitments, or by acting jointly to persuade or enable poor performers to

improve their compliance. They could similarly benefit by jointly funding improvements in monitoring capacity, or joint-development of new technologies to facilitate improvements in environmental performance.

Where such cooperation is explicitly provided for in the established regime, IRMs may have been established to improve transparency and facilitate joint action. However, more generally, the transparency associated with verifiability may be useful for finding and maintaining such cooperation. One possible example relates to joint action to pressure a state to improve its compliance or performance. Since verifiability is the ability to monitor and assess other parties performance and compliance, it is an important factor in the capacity of groups of states effectively to generate and target pressures for improved compliance or even joint enforcement actions.

The *distribution* of verification capacity is potentially important in this context. States with a relatively good capacity to monitor or assess other states activities or performance will be in a better position to set agendas for joint action than states with relatively little ability to monitor or assess. Such states may thus be better able to identify and pursue its interests through these joint actions.

Empowerment of states

Verifiability may thus relate to the capacity of states to influence or coerce others. The capacity to expose non-implementation of commitments can be used not only in the interests of the regime itself but as an instrument wider foreign policy objectives. There will be differences between states monitoring and assessment capacities, due to differences in their technical monitoring capacities and expert resources, and to differences in the nature of the states themselves (some are more transparent than others, etc.). Such differences in states capacities to identify and expose non-compliance in others will affect distributions of power and influence. Moreover, influence may not only derive from a capacity to expose poor performance: the ability to monitor and assess the activities of other states may provide many opportunities to exert political or economic influence or advantage.

In principle, perceptions of a state s ability to verify could sometimes be as important as its actual ability. If others believe that a state has a capacity to identify poor performance, this could in itself deter non-compliance. Moreover, claims made by such a state about the performance of others would be likely to gain serious attention, even if they are not well-founded. However, the potential for exploiting such a reputation is probably more limited in the environmental issue area than for example in arms control or counter-terrorism: environmental monitoring capacity is not classified, and there would be little excuse for not sharing evidence fully with others.

The design of monitoring and assessment systems associated with the agreement can affect the ways such capacities may be distributed. International organisations and international monitoring systems tend to empower relatively poor or weak states in this context. But this is not necessarily always the case and would need to be investigated for each regime.

Empowerment of International Organisations

The resources and influence of international organisations themselves may also be affected by their ability to monitor or assess activities or materials covered by environmental commitments. Existing international organisations with relevant expertise or responsibilities may be able to extend their role and influence by providing monitoring or verification services to the parties of a new environmental agreement. For example, the FAO has

apparently been keen to play a role in emerging environmental conventions relating to land use, where it has established monitoring and data-collection experience (though so far seems to have had only limited success in securing such roles). Similarly, the Secretariat or international bodies of experts specifically associated with an agreement may increase their resources and influence if they gain the ability (that is, both the capacity and the remit) to monitor or assess parties performance in relation to their commitments.

2.2.2 Verifiability, learning and states behaviour

Learning about interests

Verification systems are primarily designed to help states keep abreast of their changing interests, as they are affected by the performance of other states in meeting their commitments. Verifiability is a measure of the ease and reliability with which such learning processes take place. More broadly, if key activities are relatively monitorable, relevant information will tend to be easier to collect and be more persuasive to decision makers.

If states learn more about their interests, it will not necessarily lead to more effective agreements. For example, measurability may make it easier for governments to agree impressive sounding targets (and thus reduce pressures for further action), confident in the knowledge that the targets can actually be achieved with little cost or change in policy. In this context, "verifiability by whom?" is a potentially important question. Activities that may be easily measurable by some governments may not be so measurable by others, or by non-state actors. Asymmetries in learning about interests may affect the negotiation and implementation of agreements in a variety of ways, as discussed above.

Confidence-building between states

An effective verification system can play an important confidence-building role, in that it can help to reassure states that treaty partners are implementing their commitments. In part, this is simply a question of helping states to learn about their interests, and is a consequence of the confidence arising from parties being able to detect poor compliance in time to allow actions to be taken to protect their interests. However, in this confidence-building role, the knowledge gained through verification processes can also help to shape broader perceptions of the trustworthiness of states as future cooperation partners in this and other regimes. Verifiability will shape the effectiveness and character of these verification systems and thus overall confidence-building processes.

Moreover, the ability to monitor and assess of the activities of other states will provide governments with opportunities to learn about the constraints under which their treaty partners are operating. As governments become more aware of the efforts other states are making to meet their commitments, and the obstacles they have to overcome to achieve them, reactions to evidence of non-compliance are likely to become more sophisticated and less prone to undue suspicions of bad faith. With more knowledge, they may be more able to target assistance or political pressure more effectively to improve performance. Once again, even in this context increased knowledge will not always increase mutual confidence. It may help other states to see through superficially impressive government programmes, or to appreciate that seemingly stringent commitments were actually relatively painless for some states.

Verifiability could also be an important factor in determining the effectiveness of unilateral actions in stimulating positive international responses, and perhaps initiating international cooperation. The international impact of unilateral commitments may often depend on their verifiability. An unverifiable commitment may generate cynicism and resentment rather than confidence: since they cannot monitor whether it is being implemented, other states may suspect the declaration to be purely symbolic and designed to secure domestic or international political advantage.

Often, such suspicions may be justified. However, it may also be that governments had acted in good faith, but had neglected to design their commitment so that it is verifiable by others. Thus, assessments of the verifiability of one's own country's actions may be important in shaping unilateral commitments.

Moreover, unilateral measures aimed at increasing the verifiability of relevant activities within their state may be one of the most effective types of unilateral confidence-building measures. Unilateral initiatives to provide information or increase transparency can be most effective in building confidence when they substantially improve verifiability in areas of greatest concern to cooperation partners.

Designing such unilateral confidence-building measures effectively could therefore require a government to have a relatively sophisticated appreciation of the significance of verifiability for the effectiveness of the agreement and of the gaps in key treaty partners' abilities to verify its performance. These gaps may be in the areas where the government concerned has relatively little problem in auditing its own progress in implementing its commitments.

While such unilateral transparency measures to improve verifiability can build mutual confidence in an international environmental agreement that defines specific environmental commitments for each party, they can be much more important for 'framework' conventions which define broad obligations but allow flexibility about how each party chooses to implement them. The conventions and Agenda 21 process agreed at the 1992 Rio Conference have some of these characteristics. For example, pending future protocols, the Framework Convention on Climate Change (FCCC) essentially establishes a 'pledge and review' process, whereby parties (particularly developed countries) are required to pledge themselves to unilaterally-defined policies and targets for limiting greenhouse gas emissions and to provide reports allowing their plans and progress in limiting emissions to be reviewed by their treaty partners [3]. The effectiveness of the FCCC in changing parties' greenhouse gas emissions will depend greatly on the effectiveness with which their performance can be

[3] Proposals to establish a 'pledge and review' process were much debated during the process of negotiating the FCCC and where opposed by many states as an attempt to legitimise a lack of specific commitments such as emissions targets. Therefore, no reference is made to 'pledge and review' in the convention, although its main obligations amount to a requirement for parties (particularly developed countries) unilaterally to declare policies and commitments to limit their greenhouse gas emissions and to provide reports to allow their performance to be reviewed. For a discussion of pledge and review in the context of the FCCC, see M. Grubb and N. Steen (eds), (1991); and also Chayes (1991); D. Victor (1991).

reviewed and thus partly on the verifiability of their pledges and the transparency of their performance (Greene and Salt (1993); Victor and Salt (1994)).

National Capacity

The verifiability of activities under a state s jurisdiction may nevertheless often be a measure of its national capacity to monitor its own activities and to implement environmental policies. As discussed in section 3 below, the verifiability of activities within a state will often depend on the existence of the national infrastructure and resources on which monitoring or measurement can be based, and in a broader sense on the character and development of the state and society concerned. In many environmental agreements, much of the information on which assessments of national performance can be based will be collected by the government concerned, or by associated national agencies or regional authorities. Thus, the extent to which a government can itself monitor relevant activities inside its own state is probably frequently correlated with its capacity to regulate activities under its nominal jurisdiction, and thus to implement policies designed to ensure compliance with treaty commitments. Commitments made by weak or less developed states will thus often be much less verifiable than similar commitments made by strong developed states.

