Voting Power in Environmental Policy Making

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Introduction

Global warming is believed to be one of the most serious environmental problems for current and future generations. In only a short time environmentalism has become a dominant theme of development policy. The concerns about global climate change led the World Meteorological Organization (WMO) and the United Nations Environment Program jointly to established the Intergovernmental Panel on Climate Change (IPCC) in 1988. The first IPCC report was published in 1990; it led to the signing of the *United Nation Framework Convention on Climate Change* (UNFCCC) in Rio de Janeiro in June 1992 by more then 180 countries. This convention declares that serious actions should be taken to reduce greenhouse gas emissions. The Kyoto Protocol is an international agreement linked to the United Nations Framework Convention on Climate Change. It was signed by 38 mainly industrialized countries[1] in 1997. These countries agreed to reduce their greenhouse gas emissions by an average of 5.2% compared to 1990 emissions levels by the target period of 2008-2012. Currently, there are 191 states that have signed and ratified the protocol. But the Kyoto Protocol euphoria soon turned into disappointment. The US bailed out of the protocol already in 2001, and just recently in 2011 Canada renounced the Protocol before the end of the first commitment period as well.

It seems hard to establish efficient international binding agreements. When faced with an economically significant issue such as climate change, it seems to be more important to build strong and efficient international climate policy institutions than to reach a particular deal at a particular point in time. Strong institutions geared to solve this particular problem will stand a much better chance of carrying the process forward and underpinning rational argument than would a permanent state of diplomatic negotiation (Rutqvist et al., 2010).

[1] The USA, all countries of the European Union, Norway and Switzerland, Australia, New Zealand, Canada and Japan, and a few countries in transition to a market economy like Russia and the Ukraine.

Robert N. Stavins (2010) says that one problem within the UNFCCC is that the decision making rules of the organization's process require unanimity (all 194 parties voting in favor) for nearly all decisions. It was lack of such consensus that resulted in the COP15[2] not adopting the Copenhagen Accord, but rather simply noting it: only 188 of 194 countries supported it.

Subject of the present work is to examine the decision structure of the UNFCCC, discuss possible changes within that structure like a different decision rule, or the implementation of voting weights and the consequences of those changes related to the distribution of voting power amongst the member states of the UNFCCC with the possibility of a priori unions. Power is one of the most important concepts in the social sciences. According to the often used definition of Max Weber, it is an individual's potential to enforce his own interest against the resistance of others (Weber, [1922]1947, p. 28)[3]. By applying power measures, we estimate the impact of the various agents in instrumental arrangements like the UNFCCC.

The thesis consists of three articles. All of them are kind of dependent, although every single paper is fully self-contained and can be read on its own. The three papers deal with the climate institution UNFCCC, the decision structure, possible changes within that structure and the power allocation between the member states according to the Public Good Index *PGI* (Holler, 1982), the Coalitional Solidarity Public Good Index (Alonso-Meijide et al., 2010a) and the Union Public Good Index (Holler and Nohn, 2009).

The first paper, 'Power and Responsibility in Environmental Policy Making', is co-authored with Manfred J. Holler from the University of Hamburg, Germany and Public Choice Research Centre in Turku, Finland. It has been presented at the Adam Smith Seminar, Hamburg (Jan 2010) and at the Prague research workshop 'Voting, Power

[2] The Conference of the Parties is the supreme body of the Convention. All countries that ratified the treaty are represented within this body, which has the highest authority.

[3] In the original German version, Weber uses the word 'Chance'. While 'Chance' could also be translated by 'probability', or simply by 'chance', Holler and Nurmi (2010) argue that it should rather be seen as 'possibility' or 'potential'.

and Manipulation' (Sept 2010). It is published in AUCO Czech Economic Review 5, 2011. A follow-up paper is a single-authored article, 'Cluster Analysis and A Priori Power Measures within Climate Conventions'. It is available as a Social Science Research Network working paper. It has been presented at the NCCR Summerschool, Grindelberg (Aug 2010) . 'Voting Weights and Power Measures within Climate Conventions' is the last paper, which is single-authored as well. It has been presented at the PhD conference of CliSAP. It is submitted to and currently under review for *Strategic Behavior and the Environment*.

The first paper 'Power and Responsibility in Environmental Policy Making' designs instruments for allocating responsibility to the parties involved in regulating climate conventions. In this paper we examine the climate institutions 'United Nations Framework Convention on Climate Change' and the 'United Nations Convention to Combat Desertification'. We give a detailed description of the bodies of the conventions and the actors in the negotiation process. As 'climate' is a public good we therefore apply the PGI, the Coalitional Solidarity PGI and the Union PGI and thus estimate the impact of the various agents in these instrumental arrangements taking a priori unions into consideration. For the UNFCCC the decision rule is unanimity and for the UNCCD there is a two-third majority decision rule. There are equal voting weights. Voting power and responsibility are thus equally distributed amongst the parties to the conventions if we do not include a priori unions. We define ten a priori unions and apply the corresponding a priori power measures. Depending on the decision topics, developing countries can hold more power and responsibility than developed countries. Both conventions refer to responsibilities of the parties as common but differentiated responsibilities. The primary responsibilities and thus power should fall to the industrial countries which is not reflected in our calculations.

The second paper claims that the existing a priori unions within the UNFCCC get obsolete. Over the past few years new negotiating coalitions emerged due to new decision topics. It is important for small countries that do not hold much power in the political arena to cooperate allowing them to share information and coordinate their actions. This

paper makes use of a hierarchical cluster analysis to identify the a priori unions/coalitions. The agglomerative algorithm that is used is the average linkage cluster analysis and as a distance measure the squared Euclidean distance. We consider 194 member states of the UNFCCC (cases). To cluster these cases three decision-fixed variables (GDP per capita based on purchasing power parity, contributions to the core budget of the UNFCCC, Environmental Performance Index) and in each decision case one cluster-identifying variable (Forest area, CO2 Emissions, Renewable internal freshwater resources per capita) for the three different decision situation (decisions on 'reduced emissions from deforestation and degradation' (REDD), decisions on CO2 emission cuts and decisions on water shortage) are taken into account. We calculate three cluster cases (10, 15 and 20 clusters) for the decision topics. To estimate the impact of the resulting a priori unions and accordingly the member states of the UNFCCC within the decision making process we apply the Coalitional Solidarity PGI and the Union PGI. We suggest a two-third majority decision rule as within the UNCCD and there are no voting weights in this setup. Based on the Coalitional Solidarity PGI the USA, EU, Norway, and China would hold more a priori decision power if there are many small cluster groups. However, based on the Union PGI the developing countries hold most power.

The third article deals with the allocation of voting weights within the UNFCCC. The ability of the UNFCCC to function effectively is limited. The one-country/one-vote system of decision making within the UN is unrealistic, bearing no relationship to the actual distribution of power amongst the world's nations (Schwartzberg, 2004). Therefore, its decisions are mostly only recommendatory rather than binding. It reflects the principle of the equality of sovereign states, as codified in the UN Charter (Chapter I, Article 2). Weighted voting has been suggested as one possible solution to the problem of representation in the conference of parties. We calculate voting weights based on contributions to the UNFCCC regular budget, GDP, the Environmental Performance Index (EPI), and a measure of the equality of sovereign states. Based in an idea of Strand and Rapkin (2010) these factors are assigned different weights in order to formulate three sets of weighted votes. After this, we calculate the a priori voting power based on the

Solidarity PGI and the Union PGI for the three different decision topics we dealt with in the second paper (cuts in CO2 emissions, REDD, and water shortage). The a priori unions we use in the third paper derive from the resulting 20 cluster cases for all three topics of the hierarchical cluster analysis we performed in the second article. The US for example will benefit from a set of voting weights where population and GDP are set at 35% and contribution, EPI and basic votes at 10% each within all three decisions and measured by both a priori power indices compared to the voting weight set that gives equal weight to all five factors. The least developed countries would almost always benefit from a set of voting weights where the components are equally weighted.

It will be hard if not impossible to find a voting scheme that all members would accept as optimal (Dervis, 2005). But a reform of the decision making process amongst other things is necessary.

Chapter 1

Power and Responsibility in Environmental Policy Making*

Abstract Given the challenges facing the world in the field of environmental policy, research on transnational policy-making has intensified. Several institutions have come into existence in response to the increasing concerns about global climate change. This paper designs instruments for allocating responsibility to the parties involved in regulating climate conventions. In order to point out the possibilities of allocating responsibility, the relationship between power and responsibility is examined. By applying power measures, we estimate the impact of the various agents in these instrumental arrangements taking *a priori unions* into consideration. We examine the *UN Framework Convention on Climate Change* and the *UN Convention to Combat Desertification*. Depending on the decision topics, developing countries can hold more power and responsibility than developed countries. Both conventions refer to responsibilities of the parties as common but differentiated responsibilities. The primary responsibilities and thus power should fall to the industrial countries which is not reflected in our calculations.

Keywords environmental policy, collective decision making, responsibility, power

JEL Classification D7, C7

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1.1 Introduction

Efforts to create an international regime which addresses the problems of global climate change have been under way since 1990. Governments have problems finding policies that concur with the demands of electoral politics and at the same time satisfy the needs for global responsibility. The *United Nations Framework Convention on Climate Change* (UNFCCC) and the *United Nations Convention to Combat Desertification* (UNCCD) are responses to the threat of global warming. This paper analyze the status of the parties involved in theses regulating climate conventions and treaties, and designs instruments for allocating responsibility to them.

In order to point out the possibilities of allocating responsibility, the relationship between power and responsibility is examined. By applying power measures, we estimate the potential impact of the various agents in these contractual or instrumental arrangements, taking the possibility of a priori unions into consideration. The set-based concept of freedom of choice is combined with the agent-based concept of power (see Holler and Alonso-Meijde ,2009, for the design of this project). In a recent paper Braham and van Hees (2009) developed causality measures, based on the NESS concept (necessary element of a sufficient set) and highlighted their formal equivalence to the Public Good Index and the Banzhaf index, respectively. Inasmuch as causality is seen as the primary source of responsibility, this relationship supports the allocation of responsibility by means of power measures (see also Braham, 2005).

Holler (2007) analysed the relation between the concept of freedom of choice, and the concept of power and responsibility. The standard theory of ranking opportunity sets was elaborated such that the Public Good Index can be applied to evaluate the rankings from the point of view of the decision makers. This paper makes use of this conceptual framework and discusses responsibility in the collective decision making bodies regulating the climate conventions and treaties referred to above. In this study, we consider the possibility of a priori unions within the sets of decision makers. For the UNFCCC the decision rule is unanimity and for the UNCCD there is a two-third majority decision rule. There are equal voting weights. Voting power and responsibility are thus equally

distributed amongst the parties to the conventions if we do not include a priori unions. We define ten a priori unions and apply corresponding a priori power measures. Depending on the decision topics, developing countries can hold more voting power and therefore more responsibility than developed countries.

Both conventions refer to the responsibilities of the parties as common but differentiated.[1] There are convincing arguments that the primary responsibilities should fall to the industrial countries; a result which is not reflected in our calculations. Goodin (1998) proposed task responsibility that specifies 'whose job it is to see to it that certain things are performed and that certain things are accomplished' (p.150). To accomplish things, however, presupposes that those held responsible, can actually do it. This of course implies a greater share of responsibility to developed countries when it comes to dealing with climate change and its costly implications. It seems that a possible solution for an adequate allocation of responsibility could be a reallocation in power.

The paper is organized as follows. In section 1.2 we provide the analytical tools such as simple games, power indices and games with a priori unions. In section 1.3 we summarize the relationship of freedom of choice, the concept of power and responsibility. Sections 1.4 and 1.5 contain an illustration of the Framework Convention on Climate Change and the Convention to Combat Desertification. Section 1.6 discusses the results of the power measurements. In section 1.7 we define the a priori unions and display the a priori power and responsibility . In section 8 we discuss the responsibility and power results and compare them with the definition of responsibility given in the context of the Conventions. Finally, we conclude in section 9.

[1] The meaning of 'common responsibility' is understood by analogy with some known and accepted concepts like common good, common interest or common concern of humankind. The 'differentiated responsibility' component can be approached from two perspectives, the different contributions to the causes of environmental harm and the different capacities to respond to environmental threats. (Timoshenko, 2003)

1.2 Preliminaries

1.2.1 Simple Games

A *simple game* is a pair (N, W) where $N = \{1, \ldots, n\}$ is a finite *set of players* and W is a set of subsets of N satisfying:

- $\emptyset \notin W, N \in W$, and
- the monotonicity property, *i.e.*,

  let $T \subseteq N$, then $S \in W \Rightarrow T \in W$ for all $S \subseteq T$.

In a simple game (N, W), a coalition $S \subseteq N$ is *winning* if $S \in W$ and is *losing* if $S \notin W$. A winning coalition $S \in W$ is a *minimal winning coalition* (MWC) if each proper subset $T \subset S$ is a losing coalition. We denote by M the set of MWC of the simple game (N, W). Since M contains all relevant information and is more suitable for what follows, we mainly denote the game (N, W) by the equivalent description (N, M) throughout this work. Given a player $i \in N$ we denote by M_i the set of MWC such that i belongs to, that is, $M_i = \{S \in M / i \in S\}$.

A *power index* is a function f assigning each simple game (N, M) an n-dimensional real value vector $f(N, M)$, where the i -th component of this vector $f_i(N, M)$ is the power of player i in the game (N, M) according to f.

1.2.2 The Public Good Index

Based on the assumptions that coalitional values are public goods and only minimal winning coalitions are relevant when it comes to power, the Public Good Index (PGI) proposed by Holler (1982) and formalized in Holler and Packel (1983), and, recently, in Alonso-Meijide et al. (2008) assigns power proportional to the number of MWCs a player belongs to. It is assumed that the coalitions that are not MWCs are irrelevant when it comes to measuring power and therefore should not be taken into consideration. That is, other winning coalitions apart from MWCs can form but, as they contain surplus players,

hold a potential of free-riding when coalitions determine the production of public goods. Therefore, the PGI focuses on MWCs. Given a simple game (N, M), the PGI assigns to each player $i \in N$ the real number:

$$\delta_i(N, M) = \frac{|M_i|}{\sum_{j \in N} |M_j|}, \quad i = 1, \ldots, n \tag{1.1}$$

This implies $\sum_{i \in N} \delta_i(N, M) = 1$.

1.2.3 Games with a priori unions

The definition of (1.1) implies that all MWCs are equally likely and no a priori unions of some members of the decision making body under consideration exist. However, coalitions among players with common economic interests and similar culture are more likely than others. In this case the idea of coalition structures is useful (Owen, 1977). Forming coalitions is a natural behaviour in transferable utility cooperative games (TU games). TU games with a priori unions were first considered in Aumann and Drèze (1974) who extended the Shapley value (Shapley, 1953) to this new framework in such a manner that the game splits into subgames played by the unions isolated from each other. A second approach was considered in Owen (1977) in which the coalitional value (or Owen value) is defined and characterized.

By $P(N)$ we denote the set of all partitions of a set of players N. $P = \{P_1, \ldots, P_p\} \in P(N)$ is called a coalition structure. It is a set of nonempty and mutually disjoint subsets of N and its union coincides with N. The coalition structure describes the a priori unions on N. P is also a mapping assigning each player i the union $P(i) \in P$ of which he is a member. A simple game with a coalition structure is a triple (N, W, P), that is, a set of players N, set of winning coalitions W and a coalition structure P on N.

Given such a game, the corresponding *quotient game* is the simple game (P, W^P), where P represents the unions and W^P is the set of winning coalitions. A coalition $R \subseteq P$ in the quotient game is winning if the coalition of represented unions $\bigcup_{Q \in R} Q$ is winning in (N, W). We denote the set of minimal winning coalitions in the quotient game by M^P. The set of minimal winning coalitions containing union $Q \in P$ is described by M^P_Q.

Simple games with coalition structures is denoted by (N, M, P) and the corresponding quotient game by (P, M^P).

A *coalitional power index* is a mapping f assigning each simple game with a coalition structure (N, M, P) to an n-dimensional real valued vector $f(N, M, P) = (f_1(N, M, P), \ldots, f_n(N, M, P))$.

1.2.4 The Public Good Index for A Priori Unions

Alonso-Meijide et al. (2010a) introduced two variations of the PGI for a priori unions: the Solidarity PGI and the Owen extended PGI. Both measures consider two levels of negotiation. First, they distribute the power among the a priori unions in accordance with the PGI of the quotient game. On the second level, they assign the power of a union to its members. In this paper, we will analyse our problem in accordance with the Solidarity PGI, and the results of our special case coincide with the results that derive from applying the Owen extended PGI.

The Solidarity PGI Υ allocates the power of an a priori union to its members by assigning each union member equal power, that is

$$\Upsilon_i(N, M, P) = \delta_{P(i)}\left(P, M^P\right) \frac{1}{|P(i)|}, \quad i = 1, \ldots, n. \tag{1.2}$$

The first term coincides with the PGI of the union P in the quotient game. The term $\frac{1}{|P(i)|}$ indicates that the payoff for player i is the same as for the other players of the a priori union P.The fact that this term looks like sharing the power is due to normalization that implies $\sum_{i \in N} \Upsilon_i(N, M, P) = 1$.

Holler and Nohn (2009) introduced another four variations of the PGI for a priori unions. The first one is called the Union PGI. The three other ones are power distributions based on threats.[2] But as the latter ones also coincide with the Solidarity PGI we only consider the Union PGI and the Solidarity PGI for our calculations below.

[2] These different approaches take the players' threat power to leave their union into account. For an axiomatization of these measures, see Alonso-Meijide et al. (2010b).

The Union PGI Λ is as close as possible to the original spirit of the PGI. Holler and Nohn (2009) denote the Union PGI based on the two assumptions that (1) the coalitional value is a public good and (2) only minimal winning coalitions are relevant. The latter assumption does in this case, however, apply to coalitions being minimal both with respect to the simple game *and* with respect to the quotient game. A player's power is hence proportional to the number of minimal winning coalitions his union is a member of in the quotient game, that is,

$$\Lambda_i(N, M, P) = \frac{|M^P_{P(i)}|}{\sum_k |P_k||M^P_{P_k}|}, \quad i = 1, \ldots, n. \tag{1.3}$$

As with the Solidarity PGI, the Union PGI satisfies the *solidarity property*. All members of the same union have equal power. However, the Union PGI is the only extension of the PGI not assigning power to unions on the basis of the PGI in the corresponding quotient game.

1.3 Freedom of Choice, the Concept of Power and Responsibility

In order to analyse the relationship between the concepts of freedom of choice, power and responsibility, Holler (2007) combines the set-based concept of freedom of choice with the agent-based concept of power. The theory of freedom of choice consists in comparing decision situations given by opportunity sets Y which are subsets of the set of alternatives X.[3] It is strictly set-based and decision-makers have no relevance in this comparison. Hence, no preferences of the individual making the decision need to be taken into account.[4]

A basis of the PGI is that each element in M^W stands for a different collective good, and the winning coalition that forms will pick one of them. So the elements of the set

[3] Pattanaik and Xu characterize an ordering R on the opportunity sets, , 1990.

[4] Klemisch-Ahlert (1993) applies a weight function to the alternatives of an opportunity set and defines an ordering R_α to deal with the preference problems.

of minimum winning coalitions will be related to the elements of the opportunity set X. Set X describes the set of potential social states. Let us define the sets of social states that a player i controls by X_i, obviously, $X_i \subseteq X$. An individual player i cannot choose an element of X_i on his own, unless he is a dictator; instead he needs the support of other coalition members to realize his choice. However, no element of X_i can be chosen without i's approval. So X_i represents the set of alternatives that i has control of.

Note that coalitions of M^W are called decisive sets. Counting the number of decisive coalitions of which i is a member, one gets a value of the decisiveness of i. To normalize these values, one has to divide them by the sum of all values of decisiveness. The vector obtained is equatable to the Public Good Index for player i.

This approach connects the players with the opportunity sets and suggests to express the freedom of choice by power as measured by the Public Good Index. As power is a potential, the freedom of choice that is considered in this case is a potential as well. Membership in a coalition can also be interpreted as a proxy for the responsibility of an individual decision maker for the social outcome. Social responsibility is a potential, whereas individual responsibility derives from choices. So, it amounts to more than the adding up of individual responsibility when the Public Good Index is used.

When player i has power, he has a potential impact on the social outcome and thus he is socially responsible for it. This may imply that i can do something while others cannot. If player i is not part of the MWC that finally forms and picks a social outcome, he in principle could have a large power value and therefore a relatively high potential to influence the social outcome. If the potential to influence the outcome does not show in its realization then the player failed to exert power which does not however set him free from his social responsibility (Holler, 2007, p. 35). Player i is individually responsible for an outcome because i has decided to act (or not to act), and this decision together with the possible decisions of the other agents determine the social outcome. Social responsibility does not assume a decision (or presuppose an action). Of course players also bear legal and political responsibility. It will be interesting to see whether the responsibility of a single player will change if we consider the possibility of a priori unions. If a priori unions

exist, it seems plausible to apply a power measure that takes them into account.

But if a union is not part of the MWC that finally forms and picks a social outcome, does it still hold some responsibility for that outcome? If it had the opportunity to form a coalition with some of the unions which are now part of the winning coalition, then it had the potential to force a different social outcome. It seems appropriate that this union bears some responsibility for what happens in society. Or, if a coalition forms which is larger then a MWC, are all of the members equally responsible?

1.4 The United Nations Framework Convention on Climate Change

To see the practical implementation of the above questions and investigate the corresponding power analysis, we introduce and explain the design of two climate convention frameworks. Climate change and thus environmental protection is a big issue. Climate and environmental concerns are public goods. In the previous sections we used the Public Good Index to connect power and responsibility. So the next question to raise is, which of the parties to the Conventions hold responsibility for the social outcome that results and to what extent?