If verification systems and implementation review mechanisms (IRMs) involve the identification or establishment of new sources of data and analysis, at least as far as the state involved with implementation is concerned, then they could increase national capacity to comply with commitments. IRMs and verification systems may also alert other states and international organisations about the need to provide assistance and also contribute to the effective targeting of that assistance. Inadequate reporting by developing states in the Montreal Protocol, for example, helped to reinforce and shape the case for assistance in capacity-building under the multilateral fund.

Learning about the problem

Verifiability relates to commitments rather than to problems per se. However, to the extent that these are linked, the measurability of activities relevant to the problem can obviously affect learning. It is also possible that systems established to improve the capacity to verify compliance will also provide resources for additional monitoring, data-collection and analysis that contributes to understanding of the problem itself (as well as to other unconnected issues of potential importance). Awareness of this possibility may in turn make agreements seem more verifiable. This is because governments and scientific funding agencies are more likely to be persuaded to invest in new monitoring and analysis capacity if this capacity can also be used to learn about the environmental problems themselves.

However, where verifiability concerns shape commitments and choices about indicators of national environmental performance, they could also affect the development of understandings of the environmental problems themselves. The relationship between environmental problems, environmental indicators, and indicators of national environmental performance is frequently complex and confused (see for example, Noss et al (1992). In most environmental issue areas, there is substantial scientific uncertainty and policy debate about what the environmental ‘problems’ really are. The processes by which such problems are defined for the purposes of prioritising research and focusing policy-debates can be murky. The same can be said about the ways in which certain activities or environmental indicators become singled out for special attention. In principle, research and attention given to activities or indicators of national performance in order to improve verifiability could in

practice affect choices about which environmental indicators to monitor for information on the problems themselves.

Environmental research and verifiability

In practice, resources are more likely to be invested in environmental monitoring and assessment facilities that are designed to improve knowledge of environmental problems, with spin-off advantages for verifiability, than the other way around. Much of the capacity available to monitor environmental activities for verification purposes has been established for the purposes of scientific research, resource mapping, and environmental management. The Landsat and SPOT satellite remote sensing systems provide examples of this, and such satellite-based environmental monitoring systems are due to be expanded greatly in the near future with the development , for instance, of the Earth Observation satellite system. Only very recently has the potential role of such systems for verification purposes begun to considered seriously (see, for example, Fischer et al, 1992).

The extent to which environmental monitoring systems, including remote sensing facilities, contribute to the verifiability of a wide range of existing and potential international environmental commitments is a potentially important area for scientific research. This does not only raise questions relating to technical monitoring capabilities. For example, principles and rules relating to access to such data for verification purposes are still at an early stage of development, and yet are becoming important policy issues.

In this context, it is important to note that the monitoring capacities of any one of such systems are likely to be relevant to more than one environmental agreement. Thus a cluster of conventions covering related issue areas could make use of the same monitoring systems.

For example, the climate change convention, biodiversity convention, desertification convention and proposed forestry agreements all generate interest in the verifiability of commitments relating to land-use, as do a number of regional agreements. The implementation of such commitments may be monitored using a range of satellite and aircraft- based remote sensing systems as well as established and emerging FAO data-collection systems. The challenges of efficiently and effectively organising the development and use of such generic monitoring facilities to improve the verifiability or effectiveness of a variety of environmental agreements with differing requirements are substantial and require research.

2.3 Verifiability, effectiveness and domestic or non-state processes

In this section, we stop pretending that states are the only major actors involved in making and implementing international environmental agreements or that states are typically ‘unitary’. Non-state actors can also be important. The behaviour of powerful groups in and around governments, and of other transnational and domestic non-state actors, may be related to the verifiability of commitments and to verification processes in general.

It can be misleading to assume that states are unitary in any issue area. The individuals, groups and ministries in and around government who assess or decide state interests will tend to bring their own interests to bear in the decisions they make on the state’s behalf. Moreover,

non-governmental or transnational organisations constrain or shape for formulation or implementation of government decisions or commitments.

Nevertheless, the links between the development and implementation of international commitments and domestic or non-state processes are likely to be more important and complex for environmental agreements than in other issue areas such as arms control. Defence and security policy-making and implementation, for example, is normally unambiguously controlled by central government. Although powerful domestic interest groups, including the military, will shape the formulation of government policy, once state policy is made, the mechanisms by which governments can ensure that military activities change in accord with it are typically well-developed and relatively direct. In contrast, most activities relevant to the implementation of environmental agreements are carried out by non-state actors, semi-autonomous state industries or agencies, or local authorities. Governments thus face a particularly complex task in successfully regulating or altering the actions of many domestic or transnational actors in their jurisdiction.

As in the previous subsection, we now briefly review the ways in which the ability to verify implementation of commitments (and the distribution of such abilities) could affect the behaviour and role of non-state actors in relation to the effectiveness of international environmental agreements - examining first interest-based mechanisms and then learning processes.

2.3.1 Verifiability, interests, and domestic actors

Cost-Benefit calculations and interest groups within states

As noted above, the domestic interest groups in (or closely associated with) governments who assess or decide state interests will tend to bring their own interests to bear on the cost-benefit calculations they make on the state's behalf. Thus, just as verification systems and verifiability could affect the cost-benefit analyses of the state per se (which is an abstraction), they can affect the calculations that these decision-makers make about their own interests and the decisions they make for the state. Since it is these groups that negotiate or otherwise determine the agreements, commitments and implementation policies of their state, this effect is potentially at least as important as the classical mechanisms outlined in section 2.2.1.

Awareness of the verifiability of the activities or materials in which they have a particular interest or responsibility could thus affect the behaviour of particular groups, ministries or government agencies. Some of the considerations and mechanisms would be similar to those discussed in relation to states, in that these groups may make cost-benefit calculations about the benefits of joining an international agreement in relation to the interest groups or types of activities for which they are particularly responsible within the state, and negotiate accordingly on the states behalf. In this context, even where verifiability issues may seem marginal in relation to the states' 'overall' interests, they could have important impacts on the development or implementation of environmental agreements because they are perceived to be important for the particular interests of the government bureaucracies or groups that represent the state in negotiations or have particular responsibility for implementation.

Moreover, these interests in verifiability may be influenced by domestic and well as international considerations. For example, the development of reporting rules or independent monitoring capacity in association with an agreement may allow practices to be monitored

that could previously be kept secret from other branches of the government or society, and even from the President or Prime Minister. This may help other groups in the state learn about their own interests. The prospect that such independent monitoring systems may be established could certainly inform calculations of interests in an agreement by groups whose activities might be exposed to government or societal as well as international scrutiny. Similar issues may arise where an agreement would require or encourage a government itself to establish effective national monitoring systems where none existed before.

Similar considerations would apply to domestic interests that are influential but outside government. The combined effects of verifiability on the way in which these groups negotiate and define government policy and the state s interests will depend on specific circumstances, as will the significance for the negotiation and implementation of commitments. However, this type of mechanism demonstrates that verifiability may affect the formulation and character of a state s interests as well as the way it pursues them and the prospects for effective agreements.

Verifiability and relative empowerment within a state

The capacity to monitor and assess implementation of commitments could empower states in relation to their own society, and may possibly empower various government bureaucracies, and non-state actors such as international organisations, NGOs and non-governmental experts. If the verifiability of implementation of commitments, or the distribution of ability to verify amongst different groups, affects the relative power and influence of domestic or transnational actors, one would expect it to have an effect on the formulation and implementation of policy.

In relation to the state s power in society, international agreements may legitimate or resource the development of new or more effective national monitoring systems, potentially enabling the state to monitor and regulate domestic activities more effectively. International or independent monitoring or reporting systems may expose activities of which the state was previously unaware. Alternatively, they may provide an opportunity for the state to gain international support in its attempts to monitor or regulate activities nominally under its jurisdiction to which it previously felt obliged to turn a blind eye.
To the extent that the state is trying to implement its commitments, these mechanisms will tend to increase treaty effectiveness, at least in the sense that behaviour would be changed in line with the rules of the agreement.

Furthermore, if the state has an ability to monitor implementation activities in other countries, it may learn more effective ways to exert its influence within society or to control powerful domestic interest groups. However, this argument can work both ways. For some areas of environmental policy, some non-state actors (such as concerned multinational companies, international organisations, or well-organised environmental NGOs) may be better placed to monitor implementation activities in other countries than the state itself.