The United Nations Framework Convention on Climate Change represents a mixture of many different political and economic interests and many complex scientific issues. Governments nominate their respective representatives to participate and negotiate at the sessions of the Convention. This may include ministers, negotiators, and other parties that Governments consider necessary to achieve their goals.

The UNFCCC was opened for signature at the 1992 United Nations Conference on Environment and Development in Rio de Janeiro, also known as the 'Earth Summit'. The Convention enjoys near universal membership, with 192 member countries having ratified. The main goal of the UNFCCC is to stabilize greenhouse gas concentrations at a level that would prevent dangerous anthropogenic interference with the climate system.

Decision making within the UNFCCC is done through an unanimity rule. Each mem-

ber of the UNFCCC has one vote. Regional economic integration organizations, in matters within their competence, have the right to vote with a number of votes equal to the number of their member states which are also parties to the Convention. They are not allowed to exercise their right to vote en bloc if any of their member states choose to vote individually, and vice versa (Rule 41). The voting will normally be by show of hands (Rule 48).

1.4.1 Bodies of the Convention

The *Conference of the Parties* (COP) is the supreme body of the Convention. All countries that ratified the treaty are represented within this body, which has the highest authority. The main responsibility of the COP is to continue stressing the need for measures on an international level concerning climate change. Other responsibilities of the COP include reviewing the implementation of convention decisions and examining the commitments of the parties (i.e. member countries). A key task for the COP is to review the national communications and emission inventories submitted by members. Based on this information, the COP assesses the effects of the measures taken by the parties and the progress being made in achieving the ultimate objective of the Convention. The COP meets every year in Bonn, the seat of the secretariat.

The *Subsidiary Body for Scientific and Technological Advice* (SBTA) is a supporting body of the COP and advises on scientific, technological and methodological matters. It focus mainly on promoting the development and transfer of new environmentally-friendly technologies, and conducting technical work to improve the guidelines for preparing national communications and emission inventories. The SBSTA also carries out methodological work in specific areas. Another important supporting function of the SBTA is harmonizing the policy-orientated needs of the COP and the new scientific information from expert sources such as the *Intergovernmental Panel on Climate Change* (IPCC). It also works closely with other international organizations that are involved in sustainable development.

The *Subsidiary Body for Implementation* (SBI) is another supporting body of the

COP, giving advice on matters concerning the implementation of the Convention. It examines the effectiveness of the Convention by assessing the information in the international communications and emission inventories that are submitted by all parties. The SBI reviews the financial assistance given to non-Annex I parties[5] for the purpose of helping them implement their Convention commitments, and advises the COP regarding adjustments to the financial mechanism. The SBI also advises the COP on budgetary and administrative matters.

Several *expert groups* exist under the Convention. The *Consultative Group of Experts on National Communications from non-Annex 1 parties* helps developing countries prepare national reports on climate change issues. The *Least Developed Country Expert Group* advises such nations on establishing programmes for adapting to climate change. The *Expert Group on Technology Transfer* promotes the sharing of environmentally-friendly technology with less-advanced nations.

Partner agencies include the *Global Environment Facility* (GEF). Since 1991 the GEF funds projects in developing countries which have a positive impact on the climate. Because of their expertise, the GEF also grants loans to poorer countries to help them address the difficulties of climate change. The Intergovernmental Panel on Climate Change provides services to the Convention, although it is not a part of it, through publishing comprehensive reviews every five years on the status of climate change and climate-change science, along with special reports and technical papers on request.

1.4.2 Actors in the Negotiation Process

The member countries of the Convention take decisions at sessions of the COP. In order to increase their influence, member countries often form alliances during negotiations. The Conference has several groupings representing the concerns of developing countries, least-developed countries, small-island states, Europe (through the European Union), non-European industrialized nations, oil-exporting nations, and nations committed to

[5] Non-Annex I are all countries that are not listed as Annex I parties. They are mostly developing countries, like for example Cambodia, Ghana. They do not have binding emission reduction targets.

'environmental integrity'.

Additionally, there are the 'Observers' which are groups and agencies allowed to attend international meetings. The term 'Observers' is used because, although these groups can speak at the meetings, they are not allowed to participate in the decision making. Among observers permitted by the Convention are intergovernmental agencies, such as *United Nations Development Programme* (UNDP), the *United Nations Environment Programme* (UNEP), the *World Meteorological Organization* (WMO), the *OECD*, the *International Energy Agency* and *OPEC*. To date, there are over 50 intergovernmental agencies and international organizations attending sessions of the Conference of Parties.

Observers also include a lively crowd of non-governmental organizations (NGOs). These represent business and industrial interests, environmental groups, local governments, research and academic institutes, religious bodies, labour organizations, and population groups such as the representatives of indigenous peoples. In order to be identified as an observer, NGOs must be legally constituted not-for-profit entities, competent in matters related to the Convention. Currently, more than 600 NGOs participate in meetings related to the Convention.

Countries, i.e. their representatives, also get extensive input from other sources, both through official channels and in behind-the-scenes dialogue. This is not surprising, considering that the global climate is facing a major threat – coastlines and even whole countries may disappear – and that billions of dollars are being allocated for programmes and activities. This combination attracts all kinds of groups which attempt to influence the outcome of the Convention.

1.5 United Nations Convention to Combat Desertification

The second institution we will investigate is the United Nations Convention to Combat Desertification (see Johnson, 2006). Its aim is to combat desertification and reduce the effects of drought. The UNCCD tries to achieve its goals through national action programs that incorporate long-term strategies supported by international cooperation and partnership arrangements.

The UNCCD was established in 1992 at the Earth Summit in Rio de Janeiro. It was adopted in Paris, France, on 17 June 1994, coming into force in December 1996. It is the only international framework set up to address the problem of desertification. Desertification is defined as land degradation in arid, semi-arid and dry subhumid areas, and these 'drylands' cover approximately 47% of the Earth's surface, excluding polar and sub-polar areas. 192 parties and the European Community have acceded to the UNCCD as a legally binding framework that helps to provide a comprehensive answer to problems relating to the environment.

The ultimate objective of the UNCCD is to reduce poverty through improved living conditions and the achievement of sustainable development in areas affected by desertification. The UNCCD interprets the fight against desertification as a multidimensional process that requires action in the fields of policy-making, management of natural resources, and social and economic development.

National Action Programmes (NAPs) are the UNCCD's main instruments of implementation in participating countries. In a NAP each affected country defines the priority activities to be undertaken and the roles of various national actors in the implementation of the UNCCD policy. Through the national action program process, the UNCCD places the affected countries in the 'drivers seat'. The developed countries, intergovernmental and non-governmental organizations and other relevant stakeholders are then requested to actively support the implementation of the programs. It therefore establishes a system of shared responsibility, in which the UNCCD parties agree to a set of specific obligations.

Within the UNCCD each member party has one vote. Regional economic integration organizations have the right to a vote weighted by the number of votes that equals the number of their member states that are also parties to the Convention. They are not allowed to exercise the right to vote en bloc if any of their member states exercises its right (Rule 46).

The parties have to make every effort to reach a unanimous agreement on all matters of substance. If all efforts to reach consensus have been exhausted and no agreement has been reached, the decision will, as a last resort, be taken by a two-thirds majority vote

of the parties present and voting. Decisions of the COP on matters of procedure have to be taken by a majority vote of the parties present and voting (Rule 47). Voting, except for elections, will normally be by show of hands (Rule 52).

The structure of the UNCCD is very similar to the one of the UNFCCC. The Conference of the Parties is the supreme body of the Convention. One of its main functions is to review reports submitted by the member states of the Convention detailing how they are carrying out their commitments; the COP makes recommendations on the basis of these reports. The COP is assisted by two subsidiary bodies, the body of the Committee on Science and Technology and the Committee for the Review of the Implementation of the Convention. The COP meets biennially, interchanging with sessions of the Committee for the Review of the Implementation of the Convention.

Under the supervision of the COP the Committee on Science and Technology should make provisions for surveying and evaluating of the relevant existing networks, institutions, and agencies which are interested in becoming a member of the Convention. Another supporting body of the UNCCD is the Committee for the Implementation of the Convention.

1.6 Power and Responsibility Measurement

As the decision rule for the UNFCCC is a unanimity rule, the a priori voting power and thus the responsibility are equal for each member party. There is just one minimum winning coalition which contains all 192 member parties. Therefore, by symmetry the power is 1/192.

The decision rule for the UNCCD is a two-third majority rule on all matters of substance if all efforts to reach consensus have been exhausted. Each of the member states has one vote. With 193 parties present and voting 129 votes are required for a decision to pass. The a priori voting power is by symmetry, 1/193.

The difference in the measures is due to total membership numbers. However, regional economic integration organizations have the right to vote with a number of votes equal to the number of their member states if the latter are parties to the Convention. These

organizations can vote as a bloc only if none of their member states will vote for itself.

All decisions on the UNFCCC must be adopted by consensus. This is not quite the same as unanimity. Here, the will of the Chair[6] and his or her ability to reflect consensus take precedence. For example, the Chair may decide to ignore a party's objection, or a party may choose not to object formally to a decision, but to ask for its concerns to be taken note of in the report on the session.

We calculate the passage probability[7] by dividing the number of winning coalitions by the number of possible coalitions. For the UNFCCC there is just one possible winning coalition and that is the one containing all the member states. Therefore, the passage probability and thus efficiency is minimal. The ability to assert decisions compared to the status quo is minimal in the UNFCCC.

However, the a priori voting power of the members of the UNCCD and UNFCCC is likely to differ if one considers a priori unions and a priori power. As a consequence, responsibility should change as well.

1.6.1 A Priori Unions

The member parties of the climate change regime (the UNCCD as well as the UNFCCC) are organized into a number of different groups and coalitions. Established practise in the UN system divides UN members into five regional groups: Africa, Asia, Central and Eastern Europe (CEE), Latin America and the Caribbean (GRULAC) and Western Europe and others (WEOG). The fifth group includes Australia, Canada, New Zealand and the United States.

The regional group system is only of limited relevance to the main interests of parties in the climate change negotiations. With the exception of the African Group which also serves as a negotiating coalition, the regional groups are used to nominate candidates to the Bureaux and the specialised bodies only.

[6] The chair is elected by the parties to head chair the Committee of the Whole or one of the subsidiary bodies. He is responsible for facilitating progress towards an agreement.

[7] Baldwin and Widgrén (2004) refer to the passage probability for measuring the EU's decision making efficiency.

Most parties belong to political negotiating coalitions, formed on the basis of members' common interests or cultural, economic or geographic affinities. Some are active throughout the intergovernmental arena, while others are specific to the environmental or climate change context.

There are a few parties that do not belong to any of these coalitions and some others that are members of several coalitions. There is no formal process for establishing these groups. They meet informally during sessions of the COP or the Subsidiary Bodies. Their purpose is to exchange information on common issues, and, in some instances, develop and agree to common positions.

In the following we introduce the various a priori unions that are (or were) relevant for the voting in the climate conventions.