As discussed above, the ability to verify may well empower certain government bureaucracies. Information or resources for monitoring or assessment resources over which they have control or access may gain new importance after an international environmental agreement has been established or as verification concerns become salient, empowering particular bureaucracies in relation to their rivals in and around government. Moreover, new

verification or monitoring processes established in association with an international agreement may change the relative power of government bureaucracies. An arms control example of this is the Soviet foreign ministry officials who (much to the irritation of the military officials present) found out about Soviet military programmes from US representatives during discussions about verification during the SALT process). Such processes may also give certain bureaucracies access to a range of international organisations or experts with which they did not previously have contact.

To the extent that governments care about the implementation of commitments by others, the experts and bureaucracies charged with verification will gain additional means of influencing government foreign policy. Moreover, the knowledge they gain about other countries' performance and also about the verification capacities themselves may enable them to influence other dimensions of government policy making. They could shape decisions about how to implement domestic programmes, either because they have knowledge about the experiences of other countries or because they know the limits of the capacity of other countries to monitor their own country's activities. Whether or not this will increase or decrease the effectiveness of the agreement is uncertain.

The ability to verify will depend partly on experts, who are needed to carry out monitoring or assessment, to develop or adapt new monitoring and assessment resources (including building models or gathering data) and to provide expert advice. To the extent that governments and other actors believe that verification issues are important, this will place experts in positions of influence, both in relation to government assessments of other countries' performance and also in relation to domestic implementation. Technical or scientific experts tend to have an independent professional concern to carry-out their allocated tasks in a scientifically or technically competent way, and to extend their monitoring or assessment capacity where they can (and potentially into areas that sections of governments or other interest groups would prefer to remain murky).

To the extent to which such experts are part of a transnational scientific community, they tend to act in accordance with the values of that community which may help to encourage them to try to improve the effectiveness of international agreements and to try to improve domestic implementation of commitments. In practice, there are often strong links between monitoring and assessment relating to learning about environmental problems, reviewing the adequacy of commitments, and monitoring parties' performance in meeting their existing commitments. This will tend to further extend the ways in which experts' role in verifiability could be used to exert influence over policy: Concerns they have that arise from their ability to verify could feed into the advice the scientific community gives about the nature of the problem and the adequacy of existing commitments.

The ability of domestic or transnational non-state actors to verify compliance with treaty commitments may empower them in their dealings with their own state authorities and other relevant actors. Their ability to expose inadequate implementation may be relatively important in the effectiveness and development of agreements in the environment and human rights areas. Not only are domestic groups and citizens often in a better position to monitor some types of activities in their states than outsiders, but they may be relatively willing to publicise the problems and cause embarrassment. Foreign governments, in contrast, may be willing to turn a blind eye to inadequate compliance in the pursuit of broader interests or as part of a tacit agreement amongst states to tolerate poor compliance. In other words,

environmental groups and other non-state actors may not only accord a higher priority to the effectiveness of environmental agreement than governments, but also insist upon interpretations of treaty requirements that involve higher (i.e. more stringent) standards. Verifiability may help to empower them to pursue these objectives.

To the extent that the ability of certain non-state actors to monitor or assess compliance or implementation is recognised by parties, it may enhance their standing in the treaty regime overall, empowering them in implementation review processes and in debates about refining and developing commitments.

Non-state actors may also be in a position to promote compliance more directly. In many environmental agreements, governments are only indirectly involved in implementation and compliance. The capacity of non-state actors to monitor relevant activities by industry, exotic pet traders, and such like, may directly encourage compliance with the standards set by the international agreement, even without working through the state.

Similarly, the ability of companies to monitor the activities of their rivals in their industry may encourage compliance. If some firms are gaining competitive advantage through poor environmental performance, their rivals could have incentives to expose them. On the other hand, this is an area where the distribution of abilities to verify could be critical. If government regulators, NGOs, or international organisations have little ability to monitor their performance (or if 'whistle-blowers' in the industry are likely to be punished badly), companies could tacitly agree to tolerate poor compliance with environmental regulations in their industry.

Standard setting by leaders

As with implementation review mechanisms in general, verifiability may increase the effectiveness with which (political or commercial) leading groups or organisations can set standards which are in tune with their own interests. Once standards are set, there is the problem of encouraging their widespread adoption. The verifiability (or transparency) of activities or materials relevant to implementation may speed up the adoption of 'best practice' and 'new' technologies and such like. Those who stand to benefit from this may discover an interest in a verifiable agreement. To the extent that the standards are useful to promote implementation of the agreements, such mechanisms will tend to promote treaty effectiveness.

2.3.2 Verifiability, learning, and non-state actors

Verifiability of commitments is correlated with the transparency of the activities or phenomena involved, and transparency can facilitate learning. Moreover, international or independent monitoring and assessment systems associated with verifying a treaty may provide governments, regulators, bureaucracies, and non-state actors with information that they would not otherwise have had. National monitoring systems may be enhanced in order to fulfill international reporting requirements, with similar results.

To some extent, the implications of this for effectiveness have already been discussed in relation to learning about interests and empowerment. However, simply learning the new

information may improve effectiveness without changing power balances and interest calculations.

Governments and non-state actors will typically by uncertain about the effectiveness of the measures they are taking. Information available as a result of verification capacity could improve internal auditing and enable actors to implement their policies more effectively. Regulators and others responsible for implementation could learn from the performance of their counterparts elsewhere: a particularly important process in relation to environmental agreements where the task of shaping or regulating complex and decentralised social practices is particularly challenging. It may also alert them to unintended consequences of their actions for compliance with agreements, so that they can take corrective action.

The openness and timely availability of the information gathered and used for verification purposes will affect its value for such learning processes. Where compliance assessments are to the fore, governments can be concerned to limit the availability of information. This can be justified as a measure to prevent undue disputes and limit possible damage to the regime. However, it also limits the extent to which the information is likely to be used to increase effectiveness through learning and empowerment mechanisms.

3. THE DETERMINANTS AND CHARACTERISTICS OF VERIFIABILITY

3.1 Introduction

The *Verifiability* of a commitment is the ability to verify it. As briefly outlined in section 1, it is determined by a combination of two properties: the *monitorability* and *assessability* of the implementation of the commitment. The monitorability of a commitment is the ability to measure or monitor the activities or substances covered by the commitment. Assessability is the ability to assess compliance and performance by comparing monitored performance with the commitment.

Verification is carried out by organisations or states other than the state whose performance is being assessed, and thus assessments of verifiability will partly depend on the extent to which there is an ability to *independently* monitor or assess the performance of the state concerned. Moreover, assessments of verifiability will also depend on judgments about how reliable a verification process would have to be to be adequate or effective , and this will depend upon assessments of interests, the strategic situation (or game), the stringency of the commitments, and the main purposes which important actors hoped to achieve through the verification system. States and other interested actors have different characteristics, capacities, and verification requirements, and thus assessments of verifiability will depend on the question verifiability by who, and of whom? .

In principle these are relatively straightforward concepts, and they have been sufficient to allow a review in section 2 of the potential mechanisms by which verifiability may affect the development and effectiveness of environmental agreements. It is now, however, necessary to explore the determinants and characteristics of verifiability further, to provide a basis for assessments of the verifiability of particular commitments and refining possible research questions relating to the significance of verifiability for environmental agreements.

The following subsections examine the main factors determining the monitorability and assessability of commitments, bearing in mind the importance of the degree of independence of the monitoring and assessments systems and which actors are involved.

3.2. Monitorability

Some types of things or activities are more amenable to reliable monitoring and measurement than others. This will depend upon a combination of a range of factors, which can roughly divided into the following categories:

- the intrinsic characteristics of the activities or phenomena to be monitored;

- the characteristics of the monitoring, data-collection and assessment infrastructure available to provide a basis on which specific monitoring can take place;

- the characteristics of the states and societies being monitored.

The possibility of monitoring other indicators as effective proxies for the activities or phenomena to which the commitment applies is also a potentially very important consideration. If the substance or activities specifically referred to in the commitments are relatively unamenable to monitoring, it might still be possible to identify relatively monitorable indicators to indirectly measure performance and compliance.

We now examine each of these factors briefly in turn.

3.2.1 Intrinsic characteristics

The intrinsic monitorability of materials or activities may relate to their physical or their social or economic characteristics. Physically, the existence in a country of a large, fixed, factory complex is nearly always more easily monitored than small, mobile or easily moved, items. Everything else being equal, regular or permanent features or activities are easier to monitor reliably than irregular or single events. Activities involving large numbers of ordinary civilians or which impinge on many aspects of social and economic life are harder to hide than relatively isolated activities that are carried out by the military or government officials.