The *European Union* (EU) is the most cohesive negotiating coalition in the climate change regime. Its 27 member states plus the European Community (represented by the European Commission) articulate a common position on all issues, almost always speaking with a single voice[8].

The European Community, represented by the European Commission, has become a party to the Convention as a regional economic integration organization.

Umbrella Group (UG) members share similar values and principles in the climate change negotiations, centred on the dual ambition of flexibility and cost-effectiveness. Their national circumstances and their political engagement, however, are very diverse. This explains why the Umbrella Group is only a loose coalition, which does not always negotiate as a single entity. The Umbrella Group consists of 9 members: Japan, U.S., Canada, Iceland, Australia, New Zealand, Russia, the Ukraine and Norway. This group developed from the longer standing *JUSSCANNZ* group. The difference between these two groups is that the Umbrella Group does not include Switzerland but Russia and the Ukraine instead.

The *Environmental Integrity Group* (EIG) is a group comprising Mexico, the Republic

[8] For our calculation we use a voting weight of 29 for the EU bloc. Estonia is not a member of the UNCCD. Furthermore, we count Turkey and Croatia's vote to the EU bloc as they are in no other a priori union and candidates to join the EU.

of Korea and Switzerland. It emerged at the thirteenth session of the SBs held in Lyon in September 2000. It aims to achieve environmental integrity in the outcome of climate change negotiations. It is the only group that brings together the non-Annex I parties (Mexico, Republic of Korea) and an Annex I party (Switzerland). All three parties are members of the OECD. Like most other negotiation groups, the EIG develops common positions and feeds them into the climate change process.

A number of countries of Asia and of Central and Eastern Europe, which are not included in Annex I, have joined to form the group *Central Asia, Caucasus, Albania and Moldova* (CACAM). Although these countries are not included in Annex I, they do not consider themselves to be developing countries and are not members of the G77. They have consequently asked the COP for a clarification of their status under the Convention. However, so far the COP has been unable to take a decision on this matter and will consider it at a future session.

Open Balkan Group (OBG) consist of Bosnia Herzegovina, the Former Yugoslav Republic of Macedonia and Yugoslavia (which has since become Serbia and Montenegro). In 2001 they expressed interest in forming their own negotiating coalition. The countries are Non-Annex I parties but consider themselves to be economies in transition and not developing countries.

The *Group of 77 and China* (G77) was founded in 1964 by seventy-seven developing countries in the context of the United Nations Conference on Trade and Development, explicitly to counter the power of the developed world. They now function throughout the United Nations system, comprising 130 members. The G77 consists of small island countries, oil-exporting countries, LDCs, industrializing countries, and middle-income countries. China is exclusively a member of the G77 and not of any subgroup.

While G77 members broadly share common principles, their national circumstances vary considerably. This is reflected by the other groups that act within the G77, such as the *African Group*, the *Alliance of Small Island States* and the group of *Least Developed Countries*. Although the members of the G77 have increased to 130 countries, the original name was retained because of its historic significance. Here are various subgroups:

(i) The 49 countries defined as *Least Developed Countries* (LDCs) by the United Nations are also Convention parties. They include Afghanistan, Haiti, Nepal and the Sudan. Some LDCs are also members of the African Group, the Alliance of Small Island States and others. They are increasingly active in the climate change process, often working together to defend their particular interests in, for example, vulnerability and adaptation to climate change.

(ii) The *Alliance of Small Island States* (AOSIS) is an alliance of 39 (plus 4 observers) small island states and low-lying coastal countries, e.g. Singapore, Saint Lucia and Mauritius. They share similar development challenges and environmental concerns, especially their vulnerability to the adverse effects of global climate change.

Most of the AOSIS members also belong to the *Small Island Developing States* (SIDS).

(iii) The *League of Arab States* (ARAB) is a regional organization of Arab states in Southwest Asia, and North and Northeast Africa, e.g. Morocco, Lebanon and Bahrain. The Arab League currently has 21 members (plus Palestine). The main goal of the league is to draw closer the relations between member states and to coordinate collaboration between them. All members of the League of Arab States are members of the Group of 77.

(iv) As already mentioned, the *African Group* (AG) is the only regional group working as an active negotiating group. It consists of 53 members, e.g. Angola, Egypt and Ghana. They have common concerns, such as the lack of resources and the vulnerability to extreme climate conditions. The group often makes common statements on various issues, e.g. capacity-building and technology transfer.

Figure 1.1 gives an overview of the a priori unions and their relationships and origins among each other. The shaded boxes represent groups that are also active outside the climate change regime in contrast to the unshaded spheres which stand for the groups which are exclusive to the climate change regime.

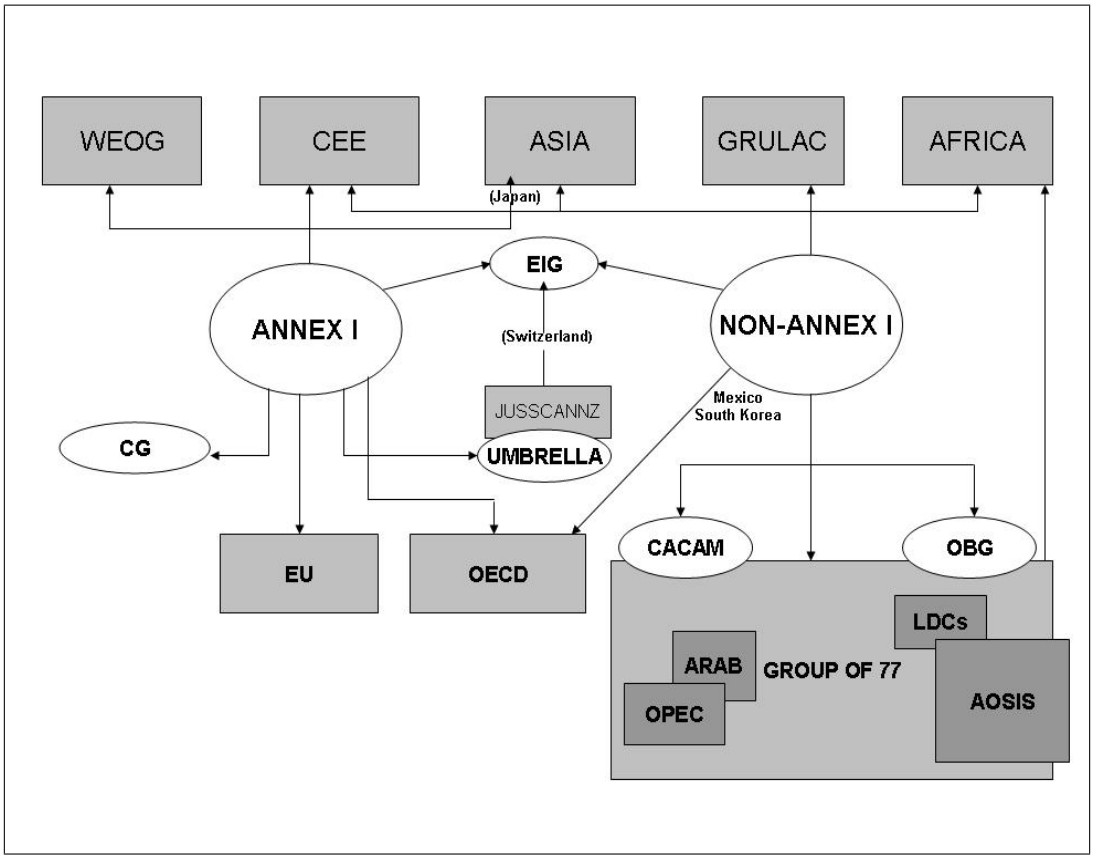


Figure 1.1: Party Grouping in the International Climate Change Regime
(Source: Yamin and Depledge, 2004, own alterations)

1.6.2 A Priori Power and Responsibility

We will now compute two a priori versions of the PGI, the Solidarity PGI and the Union PGI, to analyze the UNCCD. It will suffice to focus on this institution because the parties of the UNCCD overlap closely with those of the UNFCCC. Moreover, as the UNFCCC decision making rule is an unanimity one, the assertiveness of new decisions compared to the status quo is minimal in the UNFCCC. The calculation has been computed with *Mathematica*.

We consider 193 players (member states). If we abstract from a priori unions, the UNCCD can be represented as the following weighted two-third majority game:

$$v = [129 : \underbrace{1, 1, 1, \ldots, 1}_{193}].$$

The corresponding set of minimal winning coalitions, M^W, is obvious. However, if we take likely a priori unions into account, we may divide the parties of the UNCCD such that the following system of a priori unions applies:

$$P = \{EU, CACAM, UG, EIG, LDC, AOSIS, OBG, G77, AG, ARAB, RoW\}$$

Table 1.1. shows all the existing a priori unions in the first column. As there are some member states which are part of more than one a priori union,[9] there exist many possible weighted combination of a priori unions (i.e. partitions). We examine five of them (column $P1, \ldots, P5$). The numbers in the cells describe the weight of the respective union which are equatable to the number of countries within that union as every country has one vote. The order of the priority of the a priori unions can be justified by their preferences toward a given decision topic. For example, an issue related to the changing sea level could be a fundamental topic to the AOSIS. Countries which are members of the AOSIS as well as of the LDC, in the case of $P1$, give their vote to the AOSIS. If they are a member of LDC and ARAB but not of the AOSIS, they would give their vote to the LDC group and so on.

The justification for the dividing line between the a priori unions is that the bottom half of Table 1.1 are unions which contain countries that belong to more than one a priori union and, therefore, the weights of these a priori unions will differ depending on the decision topic. Table 1.1 shows the alternative partitions $P1, \ldots, P5$ and the related voting weights.

The individual member states of the UNCCD are symmetric, inasmuch as they all have the same voting weights. As a consequence, as already demonstrated in section 2.4, the Solidarity PGI, the Owen extended PGI and the three power distributions based on threats coincide. Therefore, we focus on the Solidarity PGI and the Union PGI.

[9] Most of the G77 members are in more than one negotiating group.

Table 1.1: A Priori Unions of the UNCCD

	voting weights				
A Priori Union	*P1*	*P2*	*P3*	*P4*	*P5*
European Union (EU)	29	29	29	29	29
CACAM	7	7	7	7	6
Umbrella Group (UG)	9	9	9	9	9
Open Balkan Group (OBG)	4	4	4	4	3
Environmental Integrity Group (EIG)	3	3	3	3	3
Least Developed Countries (LDC)	38	49	43	16	2
Alliance of Small Island States (AOSIS)	39	28	28	25	4
League of Arab States (ARAB)	14	14	20	9	0
African Group (AG)	12	12	12	53	0
Group of 77 (G77)	29	29	29	29	128
Rest of the World (each weight 1)	9	9	9	9	9

	AOSIS	LDC	ARAB	AG	G77
	LDC	AOSIS	LDC	LDC	AG
Example of an order of the Unions	ARAB	ARAB	AOSIS	ARAB	LDC
related to the topic of decisions	AG	AG	AG	AOSIS	ARAB
	G77	G77	G77	G77	AOSIS

In Table 1.2 we calculated the results of the quotient game of the Solidarity PGI, i.e. the Public Good Index for the different a priori unions with regard to the different weighted systems. For the Solidarity PGI the second step is to divide the assigned union power by the number of members of the respective union.

Table 1.3 shows some results for selected member countries according to the Solidarity PGI and the Union PGI. In regards to the Solidarity PGI, Germany, as a representative of the EU, holds the same power as India and China which are members of the G77. That can be explained by the fact that there are 19 players[10] and that the decision rule requires 129 votes, so all a priori unions are almost equally represented in the set of

[10] There are 10 unions and 9 single player, see Table 1.1.

Table 1.2: PGI of the unions in the quotient game

	UNCCD				
	Public Good Index				
A Priori Unions	*P1*	*P2*	*P3*	*P4*	*P5*
European Union (EU)	0.06948	0.06237	0.06158	0.05978	0.03125
CACAM	0.04441	0.05136	0.05007	0.04929	0.03125
Umbrella Group (UG)	0.04743	0.04802	0.04977	0.05687	0.03125
Open Balkan Group (OBG)	0.05216	0.05283	0.05584	0.04313	0.03125
Environmental Integrity Group (EIG)	0.04933	0.04761	0.04891	0.04944	0.03125
Least Developed Countries (LDC)	0.07099	0.08111	0.07709	0.04117	0.03125
Alliance of Small Island States (AOSIS)	0.07185	0.06211	0.05922	0.06094	0.03125
League of Arab States (ARAB)	0.04912	0.05046	0.05063	0.05687	0
African Group (AG)	0.04852	0.05198	0.05843	0.08626	0
Group of 77 (G77)	0.06948	0.06237	0.06158	0.05978	0.5
Rest of the World:(9 members)	0.04747	0.04775	0.04743	0.04850	0.03125

MWC. Lichtenstein as a single player bears most of the power, because it does not share its power inside a union. But this does not seem reasonable since Lichtenstein is a very small country and it stands on its own with no alliance.

In regards to the Union PGI, the single player Lichtenstein has less power then most of the other member states. Germany as the EU representative again holds the same power as the G77 members. Depending on the decision topic, and thus on the voting weights, in almost any of the considered cases the developing countries of the AOSIS, LDC or the G77 hold the most power. Therefore even though Germany or any other EU member holds substantial voting power, in almost every decision case there are developing countries which are more powerful. In the extreme case, where the $P5$ partition for a priori unions applies, the group of G77 has a 50% share of the power in the quotient game. One can see that, if power is measured by the Union PGI, the member states of the G77, when voting as a bloc, hold much more voting power than all other states.

Table 1.3: Selected member states and their power/responsibility

	UNCCD										
	Coalitional Solidarity PGI/ Union PGI										
Member States	P1		P2		P3		P4		P5		a priori union
Afghanistan	0,0019	0.0058	0,0017	0.0066	0,0018	0.0065	0,0026	0.0033	0,0039	0.0076	LDC, G77
Bosnia&Herzegovina	0,0130	0.0042	0,0132	0.0043	0,0139	0.0047	0,01078	0.0035	0,0039	0.0005	OBG
China	0,0024	0.0056	0,0022	0.0051	0,0021	0.0052	0,0021	0.0048	0,0039	0.0076	G77
Germany	0,0024	0.0056	0,0022	0.0051	0,0021	0.0052	0,0021	0.0048	0,0011	0.0005	EU
India	0,0024	0.0056	0,0022	0.0051	0,0021	0.0052	0,0021	0.0048	0,0039	0.0076	G77
Kazakhstan	0,0063	0.0036	0,0073	0.0042	0,0072	0.0042	0,0070	0.0040	0,0045	0.0005	CACAM
Lichtenstein	0,0475	0.0039	0,0478	0.0039	0,0474	0.0040	0,0485	0.0039	0,0313	0.0005	no Union
Mexico	0,0164	0.0040	0,0159	0.0039	0,0163	0.0041	0,0165	0.0040	0,0104	0.0005	EIG
Palau	0,0018	0.0058	0,0022	0.0051	0,0021	0.0050	0,0024	0.0049	0,0078	0.0005	AOSIS
South Africa	0,0040	0.0039	0,0043	0.0042	0,0049	0.0049	0,0016	0.0070	0,0039	0.0076	AG, G77
United Arab Emirates	0,0035	0.0040	0,0036	0.0041	0,0025	0.0043	0,0063	0.0046	0,0039	0.0076	ARAB, G77
USA	0,0053	0.0038	0,0053	0.0039	0,0055	0.0042	0,0063	0.0046	0,0035	0.0005	UG

1.7 Responsibility and the Conventions

Both, the UNFCCC and the UNCCD, refer to the responsibilities of the parties as 'common but differentiated responsibilities'. Concerning the UNFCCC the shared responsibility of the parties is described as the contribution to the preservation of the global climate system, an obligation which is imposed on them 'for the benefit of present and future generations of humankind'[11]. This is meant to imply that all the major economic and political players, as well as their citizens and consumers, have a role in implementing the programme.

The differentiated responsibilities of the developed countries, on the one hand, and of the developing countries, on the other, is a distinction based on the principle of equity and the varying capacities of the two categories of country. The primary responsibility which falls to the industrial countries is based on their historic contribution to the increase in Green House Gas concentration in the atmosphere and also on their level of economic potential. The first argument derives from Goodin's 'blame responsibility' while the second constitutes 'task responsibility'. Goodin (1998, p. 150) argues that blame responsibility is backward-looking, and should be shunned for policy purpose but which nonetheless seems to dominate discussions of social welfare (see King, 2006, for further discussion). In general, industrial countries also have a better scientific, technological and financial capacity than developing countries. The UNFCCC recognizes that reductions by developing countries in their rate of emissions growth will depend on the provision of financial and technical assistance from developed countries. Following this argument, developed countries should be the first to act. While industrialized countries bear a greater historical responsibility, annual emissions from developing countries are expected to start exceeding those of industrialized countries within the next two decades. Yet different countries place very different priorities on the issue and climate change raises complicated issues of equity.

Regarding the UNCCD, the responsibility of developing countries is to combate desertification and mitigate the effects of drought. They are placed in the 'driver's seat'. As

[11] UNFCCC, 2004

defined in Article 6 of the Convention, developed countries once again are called upon to support those countries financially.

The question is, how can we combine this 'differentiated responsibility' definition with the responsibility approach that we deal with in section 1.3? Is it that the more developed countries hold part of the responsibility for the developing countries? And is this inequality reflected in voting power? They are obviously wealthier and have better access concerning new technologies and science. If we consider the possibility of a priori unions, power and thus responsibility differs between countries. Looking at the results of section 1.6, we may ask the question whether the developed world holds more power and responsibility? Is there a fair allocation of responsibility between developed and developing member states?

The results show that in most of the considered cases developing countries have more voting power than developed countries. The differentiated responsibilities as referred in this section are not consistent with the results of section 6. Underlying the theory we used in this paper is the assumption that developed countries should have more voting power if they are made more responsible. But what is a fair allocation? Industrialised countries bear more responsibility because of their history. Moreover, they control a larger capacity concerning science and technology. They also provide a larger financial contribution. Therefore, should they not have a greater influence on what to do with the money, technology and the scientific results? A possible solution for a reasonable allocation of responsibility and power could be a 'shift in power' from the developing countries to the industrial countries. That could be accomplished by a different decision rule or voting weights.

1.8 Institutional framing versus ad hoc decision making

In this paper we analysed the potential impact of the various agents, i.e., the representatives of member countries, in the United Nations Framework Convention on Climate Change (UNFCCC) and the United Nations Convention to Combat Desertification (UNCCD). The stability of the climate and those collective measures designed to react

to climate changes were considered public goods, and, therefore, the application of the Public Good Index promised to be a straightforward way to quantify the impact of the agents on the corresponding policies. UNFCCC decision making requires unanimity and the UNCCD relies on a two-third majority rule. Given that 'one country, one vote' applies for the UNFCCC and the UNCCD, the power calculation is rather trivial: in both cases, the representatives of individual member countries have equal power, although for different reasons. In the case of UNFCCC, our implicit assumption is that, in the long run, a qualified majority rule will be introduced, quite similar to what we observed in the decision making of the EU Council of Ministers. Our study is meant to be a first step in delivering a framework for such an institutional change. Moreover, if unanimity no longer dominates and there are more or less stable ties between groups of agents such that a priori unions exist, then the decision situation can be described by a non-trivial weighted voting game and the power distribution is not obvious. In order to exemplify the method and to derive first results we have discussed the power problem for the UNCCD under the pretext that a priori unions can be identified.

The underlying assumption of our study is that, in the long run, international environmental policy, including climate change policies, have to be defined and organized by international institutions like UNFCCC and UNCCD and cannot rely on ad-hoc meetings of national governmental representatives who, more or less, want to serve their national clientele by expressive decision making and the issuing of hollow declarations with hardly any consequences. Of course, government representatives are hardly impartial when it comes to making decisions on specific policy measures, as their main responsibility is to their national electorates. Even dictatorial governments have to take care to consider the preferences of their national power base.

It is common knowledge that, at least in the short-run, free-riding is the dominant strategy when it comes to the production of public goods like a 'clean environment.' Obviously, the time horizon of elected governments is limited by the re-election constraint. Dictatorial governments do not depend on majorities but in general rely on servicing a

political elite that contributes resources and support in exchange for privileges.[12]

Many governments, represented in UNFCCC and UNCCD, can be classified as being located between these poles. In order to circumvent the trap of self-interested national representation and free-riding, decision making power and the corresponding responsibility, should be assigned behind a veil of ignorance, i.e. allocated to international institutions before the states of nature and the related decision problems are known. Unfortunately, the possible veil of ignorance is already very thin because many problems and their corresponding addressees are known. Moreover, it is highly urgent that the international community implement institutions that can execute political power in climate change policies. Once established, it can be expected that such institutions will extend their activities and influence into those realms which are governed by national self-interest today. The history of the EU shows some evidence for this but also gives alarming examples.[13]

However, we can only expect the necessary transfer of political power from national governments to international institutions if the latter are well defined, their power structure is lucid, and the possible allocation of responsibility is acceptable. This study substantiates some of the related problems.

[12] See the various contributions in *The Rationale of Revolutions*, edited by Mario Ferrero (2004).
[13] See EU agricultural policy.

1.A Appendix. Annex I and Annex II Countries, and Developing Countries

UNFCCC are split into three groups[14]:

* Annex I countries (industrialized countries)
* Annex II countries (developed countries which pay some of the expenses of developing countries)
* Developing countries.