The extent to which a given material or activity is measurable will depend upon the level of (natural or social) scientific and technical understanding, and on the extent to which relevant monitoring devices are available or can be developed. This will depend upon past research and investment in the area, and will change with time. For example, in the 1990s, changes in atmospheric concentration of certain trace chemicals can be more accurately measured than for other such chemicals. This is partly because of laws of nature and partly because of the (humanly-determined) state of science and the development of monitoring technologies.

One could imagine developing a lists of factors that determine the inherent measurability of "Substance X" or "Activity Y". It is important to recognise, however, that these factors will be social and economic as well as natural or physical, and thus their significance (and even their definition) will depend partly on social context.

Substance X in this context could be a CFC, toxic waste, oil tanker design, forest area, or the Amazonian Red-Breasted Parrot. The factors determining its inherent monitorability could include: size; vulnerability/destructibility; phase (gas, liquid, solid); mobility; chemical reactiveness; reflective or absorptive properties; source; social or economic value; social acceptability; uniqueness (or existence of "look alikes" or similar substances); and ease of recognition by non-specialists(for example, could non-experts (such as local customs officials) be reasonably expected to learn how to distinguish the protected Amazonian Red-Breasted Parrot from the unprotected Columbian Ruby-Breasted Parakeet?).

Activity Y could be, for example: Minke whaling; lead battery disposal, or irrigation practices. Factors determining monitorability could include: number of people involved; type of people involved (civilians, military, scientists; astronauts; criminals); social or economic value (to government, to particular commercial, social or ethnic groups); relationship to core economic activities; social acceptability; public or private; social or individual; complexity; dependence on large or permanent equipment or infrastructure; similarity to activities not covered by commitment.

A possible area for further work would be to aim to develop such lists of characteristics into a a generic list of the key physical and social factors determining the inherent monitorability of 'Substance X' or "Activity Y'. Such a list could contribute to a clearer understanding of the types of environmental problems, activities or substances that were amenable to effective regulation through international agreements where verification issues may be important. More particularly, such work could inform the formulation of commitments. There are normally a number of potential ways in which any given environmental problem could be addressed and, to the extent that verifiability is potentially important for effectiveness, it would be desirable to focus attention on negotiating types of commitments that are likely to prove amenable to verification. This will often imply focusing on indirect methods of regulation and control, where the activities or substances of direct concern are relatively unmonitorable: for example, intentional oil pollution may be more effectively controlled by focusing on implementation of regulations relating to tanker design (designed to reduce the incentives and capacity to release oil at sea) than by concentrating directly on regulating the discharges themselves (which are relatively unmonitorable)[4].

However, it is also important to note that phenomena or activities can be monitored by direct or indirect means. For example, carbon dioxide emissions from fossil-fuel burning can either be monitored directly, by measuring emissions passing through the power station chimneys, car exhausts, etc., or indirectly calculated using data on the amounts of fuel burned, the carbon content of the fuels, and the efficiency of the burning processes. In practice, indirect measurements can often be more feasible or cost-effective. This is certainly the case for national emissions of carbon dioxide emissions from fossil fuel-burning.

Indirect measurement relies upon the establishment of an acceptable methodology for calculation, as well as the capacity to measure the required data inputs. Such an approach depends on the existence of an agreed 'working' scientific understanding of the relationship between the activities or processes to which the commitment refers and the measured inputs required by the methodology. The methodology will have its own uncertainties, in addition to

[4] This, at least, is the conclusion drawn by Mitchell in his study of the effectiveness of MARPOL agreements relating to intentional oil pollution (Mitchell, 1993, 1994).

the uncertainties in the input data. Moreover, scientific understanding of the relationships involved will change, implying changes in the methodologies and thus in measured performance in meeting commitments.

The intrinsic measurability of an activity or material can moreover depend substantially on the type of commitment with which the verification exercise is associated. Monitoring whether or not an activity is taking place (did any nuclear dumping at sea take place or not?) is normally more reliable than measuring the extent to which it is taking place (was nuclear dumping within agreed limits?). For this reason, prohibitions are typically more verifiable than non-zero limits. This is also an 'assessability' issue: evidence of non-compliance is less ambiguous and less contestable.

In principle, assessments of the inherent monitorability of commitments should to take into account the possibility that the state or other actors involved will try to camouflage or hide monitored substances or activities or distort measurements of them. Some activities are easier to hide or camouflage than others, due to their inherent characteristics or their place and role in society. The scope for such practices will also depend on the character of the monitoring systems used, and the extent to which they are independent of the government and other interested parties in the country whose performance is being monitored. How seriously the possibility of camouflage or covert activities will be taken in assessing the monitorability of a given commitment will depend on a variety of judgments relating to the incentives and costs that would be associated with them. When monitoring relies substantially on self reporting, it may be relatively easy to neglect to report certain data. The costs of hiding activities from independent inspectors or monitoring systems may well be more substantial. The cost of hiding or disguising the activity may be large, and the restrictions that the covert measures might place on the value of the hidden substances and activities may well render such activities unattractive.

3.2.2 Infrastructure and monitoring systems

Even if an activity is inherently monitorable, it may not be possible actually to monitor it without an adequate infrastructure of monitoring platforms, data-collection systems, and expert or institutional resources. In principle, the necessary infrastructure and resources for monitoring could be specially developed for the purposes of improving treaty verification. In practice, governments and other interested parties will be reluctant to allocate additional resources to develop the infrastructure needed for monitoring performance in meeting treaty commitments if the costs are disproportionate to the benefits of reliable monitoring.

Thus, assessments of monitorability must take into account the extent to which an adequate monitoring infrastructure is available or is likely to become available. Thus judgments may have to be made about acceptable costs for developing new monitoring capacity or infrastructure. Such costs may be political or social as well as economic. For example, new data-gathering institutions or systems are unlikely to be politically, socially or economically acceptable unless they are compatible with the existing structures, goals, and values of the state, society or dominant domestic interest groups.

Moreover, the measurements and information collected will typically be shaped by characteristics of the data-gathering infrastructure. For example, data on the size of cattle stocks that is collected primarily for the purposes of taxation may well tend to understate

actual numbers, whereas if it was collected for the purposes of distributing agricultural subsidies one would expect the opposite effect. Similarly, it is important to know whether a government primarily relies on self-reporting by farmers for such data, or whether they make use of an extensive system of independent inspectors. Differences between countries or regions in the characteristics and purposes of the monitoring infrastructures they use may make information on national compliance difficult to compare.

One standard way of reducing such problems of comparability is to formulate commitments in relation to changes from a baseline established for each country (for example, 'national cattle stocks should be 10% smaller in 2000 than they were in 1990'): provided that the data-collection systems remain the same over the period, any systematic biases associated with them will apply equally for the 'baseline' and 'target' years. However, in practice national monitoring infrastructures will also tend to change with time, and often for reasons that are unrelated to the environmental agreement or to verification concerns. For example, bureaucracies may be re-organised, data-gathering systems may change, and new methodologies adopted. Moreover, the social context will also change, altering the effects of 'infrastructural biases' on the data. Changes in measured national performance in meeting commitments may thus be an artifact of institutional change, involving perhaps changes in taxation or subsidy systems, or switching data-collection from use of tax returns to on-site monitoring. The potential for such infrastructural change, and the likely character of such changes may affect assessments of monitorability of commitments.

This provides a further reason for preferring to use independent monitoring systems that are operated mainly for the purposes of reliable environmental monitoring, if not solely in the interests of ensuring verifiability. However, such independent or dedicated systems will not always be available or adequate.

3.2.3 Characteristics of state and society

Many of the factors determining monitorability discussed in the two subsections above relate to particular characteristics of the state or society concerned. However, broader and perhaps more fundamental political, social and economic characteristics will also be important.

Societies that are relatively open in relevant areas will tend to regard monitoring and inspections as less intrusive and costly. Pluralist or democratic societies will be less able to hide activities involving significant numbers of civilians. Weak states will tend to be less able to monitor activities by powerful domestic interest groups (but may also be less able to prevent independent monitoring activities). Activities in countries that are involved in relations of complex interdependence, and in dense transnational economic, social and political networks, are different in this context to relatively autonomous and 'un-networked' states (such as North Korea, to take an extreme example). Market economies pose different monitoring challenges than planned economies.

The significance of these societal characteristics for monitorability will partly depend on the extent to which adequate monitorability relies on the resources or cooperation of the state concerned. It will also depend on the extent to which the rules and operational procedures for this cooperation have been formally agreed. Similarly, such societal characteristics may be

more important where assessments must largely be based self-reporting, rather than on independent monitoring systems or intrusive inspections.

As always, broad social, political and economic changes will affect the effectiveness and character of the infrastructure and monitoring systems required for measurement. The transformations in the former Soviet Union, for example, have profoundly affected the monitorability of its performance in meeting environmental commitments (though perhaps not always for the better)

3.2.4 The use of indicators as proxies to improve monitorability

Commitments in environmental agreements frequently relate to substances, processes or activities other than the ones that the agreement is primarily aiming to affect, limit or prevent. This may often be because of concerns about verifiability. For example, a commitment aiming to limit net greenhouse gas emissions from forestry might be formulated in terms of national forest areas, partly because these are more monitorable than emissions. This use of indicators as proxies in the formulation of commitments is probably important in the development and implementation of commitments and, as discussed in section 2.2, is a major way in which verifiability issues may be important for environmental agreements.

However, indicators of performance may also be formally or informally developed to improve the verifiability of a commitment. Thus, a state's compliance with a relatively unmonitorable commitment might be measured by monitoring a range of indicators that are not explicitly defined in the formal commitments. This is similar in principle to indirect measurement of compliance, where an agreed methodology is used to calculate performance in relation to a treaty commitment on the basis of data-inputs for relatively monitorable quantities. However, where even indirect measurement of compliance using an agreed methodology is not possible, treaty partners may monitor one or more related indicators of performance to provide some reassurance that states are implementing their commitments in good faith.

For example, it would be impossible reliably to measure compliance with a legal commitment to reduce national anthropogenic emissions of methane by 10% between 1990 and 2000, either directly or indirectly. There are many different sources of methane within a country, and even if there are relatively reliable indirect methods of calculating annual methane emissions from some subsectors, these would typically be swamped when aggregated with estimates of emissions from other sectors where there are great uncertainties. Nevertheless, treaty partners may nevertheless try to monitor performance in the subsectors for which relatively reliable estimates of methane emissions can be obtained, as indicators of overall performance. Similarly, they may monitor indicators of whether the country is effectively implementing measures designed to reduce methane emissions in some key sectors. While this will not allow compliance with the specific treaty commitment to be measured, it does establish some relatively measurable informal indicators of performance.

Such informal indicators may acquire some standing in the agreement. For example, aware that a commitment to make a 10% reduction in methane emissions cannot in itself be monitored, countries could informally pledge themselves to a number of more monitorable targets against which their performance may be assessed. Alternatively, some or all of their treaty partners may adopt a number of monitorable standards against which they decide to assess performance. Clearly, if there is confusion or disagreement about the use of such

indicators, this could lead to differing expectations and damaging disputes about compliance. Thus, the process of formulating or communicating sets of informal indicators could usefully be facilitated by appropriate implementation review mechanisms.

Indeed, one could envisage the process being further formalised, in order to translate a relatively unverifiable treaty commitment into a set of informal but verifiable pledges. In regimes where this process could usefully enhance effectiveness, internationally agreed guidelines and procedures could be developed for the ways in which countries should formulate, communicate and agree upon such clusters of informal yet relatively monitorable pledges (Greene & Salt 1994).

For example, suppose that a protocol to the FCCC were to include the (relatively unmonitorable) legal commitment outlined above - to reduce national methane emissions by 10% between 1990 and 2000. Each party could informally disaggregated this commitment into a number of more specific pledges on emissions relating to each type of source of methane, such as landfills, gas distribution, wet-rice production, forestry and agricultural waste management, customised to its particular methane emissions profile. Thus one country might one country might pledge itself to meet the overall 10% cut by reducing methane emissions from landfills and gas distribution by 20% and stabilising emissions from other sectors. Another country might prefer to achieve its formal commitment by focusing on reducing emissions from forestry and agricultural waste. The main overall constraint would be that each country's set of sub commitments should be shown to be likely to add up at least to an overall 10% reduction overall, calculated on the basis of agreed methodologies (e.g. the IPCC methodology) using the baseline data on emissions in 1990 already submitted as part of the FCCC reporting system.

At this stage, this set of informal sub-commitments for each sector in each party would still relate to methane emissions, and would thus remain relatively unmonitorable in most subsectors. However, through disaggregation, the monitorability of those subsectors which are relatively amenable to reliable measurement would at least not be undermined by combining them with unmonitorable emissions from other sub-sectors. However, the procedure could be for each country to further disaggregate each informal sub commitment into a cluster of more monitorable pledges. For example, a sub commitment to reduce emissions from rice paddies by 10% could be disaggregated into pledges to stabilise areas under production, reduce average inundation periods by 30%, and adjust varieties of rice grown and fertilizer practices in specified ways. Similarly, a sub-commitment to limit methane emissions from landfills could be articulated in terms of pledge to implement specified changes in landfill management. In each case, the cluster of pledges should be shown to be likely to achieve the sub commitment in each sector, using agreed methodologies.

Thus, through a combination of disaggregation and the articulation of commitments in terms of a cluster of informal pledges relating to relatively monitorable indicators, an unmonitorable commitment may become relatively verifiable for all practical purposes. The cluster of indicators of performance may vary from country to country, according to their particular characteristics and to the ways in which they aim to meet their overall commitments. Such indicators may relate more closely to the specific policies the government plans to adopt to meets its agreed environmental targets, and thus to the requirements for auditing of domestic implementation by the governments or international aid agencies

involved. Overall, therefore, such procedures could enhance regime effectiveness in a number of ways. They could also shape implementation, since performance would now be measured against the informal indicators rather than the initial commitment.

Such a process may appear unwieldy, and to the author's knowledge no existing environmental regime has fully developed such procedures for systematically articulating relatively unverifiable commitments into sets of verifiable pledges (or agreed indicators of national performance). Nevertheless, there are many examples of the use of informal indicators of national performance where the formal commitments are relatively unmonitorable. Without guidelines for the development and communication of these, there is a danger that different actors may choose unilaterally to consider different informal indicators to measure other countries performance against, according to their concerns and ability to monitor. These may not be the ones that the country concerned would choose itself, nor perhaps the most appropriate ones for promoting regime effectiveness.

The extent to which such informal indicators have been used to improve monitorability is a relatively new and potentially important area for future research, and so are the effects such practices may have on the development and implementation of the regime.

3.2.4 Independence and monitorability

International assessments of monitorability could depend significantly on the extent to which assessments of national performance depend on information reported by the parties about themselves. Activities or materials in a member country that are monitorable in principle may in fact only be monitored by the bodies under the control of the state involved. In such situations, it becomes important to assess the reliability of the agencies collecting the data, and of the methodologies they use. How likely are these bodies to be able (and willing) to resist political pressures from state authorities or domestic interests to distort or suppress information that would indicate inadequate performance or non-compliance? Are the methodologies used compatible with those used for other parties, so that data-reported can be interpreted and compared?.

The answers to such questions will vary according to a variety of factors, relating, for example, to the type of information required and to the interests of the state concerned in collecting accurate data. For instance, reliable energy statistics are important to the states for a variety of important economic reasons, providing reassurance that they would not distort them simply for the purposes of under-reporting CO2 emissions to the climate change convention. However, there is always the risk that the country may maintain parallel accounting systems: one for internal use and one for international reporting. The recent revelations about Soviet misreporting to the International Whaling Commission are an example of this latter practice, and was entirely successful for decades (Guardian, 1994).

For this reason, many people might be tempted to insist that the availability of entirely independent monitoring systems is a pre-condition for adequate verifiability. Adequate and entirely independent monitoring may be possible in some cases, particularly where performance can be monitored using remote sensing technologies. In general, however, the permission and resources will not be given to establish entirely independent monitoring

systems. Thus, substantial reliance will typically have to be placed on information provided by the governments and national agencies in the countries being monitored.

In general, self-reporting by some states will be more widely trusted than by others, according to their reputation and past performance, and according to the characteristics of the society or state concerned. As discussed above, for example, some states have greater capacity to monitor domestic activities reliably or have more independent domestic reliability checks than others. Similarly, the likelihood that government misreporting will be exposed by whistle blowers or opposition groups is greater in open or democratic societies.