These are mostly developed countries, of which there are currently 42, including the European Community which is a party in its own right. Annex I countries were aiming to return their emissions by 2000 to 1990 levels. They also have to make regular reports on their implementation of the Convention – in particular, on the policies and measures they are taking and the impacts that these are having on emission trends, as well as on the amount of greenhouse gases released into the atmosphere. Annex II parties, an Annex I subset, are the 25 highly developed countries. In addition to reducing their own emissions, they are also required to financially and otherwise support the efforts of developing countries. Developing countries, like all parties to the Convention have general commitments to respond to climate change but they have fewer specific obligations and can also rely on external support. They are required to provide a general description of the steps taken or envisaged to implement the Convention and estimate emissions of greenhouse gases. Developing countries have no immediate restrictions under the UNFCCC. This serves three purposes:

* Avoids restrictions on growth because pollution is strongly linked to industrial growth, and developing economies can potentially grow very fast.
* It means that they cannot sell emissions credits to industrialized nations to permit those nations to over-pollute.

[14] UNFCCC

* They get money and technologies from the developed countries in Annex II.

Developing countries may apply to become Annex I countries when they are sufficiently developed.

Developing countries are not expected to implement their commitments under the Convention unless developed countries supply enough funding and technology, and responding to climate change often has lower priority than economic and social development and dealing with poverty.

Some opponents of the Convention argue that the split between Annex I and developing countries is unfair, and that both developing countries and developed countries need to reduce their emissions. Some countries claim that the costs of following the Convention requirements will stress their economy.[15]

Annex I countries

Australia, Austria, Belarus, Belgium, Bulgaria, Canada, Croatia, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Latvia, Liechtenstein, Lithuania, Luxembourg, Malta, Monaco, Netherlands, New Zealand, Norway, Poland, Portugal, Romania, Russian Federation, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey, Ukraine, United Kingdom, United States of America (41 countries and separately the European Union)

Annex II countries

Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Japan, Luxembourg, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, United Kingdom, United States of America (24 countries and separately the European Union)

[15] This is one of the reasons why President Bush did not sign the Kyoto Protocol.

Chapter 2

Cluster Analysis and A Priori Power Measures within Climate Conventions

Abstract Almost twenty years ago, most countries have joined an international treaty, the United Nations Framework Convention on Climate Change. Over the past years, several negotiating coalitions have emerged as new decision topics came to the table. This paper makes use of a cluster analysis to identify the a priori unions/coalitions within three different decision topics (reduced emissions from deforestation and degradation (REDD), CO2 emissions, water shortage). To estimate the impact of the a priori unions and accordingly the member states of the UNFCCC within the decision making process we apply power measures, more precisely the Coalitional Solidarity Public Good Index and the Union Public Good Index. Based on the Coalitional Solidarity Public Good Index the USA, EU, Norway, and China would hold more a priori decision power if there are many small cluster groups. However, based on the Union Public Good Index the developing countries hold most power.

Keywords environmental policy, collective decision making, voting power, Public Good Index, cluster analysis

JEL Classification C7, D7

2.1 Introduction

Governments all over the world struggle with finding and implementing practical solutions to address the global problem of climate change. A response to the threat of global warming is the United Nations Framework Convention on Climate Change (UNFCCC) which was adopted in 1992 and entered into force two years later. Today, it consists of an almost universal membership. In this process countries discuss and agree on actions that stabilise our global climate.

The existence of negotiating coalitions is crucial to the functioning of the climate change regime. By forming coalitions, parties can syndicate their resources and negotiating power which is especially important for countries that do not hold much power in the political arena and would otherwise find it difficult to get their opinion on certain topics heard. The complexity of the climate change process also generates an incentive for small countries to cooperate allowing them to share information and coordinate their actions. Over the past few years new negotiating coalitions emerged. The request by countries to form groups also responds to the growing trend of arranging negotiations based on coalitions.

This paper analyses the status of the parties involved in regulating climate conventions and treaties and allocates power to the countries measured by the Solidarity Public Good Index (Alonso-Meijide et al., 2010a) and the Union Public Good Index (Holler and Nohn, 2009). By applying power measures, we estimate the potential impact of the various agents in these contractual or instrumental arrangements with the possibility of a priori unions within the sets of decision makers.

In Holler and Wegner (2011) the United Nations Framework Convention on Climate Change (UNFCCC) and the United Nations Convention to Combat Desertification (UNCCD) were analysed according to their power and responsibility distribution amongst their member states. For the calculation of the a priori power, existing coalitions/a priori unions were considered, e.g. European Union, Group of 77 and China, Least Developed Countries Group.

In this study we will identify the a priori unions by making use of a cluster analysis. As new decision topics are coming into perspective, the existing coalition get obsolete. The countries would rather cooperate with other countries than the ones in their own group.

The paper is organized as follows. In section 2.2 we provide the analytical tools such as simple games, the Public Good Index and simple games with coalition structures. In section 2.3 we introduce the United Nations Framework Convention on Climate Change and describe the existing coalitions/a priori unions. In section 2.4 we describe the method and variables used within the cluster analysis. Section 2.5 discusses the results of the cluster analysis based on three different decision topics. In section 2.6 we display the a priori power and conclude with the results.

2.2 Preliminaries

Cooperative games with transferable utility (TU game) model conflict situations where the involved agents can achieve binding agreements and the joint utility can be split in any way among the players.

A particular class of TU games for modeling voting situations is the class of simple games. In this setting values are referred to as power indices. They are quantitative measures to express power. Power is an important concept to study the social, political and economic relationships represented as simple games.

In the literature we can find a series of power indices: the Shapley-Shubik index (Shapley and Shubik, 1954), the Banzhaf-Coleman index (Banzhaf, 1965, Coleman, 1971), the Deegan-Packel index (Deegan and Packel, 1978), and the Johnston power index (Johnston, 1978)[1]. In this paper we focus on the Public Good Index which was proposed in Holler (1982) and formalized in Holler and Packel (1983), and, recently, in Alonso-Meijide et al. (2008).

[1] See Felsenthal and Machover, 2006, for a brief overview. More extensive introductions to power measurement are given by Laruelle and Valenciano (2008) and Felsenthal and Machover (1998).

2.2.1 Simple Games, the Public Good Index and the Coalition Structure

In the following we consider a simple game which is a pair (N, W) of the finite set of players N and the set of winning coalitions W. We furthermore only look at coalitions that are minimal winning coalitions (MWC) which means that each proper of that coalition is a losing one. The power index we make use of in the paper is the Public Good Index (PGI). It is based on the assumptions that coalitional values are public goods and only minimal winning coalitions are relevant and assigns power proportional to the number of minimal winning coalitions a player belongs to. We furthermore examine the possibility of a priori unions or a coalition structure which is a partition of the player set N. (See Section 1.2.1, 1.2.2 and 1.2.3, page 9.–11.).

2.2.2 The Public Good Index for A Priori Unions

There have been several extensions of the PGI for a priori unions. Alonso-Meijide et al. (2010a) introduced two variations: the Solidarity PGI and the Owen extended PGI. Holler and Nohn (2009) introduced another four variations of the PGI for a priori unions. The first one is called the Union PGI. The three other ones are power distributions based on threats. But as in our special case the latter ones coincide with the Solidarity PGI we only consider the Union PGI and the Solidarity PGI for our calculations below (See Section 1.2.4).

Holler and Nohn (2009) discuss the similarities of the two measures in their paper. To begin with both measures are efficient values. While the Solidarity PGI satisfies symmetry among unions, this holds for the Union PGI Λ for equally sized unions only. Symmetry inside unions does, however, always apply. The indices give a power of zero to null unions. But as they satisfy the solidarity property null players have positive power if their union is not a null union.

In addition, the Solidarity PGI distributes power in a two-step way such that unions receive overall power as much as assigned by the PGI in the corresponding quotient game (quotient game property). In games where the coalition structure is given by singletons, both indices coincide with the PGI of the game without union structure. However, in

the case with one grand union, the Union PGI and the Solidarity PGI amount to the egalitarian power distribution. Both indices coincide whenever all unions have equal size.

2.2.3 Cluster Analysis

For our calculation of the a priori unions we make use of the concept of cluster analysis, also called data segmentation. Cluster analysis examines multivariate data with a view to uncovering or discovering groups or clusters of observations that are homogeneous and separated from other groups (Everitt and Hothorn, 2006). The method can be used to discover structures in data without providing an explanation/interpretation. The results should help us to identify how the voting behaviour distributes the UNFCCC member states into groups/clusters.

In hierarchical clustering these algorithms are either agglomerative or divisive in their way of clustering the objects. Agglomerative algorithms begin with each element as a separate cluster and merge them into larger clusters. Divisive algorithms start off with the whole set and proceed to divide it into smaller clusters.

The output of the data analysis is a dendrogram outlining the mode of clustering of the objects. The table in the Appendix represents such dendrograms. The clusters are identified by closed branches of vertical lines representing individual member states in horizontal direction. The similarity between two objects in a dendrogram is represented as the height of the lowest internal node they share.

Agglomerative Methods

In practice, mainly agglomerative methods play a major role, as divisive algorithms, which search for an optimal allocation of the data set into subsets, are highly computationally intensive leaving even today's computers to reach their limits. For agglomerative approaches, varying measurements of cluster proximity derive different strategies which are amongst others the single link, complete link, average link, group average, centroid and Ward's method (Barbara, 2000).

In the paper we make use of the concept of the hierarchical cluster analysis. For this

undertaking we will use the *average linkage cluster analysis*. The average linkage cluster analysis demands that an observation is joined to a cluster if it has a certain average level of similarity with all current members of the clusters.

This is an intermediate approach between the single and the complete linkage approaches. Within the *single linkage cluster analysis* an observation is joined to a cluster if it has a certain level of similarity with at least one of the members of that cluster. Connections between clusters are based on links between individual entities. For the *complete linkage cluster analysis* an observation is joined to a cluster if it has a certain level of similarity with all current members of the cluster. The single linkage technique is sensitive to noise and outliers, it tends to form only small clusters and chain formation is a big problem. The complete linkage approach is less susceptible to noise and outliers and it tends to form many small clusters.

Because the average linkage method considers all members in the cluster rather than just a single point, it tends to be less influenced by extreme values than other methods. Therefore, the intermediate approach of the average linkage cluster analysis is used.

As the considered variables have different metrics it is necessary to standardize the data. A z-transformation will be performed for this purpose. If for example the considered variables are weight in kg (70 kg) and height in meters (1,80 m), the distance value of the weight would far exceed the distance value of the height and would therefore dominate the classification.

Proximity/distance Measure

Proximity/Distance measure is a measure that quantifies the similarity (or dissimilarity) of two data points, e.g. x and y.

The choice of the measure will influence the shape of the clusters, as some elements may be close to one another according to one distance and farther away according to another. For a hierarchical clustering one can consider the following proximity/distance measure (Bacher et al., 2010):

The *Euclidean Distance* simply displays the geometric distance in the multidimensional

space. It is computed as:

$$\text{distance}(x, y) = \left[\sum_i (x_i - y_i)^2\right]^{\frac{1}{2}}.$$

Another similar distance measure is the *Squared Euclidean Distance*. You may want to square the standard Euclidean distance in order to place progressively greater weight on objects that are further apart. This distance is computed as:

$$\text{distance}(x, y) = \sum_i (x_i - y_i)^2.$$

Another distance measure is the *Chebyshev distance*. It is computed as:

$$\text{distance}(x, y) = \text{Maximum}|x_i - y_i|.$$

The Chebyshev Distance Measure may be appropriate in cases when we want to define two objects as different if they are different on any one of the dimensions.