Nevertheless, judgments about the reliability of self-reporting are always uncertain and contestable. Thus, confidence in the reliability of measurements will always tend to be improved by increasing capacity to independently monitor relevant activities, or at least to be able to independently check the reliability of national reports. Since it is generally not diplomatic to identify countries whose national reports are relatively untrustworthy, where such independent monitoring and checking procedures are established they will tend to apply to all parties.

One approach to increasing confidence in national reports is to increase the transparency of the process by which national reports are produced. One type of independent check is the ability of outside observers to examine or monitor the raw or semi-processed data collected or produced by different agencies and mechanisms within the state concerned. Even if each agency is susceptible to domestic pressures, their susceptibility will vary between agencies. In any case, it is likely to be complex and costly to "fix" the data without generating observable inconsistencies may be great.

Similarly, the more disaggregated data provided in government reports, the greater the confidence in the reliability of reported measurements of performance (although, for the un-initiated, exposure to the normal chaos, uncertainties and inconsistencies in official (or unofficial) statistics could undermine their confidence in the reporting process). In the same way, systems for clarifying or harmonising national methodologies for collecting and analysing data will tend to improve international confidence in measurements of performance.

In this context, the capacity of actors other than the state concerned to use data provided by that state to monitor implementation of commitments depends on a combination of:

(i) the state's own monitoring capabilities (which depend on all of the physical, infrastructural and societal characteristics discussed above);

(ii) the nature of the national systems used to carry out such monitoring activities (are they directly under national government control?; what role do semi-autonomous national agencies play in the process?; are they appropriately resourced?; what are the interests of the agencies involved? as discussed above);

(iii) the transparency of the process by which national reports are compiled.

(iv) the rights and opportunities to review national reports, ask for and obtain clarification, or conduct country visits to clarify uissues arising from the national reports.

A second type of independent check is to compare the information in national reports with alternative, independently-collected data. That is, to compare national reports with the results of monitoring or measurements carried out by observers or agencies that are not under the control of individual states concerned.

In some cases, activities or materials can be monitored in ways that do not depend on any cooperation of the states in which they are situated. For example, the physical characteristics of the objects or activities to be monitored may be such that remote sensing techniques may be used. In others, relevant data can be collected by monitoring outside state boundaries or state jurisdiction (for example transboundary river or air pollution, or trading practices).

Alternatively, independent transnational or domestic non-state actors (or 'independent' regional authorities) may be in a position to monitor or measure relevant activities or materials. In some cases, some non-state groups may be in a position by themselves to monitor national compliance with a commitment - for example, a sole national producer of a restricted ozone depleting substance, or citizens groups able to detect a particular prohibited activity (such as whaling, or illegal discharges in rivers). In general, however, such groups can only gather partial information.

To measure overall national activities or materials, a combination of such information from a range of sources is necessary. Typically, only the state involved has established systems for such comprehensive information gathering (or, indeed, the right to demand such information from companies or individuals). This is particularly the case when the commitment relates to widely diffused and legitimate activities (fishing, waste disposal, etc.).

However, given the will and resources, independent monitoring systems can be established in association with the international agreement for the purpose of collecting independent information or of integrating available information from a variety of state and non-state sources. These systems may require the cooperation of the inspected state: for example including arrangements for on-site inspections, independent interviews with relevant officials or citizens, or cooperation in exposing activities to remote sensors. The ability to independently monitor will, as before, depend on a combination of the inherent characteristics, monitoring infrastructure, and the broader characteristics of the states and societies involved. For example, the characteristics of the societies involved will affect the extent to which states are willing and able to cooperate with independent monitoring.

Independent monitoring systems may be operated by an international organisation or Secretariat, or by individual states or groups of states or by non-state actors. How these systems are operated, and who has rights of access to the information gathered, is potentially significant. Different actors and institutions will have different stakes and concerns in the regime, and differential access to information will obviously affect different groups' capacity to monitor relevant activities and materials. For example, reliance on national technical means of monitoring relevant activities will mean that rich countries with well-developed monitoring systems (pre-eminently the United States in most areas) will have much greater capacity to measure performance than poorer countries with little national monitoring capacity. Alternatively, if independent monitoring systems are developed within an international institution of which all parties are members with equal rights to information, the differences in monitoring capacity of parties will be reduced. However, unless the information

collected by such international systems is publicly available, non-state actors will have relatively little capacity to monitor performance.

3.3 Assessability

Verifiability is a combination of 'assessability' as well as monitorability. The ability to assess commitments depends on the extent to which measured behaviour or materials can be compared against a standard. This depends on the precision with which a commitment or standard is defined and on the capacity to make assessments.

3.3.1 The existence on an adequate standard

To a large extent, assessability will depend on the precision with which the commitment is defined or expressed in the agreement: that is, on the existence of a well-defined and commensurable standard. If the commitment itself is ambiguous, an assessment of compliance would be difficult even if the information available on performance in relevant activities were perfectly complete and reliable.

This commitment or standard may be formally defined in a written international agreement. However, it could also often be defined through political understandings about the interpretation of formal commitments. Standards may also be informally established by tacit agreement or informal cooperation (for example, through Tit-for-Tat games). Moreover, for a given commitment, acceptable standards may be informally accepted to be somewhat different to those formally defined in the treaty or explicit political agreements: for example, there may be an informal understanding between parties to turn a blind eye to deviance from the formally-defined rules within certain limits. In principle, what matters in this context is the extent to which the parties assessing compliance have in one way or another established clear standards against which performance can be assessed.

As discussed in section 2.2.4 above, a treaty commitment that is relatively unamenable to reliable measurement may be disaggregated, refined or re-expressed in terms of proxies or a cluster of sub-commitments in a way that improves monitorability. The assessability of commitments may also be affected by such a process. For example, the process could make more specific the standards against which the informal indicators of performance will be compared or by simplifying standards so that compliance becomes easier to assess. The ability to informally develop clear standards to improve (or perhaps reduce) assessability will not only depend on the intentions of the participants, but also often on whether there are appropriate implementation review and dispute resolution processes to facilitate their development.

3.3.2 The capacity to make assessments

Assessability also depends on the ability to analyse the information obtained through monitoring, to compare the results of the analysis with the appropriate standards, and to arrive at conclusions.

For many agreements, there is a very large amount of relevant information available, in national reports, dedicated monitoring systems or from a wide variety of other official and

unofficial sources. Procedures and resources are required even to gather this information from the various sources and to organise it. Further, the resources required to analyse it, and to compare the results appropriately with defined standards may be substantial. Not all parties may be able to find these resources when they want them.

However, for some agreements, assessability may depend relatively little on national resources. Much of the technical task of organising and analysing information to compare performance with standards may be delegated to the Secretariat or an international expert body, providing a common basis on which parties can judge compliance and equalising the parties' capacity to make such assessments.

International secretariats and international technical bodies are notoriously under resourced, however, and may have only limited ability to carry out proper comparisons of performance with commitments. Moreover, the extent to which a multilateral body can actually make serious assessments of compliance will depend greatly on its decision-making procedures and rules, and may not be capable of making critical assessments of compliance except in extreme circumstances. Even when such multilateral assessment systems have been established, each of the parties, and other groups with an interest can assess compliance individually or in groups. However, their assessments may vary according to the use of different standards at least as much as different measuring and assessment capabilities.

3.4 Assessments of verifiability in regime development

In principle, the verifiability of a commitment is judged by combining assessments of its measurability and accessibility. However, the factors determining these two properties are many, and judgments relating to each factor will be typically be based on uncertain or contestable information or assumptions. It will often be difficult for interested parties to assess their *ability* to verify a commitment until they have gained practical monitoring and assessment experience. Even then, judgments about verifiability will vary, partly because parties capacities will actually be different, but also they will have different views on the importance of having independent sources of information about national performance, and on 'how much verifiability is enough'.

There are several types of questions that parties could ask about verifiability. Different questions are likely to be more salient at different stages in the development of the environmental regime.

At an early stage, question about verifiability arise when policy makers are assessing whether to enter negotiations for an agreement, and in what area. In this context, assessments of verifiability may be needed in order to judge whether there is a reasonable prospect of achieving an adequately verifiable agreement in this area (or of avoiding one, if parties seek merely symbolic agreements). Such assessments will relate to perceptions of the monitorability of relevant activities or possible proxies. They may also relate to the extent to which it is possible to develop a capacity for independent monitoring and for checking reliability of national reports, taking into account the character and identity of potential treaty partners.