The Euclidean distance and the squared Euclidean distance are probably the most commonly chosen types of distance. One advantage of them is that the distance between any two objects is not affected by the addition of new objects to the analysis, which may be outliers. Compared to the Euclidean distance the squared Euclidean distance puts progressively greater weight on objects that are further apart. In our paper we therefore make use of the squared Euclidean distance.

2.3 The Convention and the Coalitions

In Holler and Wegner (2011) the UNFCCC and the UNCCD were analysed according to the power and responsibility distribution among their member states. The analysis considered 193 players. The Public Good Index was used to measure power. The Union PGI and the Solidarity PGI were applied for calculating the a priori power and responsibility.

The following existing coalitions/a priori unions were considered: the European Union, the Umbrella Group, the Environmental Integrity Group, the Group of Central Asia, Caucasus, Albania and Moldova, the Open Balkan Group, the Group of 77 and China,

the Least Developed Countries Group, the Alliance of Small Island States, the League of Arab States and the African Group.

We analyse the UNFCCC with 194 member states under the assumption of no pre-existing coalitions. We will calculate the a priori unions by making use of a cluster analysis. This seems appropriate because members of one group do not always have the same opinion on certain decision topics and would be much closer in their perspective to a country belonging to another a priori union. Also, it would be more reasonable for it to join up with other member states for that decision. Furthermore, new decision topics are coming into view that are not considered in Holler and Wegner (2010).

2.4 The Method

Cluster analysis has a variety of goals. All relate to grouping objects (also called observations, individuals, or cases) into subsets/clusters, such that those within each cluster are more closely related to one another than objects assigned to different clusters (Kaufman and Rousseeuw, 2005). In this paper 194 cases (member states of the UNFCCC) are considered. To cluster these cases we consider four metric variables. Three *decision-fixed* variables (GDP per capita based on purchasing power parity, contributions to the core budget of the UNFCCC, Environmental Performance Index) and in each decision case one *cluster-identifying* variable (Forest area, CO2 Emissions, Renewable internal freshwater resources per capita) for the three different decision situation are taken into account. The missing data was calculated by the mean of all other countries that are in one cluster with the respective country abstracting the variable with the missing data.

2.4.1 The decision-fixed Variables

The decision-fixed variables are the same with respect to every decision topic. They describe the member states according to their wealth, their involvement within the institution and their opinion towards *green thinking* and should help to describe the clusters.

The *GDP per capita based on purchasing power parity* is the gross domestic product

converted to international dollars using purchasing power parity rates, the value of all final goods and services produced within a nation in a given year divided by the average (or mid-year) population for the same year. The source for the data is the CIA World Factbook, 2010.

The *contributions to the core budget of the UNFCCC* is another decision-fixed variable considered in the calculation. Financing of the UN is a highly political issue. One big issue in this delicate debate is the size of contribution of each member state. It is a discussion about the general fairness of sharing the financial burdens and being independent of national interests. The source for this data is the UNFCCC, 2010 and it is stated in Euro.

The *Environmental Performance Index* (EPI) ranks 163 countries on 25 indicators tracked across ten well-established policy categories including environmental health, air quality, water resource management, forestry, agriculture, biodiversity, fisheries and climate change which covers both environmental public health and ecosystem vitality. These indicators could provide a gauge at a national government scale of how close countries are to established environmental policy goals. The data are from 2010.

2.4.2 The cluster-identifying Variables

The cluster-identifying variables describe the decision topic. Of course there are many important climate change issues that are being discussed during the negotiations of the COP. We limit those topics in this paper to three very important issues.

The agenda item on 'reducing emissions from deforestation in developing countries and approaches to stimulate action' was first introduced to the Conference of Parties agenda at its eleventh session in Montreal (December 2005). The proposal received wide support from member states of the UNFCCC and there was general agreement on the importance of the issue in the context of climate change mitigation, particularly in light of the large contribution of emissions from deforestation in developing countries to global greenhouse gas emissions. The basic idea of REDD (Reducing Emissions from Deforestation and Degradation) is to pool funding from developed countries to reduce

forest loss in developing countries, where most of the carbon emissions from deforestation and degradation occurs. To cluster the members of the UNFCCC according to their position on REDD we introduced the variable *Forest area (sq. km)*. Forest area (sq. km) is land under natural or planted stands of trees of at least 5 meters, whether productive or not, and excludes tree stands in agricultural production systems (for example, in fruit plantations and agroforestry systems) and trees in urban parks and gardens. The source of the data is the Worldbank, 2007 and it is measured in square kilometre.

During the climate change negotiations emissions cuts, atmospheric carbon concentrations and global temperature targets were highly discussed topics. To simulate a cluster situation where the countries have to decide on such topics we consider in addition to the decision-fixed variables the cluster-identifying variable *CO2 emissions*. CO2 Emissions (kt) are those stemming from the burning of fossil fuels and the manufacture of cement. They include carbon dioxide produced during consumption of solid, liquid, and gas fuels and gas flaring. The data was derived from the Worldbank and the Carbon Dioxide Information Analysis Center, 2007 and is measured in thousand metric tons of CO2.

A U.N. Independent Expert reminds the Conference of Parties during the climate change negotiation in Copenhagen that water is a key medium through which climate change impacts on human populations, society, and ecosystems, particularly due to predicted changes in its quality and quantity. Water is a fundamental aspect of climate and needs to be at the centre of future climate agreements addressing adaptation. It is the primary transmitter of climate change impacts on society and the environment and also a key vehicle for adaptation. Water and its availability and quality will be the main problem on societies and environment under climate change (IPCC). Of course, such a topic is most important to developing countries. To cluster all member states we introduced *Renewable internal freshwater resources per capita* as a cluster-identifying variable for our cluster analysis. Renewable internal freshwater resources per capita refer to internal renewable resources (internal river flows and groundwater from rainfall) in the country. The data was derived from the World Bank, 2008 and is stated in cubic meter. The variable is supposed to describe decisions taken on, for example, water shortage.

2.5 Results of the Cluster Analysis

We make use of the concept of the hierarchical cluster analysis and use SPSS to conduct the analysis. Most clustering algorithms require specification of the number of clusters beforehand. The number of clusters is generally an unknown parameter which needs to be either specified by users based on their prior knowledge or estimated in a certain way. A variety of methods have been proposed to estimate the number of clusters[2].

One approach to decide on the optimal cluster number which is needed to represent the data is to look at the resulting coefficients. The coefficients show the value of the distance (or similarity) statistic used to form the cluster. From these numbers, you get an idea of how unlike the clusters being combined are. One should stop the cluster formation when the increase (for distance measures) or decrease (for similarity measures) in the coefficients between two adjacent steps is significant large.

In all three decision topics the coefficients increment rather uniformly. There is a slightly larger increase after 170 clustering steps for decision on CO2. That means that the cluster formation if possible should be stopped on stage 170 which would then produces 24 cluster. For decisions on REDD and WATER shortage the same holds for stage 172 which leaves 22 clusters. As there is only a slightly larger increase in the values and therefore no clearly optimal cluster number in our cases we simulate the 10 cluster case, the 15 cluster case and the 20 cluster case.

Another reason for that decision is that we want to show the different results in the case where we have many smaller coalitions (20 clusters) compared to the case where we have only few coalitions (10 clusters) for all three decision topics in the same way. To give an example see Table 2.1 (decision dealing with reduced emissions from deforestation and degradation). Within the 20 cluster case the first cluster consists of 75 countries, that is, these 75 countries are closely related dealing with decisions on REDD, the second cluster consists of 39 different countries, the third cluster of 1 and so on.

[2] e.g. the elbow method, the jump method, see Bacher (2010)

2.5.1 Results for Decisions on REDD

For decisions dealing with REDD (reduced emissions from deforestation and degradation) the cluster analysis provides the following results.

Table 2.1: Number of Countries in different REDD Clusters

	UNFCCC		
Cluster Name	10 Cluster Case	15 Cluster Case	20 Cluster Case
Cluster 1	172	136	75
Cluster 2	8	32	39
Cluster 3	1	1	1
Cluster 4	1	1	1
Cluster 5	1	1	1
Cluster 6	6	4	3
Cluster 7	1	1	1
Cluster 8	2	2	2
Cluster 9	1	1	1
Cluster 10	1	1	1
Cluster 11	0	2	2
Cluster 12	0	4	4
Cluster 13	0	4	3
Cluster 14	0	2	2
Cluster 15	0	2	2
Cluster 16	0	0	1
Cluster 17	0	0	4
Cluster 18	0	0	31
Cluster 19	0	0	5
Cluster 20	0	0	15

Table 2.1 shows the number of countries which are presented by the different clusters (see 2.A Appendix and Table 2.7–2.10 for more details). One sees that within the ten cluster case, cluster 1 includes almost all countries. Given the possibility of 20 clusters we get four bigger clusters, nine small ones and 7 single clusters. Cluster 12 for example consists of Bahrain, Oman, United Arab Emirates and Equatorial Guinea. Except for Equatorial Guinea these countries are nearby with the same vegetation. All of them consist of a rather small number of square kilometre of forest area, have a similar EPI and GDP per capita.

Comparing the 15 cluster case with the 20 cluster case, the existing 15 clusters stay almost the same in both cases (except for Norway which is a single cluster in the 20 cluster case). The large cluster 1 splits up into the remaining 5 clusters.

2.5.2 Results for Decisions on CO2 Emissions Reduction

Table 2.2 shows the results for the case of decisions on CO2 related topics (see 2.B Appendix and Table 2.11–2.14 for more details).

Within the 10 cluster case cluster 1 includes most of the countries which is similar as to decisions on REDD. In the 15 cluster case we have 3 bigger clusters which will almost stay the same in the 20 cluster case. Only cluster 1 which is the largest one will break into two clusters so that we have 4 large clusters in the last case.

There are 9 single clusters in the 20 cluster case which almost all consist of the huge emitters like China, India, USA, Japan and the EU as a bloc. Colombia, Costa Rica, Cuba and Mauritius are all members of Cluster 15. They all have a similar GDP PPP per capita and a large EPI and not very high emissions except for Colombia.

Cluster 4 consists of Germany, Italy, France and Great Britain. These four European countries have similar data with respect to all four variables and are therefore in one cluster. Sweden, Switzerland and Iceland are members of the same cluster 17. They have rather small CO2 emissions, in particular Iceland. They also have a similar GDP PPP per capita and a very high EPI.

Iceland has even the highest Environmental Performance Index followed by Sweden and Switzerland. Again there is a cluster consisting of Bahrain, Oman, United Arab Emirates and Equatorial Guinea such as in the results of decision concerning REDD.