In the context of environmental treaties, where questions of verification have rarely been dominant during the process of establishing a new regime, the requirements for assessing potential verifiability at this stage would probably be undemanding. To the extent that decision-makers care about adequate verifiability when deciding whether even to enter into negotiations, they may only want to be assured that there were at least some potential relevant commitments that could be adequately verified at reasonable cost. Nevertheless, perceptions of verifiability may play a role in agenda-setting for detailed negotiations.

At the negotiating stage, actors are deciding upon the design of the agreement and the formulation and stringency various commitments. In the process of formulating and defining types of commitments, it is the *relative* verifiability of potential commitments that most needs to be assessed, including a balance of the costs of verifying different commitments. In negotiating the stringency of a particular commitment, then 'strategic' concerns about free-riding and such like may come into play, in which case more detailed assessments of absolute verifiability, and the requirements and potential costs of achieving 'adequate' verifiability for specific commitments may also be desired. Such concerns about achieving adequate verifiability of preferred commitments may be important in defining and shaping reporting and transparency rules, independent checking and inspection rights, and implementation review procedures, and in the design and development of additional monitoring facilities or infrastructures.

Once the negotiations are complete, the main concern is whether or not to join the agreement. In this context, each party may want to judge the overall verifiability of the agreement. The verifiability of some commitments may be less acceptable than for others, but each party will have to judge the overall acceptability of the package. Each actor will probably have different views about the relative importance of various provisions in the agreement; judgments about whether the agreement is adequately verifiable (or *too* verifiable) may in principle involve assessments of the verifiability of each commitment (weighted according to the importance or stringency of the commitment) combined with judgments about the prospects for addressing deficiencies in future. The central question for those that want a verifiable agreement would be whether treaty partners' compliance with the key commitments is likely to be <u>adequately</u> verifiable.

At the stage when the agreement is being implemented and maintained, assessments of verifiability may be relevant in a range of contexts. Firstly, each party may make assessments about the extent to which its own performance can adequately be verified by others. To the extent that this contributes to decisions about how and whether to implement its commitments, assessments will focus on the risks of exposure of inadequate compliance. However, where the party is concerned to promote confidence that it is honouring its commitments, or to promote the extent to which others can learn from its own practices, this exercise may lead to parties increasing transparency or inviting independent officials and experts to monitor or participate in its programmes.

Secondly, parties may want to assess the extent to which they can verify compliance by others, leading them perhaps to: allocating additional resources to national or international monitoring systems; requesting further information from treaty partners; invoking provisions for independent reviews or assessments of other parties performance; attempting to develop implementation review processes; or agenda-setting for the further negotiations to improve verifiability or to revise or develop commitments. Assessments of the monitorability of

performance by various countries, and problems of national reports, may inform the allocation of additional resources for building some states national monitoring capacities.

In the context of discussions about developing or revising the regime, re-assessments of verifiability may be made in the light of experience. Such re-assessments may shape debates about the further elaboration or development of commitments and verification and monitoring procedures. Otherwise, the overall aims of assessing verifiability will be similar to those noted above in relation to the agenda-setting and negotiation phases, except that they take place in the context of experience and established verification and implementation review processes relating to the existing treaty.

4 DYNAMICS OF VERIFIABILITY

4.1 Changes in verifiability

Verifiability can change with time in a variety of ways, as is readily apparent from the discussion of the determinants of verifiability in section 3. Briefly, monitorability can change due to: changes in scientific (natural and social) and technical understanding; developments of monitoring technologies; identification of better indirect means of measurement or the use of indicators as proxies; developments in national and international monitoring infrastructures; and changes in societal norms and characteristics. Assessability may change as ambiguities in commitments are resolved; commitments and standards are refined, interpreted and developed; and capacity for carrying out assessments changes.

For most environmental issue areas and types of commitment, there is a great deal of scope for deliberate improvements in monitorability. New monitoring devices can be developed and national or international (or unofficial) monitoring systems can be put into place for the purpose. Research into new and more effective indirect measuring methodologies or proxies can be carried out. New transparency rules and rights for independent checks and inspections can be negotiated. These improvements would probably generally be driven by demand, whether from the some or all of the states parties or from other actors with an interest in improving or shaping verifiability

However, even without such purposeful activities, the verifiability of a given commitments will continue to change as a result of broader technical, institutional, economic, political and social processes. Moreover such unplanned ‘supply’ processes can present new opportunities for deliberate improvements in monitorability

Such changes will clearly affect the extent to which the ability to verify affects effectiveness. The various mechanisms by which this may take place (discussed in section 2) will operate in different ways as monitoring and assessment capacities of various interested parties change.

Changes in verifiability may also shape the further development of the regime. By changing cost-benefit calculations, empowering actors with an interest in such commitments, or promoting learning about the adequacy or implementation of commitments, improvements in verifiability may facilitate the negotiation of more stringent obligations or the addition of new ones. Alternatively, they may encourage higher levels of compliance with existing standards, increasing confidence in the regime and promoting its further development. On the other hand, such improvements may threaten to expose inadequate performance, prompting parties

to leave the agreement or negotiate less stringent commitments. Either way, changes in relative verifiability of potential obligations may shape debates about the revision or reinterpretation of the agreement.

The impact of changes in verifiability may depend on the stage in the development of the regime in which they occur. During agenda-setting phases, they may be particularly influential in shaping the negotiating agenda, since these are by definition times of flexibility where there are fewer institutional or negotiating constraints in adapting to new information. When parties are deciding whether to join the agreement, or whether to sign new protocols, such changes could affect assessments of adequacy of verifiability.

4.2 Changes in standards of adequacy of verifiability

Answers to the question 'how much verifiability is enough?' will not only vary between parties and other actors, but will also change with time. Changes in perceived interests in the regime or in perceived incentives for non-compliance amongst treaty partners will tend to lead to changes in verification requirements. These may arise as a result of a re-assessment of the regime (or changes in the regime) and of the costs and benefits of complying with it. They could also arise because of changes in broader political and economic relationships between parties. For example, political or economic changes in one or more of the parties (such as the collapse of Soviet-style communism or, less radically, a change of government) may change mutual confidence or change the societal context in which verification takes place.

Moreover, as new obligations are added, verification requirements for existing obligations may change - for example, a new obligation may be regarded as being more stringent for some parties than others, and the quid pro quo might be stricter adherence to existing obligations by other parties. Even without formal changes in obligations, changes in informal or tacit agreements about acceptable deviance from standards may lead to changes in verification requirements. For example, if one party is under pressure (perhaps from domestic rather than international sources) to adhere strictly to formal standards, it might be concerned that to pressure other participants to do so too.

Changes in assessments of the adequacy of existing verification capacity in an established agreement would normally be expected to lead initially to attempts to increase verifiability rather than to abandonment of obligations. Improvements in verifiability can be achieved unilaterally or multilaterally, in all of the ways indicated above. In many cases, improvements could probably be achieved at modest cost by increased scrutiny of national reports, improved monitoring technologies, and increased resources for existing institutions involved with verification. However, it is possible that achieving adequate verifiability may involve renegotiation of transparency or inspection rules, and perhaps further re-definition or interpretation of commitments and standards. The extent to which this can be achieved without damage to the regime will depend partly on the existence and design of dispute resolution and implementation review mechanisms.

5. SOME ISSUES FOR FURTHER RESEARCH

The aim of this paper is to explore the determinants of verifiability, and the possible relationship between verifiability and regime development and effectiveness, in order to identify potentially important areas for further research. This last section therefore aims to outline possible areas for research rather than to provide conclusions.

A number of questions and potential areas for research have been raised in the course of the paper. Hopefully, by raising awareness of the potential significance of verifiability, the issues raised will be taken into account in the course of empirical work on the development and effectiveness of particular regimes, and thus help to improve overall understanding of the processes involved. The following paragraphs aim to select some of the potentially most important or interesting areas for specific research that have been raised.

5.1. To what extent do concerns about verifiability affect environmental commitments or participation in agreements?

The discussion has identifies a number of reasons why states and other interested parties (international and domestic) may care about verifiability when they are negotiating commitments or deciding whether to participate in an agreement. It is widely recognised that such concerns play a significant role in other issue areas, and particularly in relation to arms control. Little empirical research has so far been carried out to determine the extent to which such concerns have been important in the formulation of commitments and the development of environmental agreements, and if they are not, why not.

Research could focus not only on the importance of the 'absolute' verifiability of commitments to verification, but also to the importance of differences in the abilities of interested parties to verify - such asymmetries could be due to a variety of social and technical factors, but they could significantly affect distributions of power, calculations of interests, and learning processes.

5.2 The importance of verifiability of commitments for the development and effectiveness of implementation review mechanisms

By definition, verifiability is a necessary condition for an effective verification process. Moreover, the ability to assess the extent to which parties are complying with commitments must be a potentially important factor in determining the effectiveness of implementation review mechanisms (IRMs). In Victor et al (1994) and elsewhere, we have argued that IRMs may play an important role in determining the effectiveness of environmental agreements. In this context, the role of verifiability is a potentially important area for research into the determinants of the effectiveness and development of environmental agreements. A range of different types of possible research issues arise:

- How does verifiability relate to the design and operation of IRMs? For example, when commitments are verifiable using existing monitoring systems and data to which there is wide access (that is, when transparency is high for a wide range of non-state and state actors), to what extent is the development of elaborate formal IRMs necessary for effective implementation review (to what extent can informal processes together with minimal consultative procedures suffice?). How do asymmetries in the ability to verify between parties affect the development of IRMs?

- What are the differences in effectiveness and the role of verification and implementation review when interested parties can monitor performance using independent information rather than mainly using information reported by the country concerned. What are the differing design considerations for effective IRMs as the balance between using independent information and national reporting varies?

- How do the characteristics of the monitorability of a commitment affect participation and influence in the implementation review process. For example, how does access to monitoring information affect the role of non-state actors in IRMs?

5.3 The role of proxies and indicators of performance in increasing verifiability, and in shaping the development and operation of IRMs

As discussed in earlier sections, commitments in environmental agreements frequently relate to proxies rather than to the activities or substances that the agreement is mainly concerned to regulate, limit or prevent. Similarly, where formal commitments are relatively unverifiable, a variety of indicators may be formally or informally used to monitor and assess performance. The choice of indicators to be used as proxies is clearly likely to be a political as well as a technical process, since it affects the impact of the agreement and the verifiability of commitments. Moreover, different interested parties may use different informal indicators according to their interests and monitoring capacities.

The development and role of indicators as proxies may often be very important factors in the development, shape, and impact of IRMs and of the commitments and implementation policies themselves. They also provide potential connections between international commitments and implementation of domestic policies or international assistance programmes, since governments and other actors will typically also identify targets and indicators for the implementation of domestic policies or activities relevant to the agreement.

Research could include empirical or historical work on the role and development of indicators in relation to IRMs, commitments and implementation in existing or emerging regimes, or in relation to particular countries. There is also the question of examining the different purposes for which indicators are used, and the relationship between their use in domestic implementation, international review, or technology transfer/aid programmes, or between the use made by non-state actors and states parties. Further, research could be conducted on guidelines and design principles for IRMs so that the identification and development of indicators is more likely to improve regime effectiveness.

5.4 How do monitoring facilities relate to the implementation of conventions?

Most monitoring facilities and data-gathering infrastructures relevant to the verifiability of commitments in an agreement were not custom-built for that agreement. For example, implementation of commitments relating to land use might be able to be monitored using existing FAO systems and remote sensing facilities (satellites and such like). Verifiability depends on access to such data, and the capacity to use or adapt existing information and facilities. Similarly, a cluster of conventions covering related issue areas could make use of the same monitoring resources, and there is potential for cooperative investment and use of monitoring facilities. There are a number of opportunities for policy-relevant empirical research here. It might also be important to examine the emergence of an international regime relating to rules of access to environmental monitoring data, and to the development of generic monitoring (and assessment) capabilities.

5.5 Determinants and characteristics of monitorability

The factors determining monitorability are discussed in this paper. They include: intrinsic characteristics of the substances or activities concerned, available monitoring resources and data-gathering infrastructures (bearing in mind acceptable costs), and the social, economic and political characteristics of the states and societies concerned. There is potential for specific examinations of the monitorability of substances, activities, or indicators of interests to existing or emerging regimes. Also, the analysis of the general physical and social determinants of the monitorability of 'Substance X' or 'Activitiy Y', as discussed in section 3.2, could usefully be developed further.

5.6 What is the relationship between changes in monitorability and changes in implementation and development of regimes?

The monitorability of commitments can change as a result of changes in monitoring science and technology, investment in monitoring and data-gathering infrastructures, and political, economic or social changes in the states concerned. These changes may be a result of the development or implementation of the regime, but also (and more often) as a result of exogenous factors. Such changes could affect the possibilities for: negotiating new commitments; implementation practices; or the development and effectiveness of IRMs; and how do they affect participation by NGOs, IOs and states in all of these processes? Empirical examinations of the role of changes in monitorability in regime and IRM development and implementation are possible.

6. REFERENCES

Ausubel and Victor (1992): J. Ausubel and D. Victor, 'Verification of International Environmental Agreements', Annual Review of Energy and the Environment 1992, Vol 17, 1992

Chayes (1991): A. Chayes, 'Managing the transition to a global warming regime, or what to do 'til the treaty comes', in J. Matthew's (ed), Greenhouse Warming: negotiating a global regime, World Resource Institute, Washington DC, 1991

Greene (1993): O. Greene, 'International Environmental Regimes: verification and implementation review', Environmental Politics, Vol 2, No 4, pp 156 - 173.

Greene and Salt (1993): O. Greene and J. Salt, 'Verification issues in the development of an effective climate change convention', World Resources Review, Autumn 1993.

Greene and Salt (1994): O. Greene and J. Salt, 'Verification and implementation review of climate change commitments relating to methane emissions', in J. van Hamm et al (eds) Non-CO2 Greenhouse Gases: why and how to control?, Kluwar Academic press, 1994.

Grubb and Steen (1991): M. Grubb and N. Steen (eds), Pledge and review processes: possible components of a climate change convention, Royal Institute for International Affairs, London 1991

Fischer (1991): W. Fischer, 'The Verification of International Conventions on the Protection of the Environment and Common Resources', Berieche des Forschungzcentrum Julich: 2495, Forschungzcentrum Julich GmbH, 1991.

Fischer et al (1992): W. Fischer, O. Greene, W. Katscher, J. Lanchbery, J. Salt, and G. Stein; 'Verification in a climate protection regime: role and limitations of space-based remote sensing', in Remote Sensing: reference handbook, Ellis Horwood Library of Space Sciences, Marcol Group.

Haas et al (1993): P.M. Haas, R.O. Keohane and M. Levy, Institutions for the Earth, MIT Press, Cambridge, USA.

Levy (1993): M. Levy, 'Political science and the question of effectiveness of international environmental institutions', International Challenges, Vol 13, No 2, 1993, pp 17 - 35.

Mitchell (1993): R. Mitchell, 'Intentional oil pollution of the seas', in P. Haas, R. Keohane and M. Levy (eds), Institutions for the Earth, MIT Press, Cambridge USA, pp 183-248.

Mitchell (1994): R. Mitchell, Intentional Oil Pollution at Sea, MIT Press, 1994.

Noss et al (1992): R. Noss, S. Cline, B. Csuti, M. Scott 'Monitoring and assessing biodiversity', in E. Lykke (ed), Achieving environmental goals: the concept and practice of environmental performance review, Bellhaven Press, London, 1992, pp 67-85.

Poole and Guthrie (1992, 1993, 1994): J. Poole and R. Guthrie (eds), Verification Report 1992 (1993; 1994): Yearbook on Arms Control, Peacekeeping and the Environment, Brasseys, London 1992, 1993, 1994 (annual yearbook).

Stein (1990): A. Stein, Why nations cooperate: circumstances and choice in international relations, Cornell University Press, London, 1990.

Victor (1991): D. Victor, 'How to slow global warming', Nature, Vol 349, 1991, pp451- 56.

Victor et al (1994): D. Victor & O. Greene, J. Lanchbery, J Di Primio, A. Korula, Review mechanisms in the effective implementation of internationnal environmental agreements, IIASA Working Paper WP-94-114, 1994.

Victor and Salt (1994): D. Victor & J. Salt, "Climate since Rio", Environment, 1994, forthcoming

Young (1992): O. Young, 'The effectiveness of international institutions: hard cases and critical variables' in J. Rosenau and E. Czempiel, Governance without government: order and change in world politics, Cambridge University Press, Cambridge, 1992.

Young (1994): O. Young, International Governance: protecting the environment in a stateless society, Cornell University Press, London, 1994