Table 2.2: Number of Countries in different CO2 Clusters

UNFCCC			
Cluster Name	10 Cluster Case	15 Cluster Case	20 Cluster Case
Cluster 1	170	116	69
Cluster 2	9	29	48
Cluster 3	1	1	1
Cluster 4	4	4	4
Cluster 5	2	2	1
Cluster 6	1	1	1
Cluster 7	2	2	1
Cluster 8	3	3	2
Cluster 9	1	1	1
Cluster 10	1	1	1
Cluster 11	0	5	4
Cluster 12	0	5	2
Cluster 13	0	16	16
Cluster 14	0	4	4
Cluster 15	0	4	4
Cluster 16	0	0	29
Cluster 17	0	0	3
Cluster 18	0	0	1
Cluster 19	0	0	1
Cluster 20	0	0	1

2.5.3 Results for Decisions on Water Shortage

The last decision topic is on Water Shortage. Table 2.3 provides the results for the three different cluster cases (see 2.C Appendix and Table 2.15–2.18 for more details). In the 20 cluster case cluster 14 consists of Bhutan, Gabon and Suriname.

Table 2.3: Number of Countries in different Water Clusters

	UNFCCC		
Cluster Name	10 Cluster Case	15 Cluster Case	20 Cluster Case
Cluster 1	171	136	87
Cluster 2	7	14	12
Cluster 3	4	4	4
Cluster 4	1	1	1
Cluster 5	1	1	1
Cluster 6	1	1	1
Cluster 7	2	2	2
Cluster 8	5	2	2
Cluster 9	1	1	1
Cluster 10	1	1	1
Cluster 11	0	3	2
Cluster 12	0	17	17
Cluster 13	0	4	4
Cluster 14	0	3	3
Cluster 15	0	4	3
Cluster 16	0	0	48
Cluster 17	0	0	2
Cluster 18	0	0	1
Cluster 19	0	0	1
Cluster 20	0	0	1

They have similar renewable internal freshwater resources per capita and a medium EPI. Congo, Liberia and the Solomon Islands are in one cluster and have similar data with respect to the internal freshwater resources per capita data and the EPI. Guyana, Iceland and Papua New Guinea are single clusters within the water cluster analysis. All of them have very high internal freshwater resources per capita.

2.6 A Priori Power Measures

We compute the two a priori versions of the PGI. The UNFCCC decision making requires unanimity. We calculate the passage probability (Baldwin and Widgrén, 2004) by dividing the number of winning coalitions by the number of possible coalitions. For the UNFCCC there is just one possible winning coalition and that is the one containing all the member states. The passage probability and thus the decision making efficiency is minimal. Therefore, the ability to assert decisions compared to the status quo is minimal in the UNFCCC. For that reason a two-third majority rule was considered in Holler and Wegner (2011) as in the decision process of the UNCCD. This paper makes the same assumption. We consider 194 players (member states). If we abstract from a priori unions, the UNFCCC can be represented as the following weighted two-third majority game:

$$v = [130 : \underbrace{1, 1, 1, \ldots, 1}_{194}].$$

This will give 1/194 for the a priori voting power of each player, irrespective of the index we apply if the index is normalized such that the sum of all power values equals 1. Next, a priori unions will be considered and the Union PGI and the Coalitional Solidarity PGI will be calculated.

2.6.1 Power Distribution based on Decisions on REDD

Table 2.4 shows the results for selected member countries according to the three cluster cases and the two a priori versions of the PGI. In the 10 and 15 cluster case all power is held by cluster 1. In the 10 cluster case India, Bahrain and Bangladesh are in cluster 1

and have most of the power together with the other cluster 1 members. In the 15 cluster case they are no longer members of cluster 1 and have therefore no power at all. As there are 20 smaller clusters in the last case more than one cluster is necessary to get a decision passed. In that last case there are no null players anymore. Based on the Coalitional Solidarity PGI Norway, the USA and China hold most decision power. These countries benefit from smaller clusters. Based on the Union PGI, Afghanistan (Cluster 1) holds most power followed by Argentina (Cluster 2). The other countries have almost equal power.

Table 2.4: REDD: Selected member states and their power

	UNFCCC					
	Union PGI/Coalitional Solidarity PGI					
Cluster Name	10 Cluster Case		15 Cluster Case		20 Cluster Case	
USA	0	0	0	0	0.00379	0.04907
EU	0	0	0	0	0.00379	0.02455
Germany	0	0	0	0	0.00379	0.01211
Norway	0	0	0	0	0.00379	0.04907
India	0.00581	0.00581	0	0	0.00324	0.00135
China	0	0	0	0	0.00379	0.04907
Sweden	0	0	0	0	0.00377	0.01627
Cuba	0.00581	0.00581	0.00735	0.00735	0.00377	0.01627
Bahrain	0.00581	0.00581	0	0	0.00374	0.01211
Ireland	0.00581	0.00581	0.00735	0.00735	0.00369	0.00958
Finland	0.00581	0.00581	0.00735	0.00735	0.00369	0.00958
Australia	0	0	0	0	0.00379	0.02455
Bangladesh	0.00581	0.00581	0	0	0.00324	0.00135
Argentina	0.00581	0.00581	0.00735	0.00735	0.00446	0.00148
Afghanistan	0.00581	0.00581	0.00735	0.00735	0.00769	0.00133

2.6.2 Power Distribution based on Decisions on CO2 emissions

Table 2.5 presents the results for the same member states, but for decisions based on CO2 emissions. In the 10 cluster case only countries which are in cluster 1 have decision power, these are e.g. Ireland, Bangladesh, Argentina and Afghanistan. In the 15 cluster case there are no null players anymore. The USA, the EU and China hold most power based on the Coalitional Solidarity PGI. Bangladesh (Cluster 2) and Ireland (Cluster 13) have least power right after Argentina and Afghanistan which are both members of Cluster 1. Based on the Union PGI, Argentina and Afghanistan which are both members of the first

Table 2.5: CO2: Selected member states and their power

	UNFCCC					
	Union PGI/Coalitional Solidarity PGI					
Cluster Name	10 Cluster Case		15 Cluster Case		20 Cluster Case	
USA	0	0	0.00335	0.07043	0.00373	0.04822
EU	0	0	0.00335	0.07043	0.00373	0.04822
Germany	0	0	0.00335	0.01761	0.00337	0.01088
Norway	0	0	0.00340	0.02385	0.00362	0.02341
India	0	0	0.00348	0.03661	0.00373	0.04822
China	0	0	0.00335	0.07043	0.00373	0.04822
Sweden	0	0	0.00300	0.01263	0.00352	0.01516
Cuba	0	0	0.00335	0.01761	0.00337	0.01088
Bahrain	0.00588	0.00588	0.00335	0.01761	0.00337	0.01088
Ireland	0.00588	0.00588	0.00003	0.00003	0.00417	0.00337
Finland	0	0	0.00300	0.01263	0.00362	0.02341
Australia	0.00588	0.00588	0.00300	0.01263	0.00337	0.01088
Bangladesh	0.00588	0.00588	0.00003	1.92×10^{-5}	0.00417	0.00186
Argentina	0.00588	0.00588	0.00768	0.00139	0.00352	0.00095
Afghanistan	0.00588	0.00588	0.00768	0.00139	0.00769	0.00144

cluster hold most power. All other countries, except for Ireland and Bangladesh, have similar power based on the Union PGI. In the 20 cluster case based on the Coalitional Solidarity PGI India joints the USA, EU and China in being one of the most powerful countries. In that case Afghanistan which is in Cluster 1 has least power. Based on the Union PGI, Afghanistan which is in cluster 1 holds most power followed by Bangladesh and Ireland which had both almost zero power in the 15 cluster case.

2.6.3 Power Distribution based on Decision on Water Shortage

Table 2.6: WATER: Selected member states and their power

	UNFCCC					
	Union PGI/Coalitional Solidarity PGI					
Cluster Name	10 Cluster Case		15 Cluster Case		20 Cluster Case	
USA	0	0	0	0	0.00379	0.04592
EU	0	0	0	0	0.00379	0.04592
Germany	0	0	0	0	0.00355	0.01073
Norway	0	0	0	0	0.00379	0.04592
India	0.00585	0.00585	0.00735	0.00735	1.29×10^{-6}	3.26×10^{-7}
China	0.00585	0.00585	0.00735	0.00735	0.00379	0.04592
Sweden	0	0	0	0	0.00376	0.02274
Cuba	0.00585	0.00585	0	0	0.00769	0.00547
Bahrain	0.00585	0.00585	0		0.00355	0.01073
Ireland	0.00585	0.00585	0	0	0.00742	0.00748
Finland	0.00585	0.00585	0	0	0.00769	0.00547
Australia	0.00585	0.00585	0	0	0.00742	0.00748
Bangladesh	0.00585	0.00585	0.00735	0.00735	1.29×10^{-6}	3.26×10^{-7}
Argentina	0.00585	0.00585	0.00735	0.00735	0.00769	0.00107
Afghanistan	0.00585	0.00585	0.00735	0.00735	0.00769	0.00107

Table 2.6 presents the power results for the Union PGI and the Coalitional Solidarity PGI for decisions on water shortage. In the 10 and 15 cluster case all power is held by cluster 1 members. India, China, Bangladesh, Argentina and Afghanistan hold most power in both cluster cases 10 and 15. Cuba, Bahrain, Ireland, Finland and Australia lost their place of being the most powerful player in the 10 cluster case to being a null player in the 15 cluster case. India and Bangladesh, now both belonging to Cluster 16, lost almost all of their power in the 20 cluster case compared to the 10 and 15 cluster case, where they belonged to the most powerful countries. In the 20 cluster case they hold least power of all countries. Based on the Union PGI Cuba, Finland, Argentina and Afghanistan hold most power followed by Ireland.

2.7 Summary and Interpretation

During the last couple of years at the conferences of the parties (e.g. the COP 16 in Cancun and the COP 17 in Durban) many new issues and policy instruments came into perspective. Therefore, the existing coalitions may not be reasonable anymore. This paper presents a hierarchical cluster analysis on the 194 member states of the United Nations Framework Convention on Climate Change (UNFCCC) based on decisions dealing with Reduced Emissions from Deforestation and Degradation (REDD), CO2 Emission and Water Shortage. To cluster the members of the UNFCCC three decision-fixed variables (GDP per capita based on purchasing power parity, contributions to the core budget of the UNFCCC, Environmental Performance Index) and for each decision topic one cluster-identifying variable (Forest area, CO2 Emissions, Renewable internal freshwater resources per capita) go into account.

With the calculated coalitions/a priori unions the decision power based on the Union Public Good Index and the Coalitional Solidarity Public Good Index is measured. We consider three cluster cases of 10, 15 and 20 cluster. Referring to all decision topics there is one large cluster in the 10 cluster case, 2–3 large clusters in the 15 cluster case and 3–4 large clusters in the 20 cluster case. In the 10 cluster case all power is held by cluster 1 countries which are mainly developing countries. In the 15 cluster case the same

holds for decisions on REDD and water shortage. In all cases it seems that based on the Coalitional Solidarity Public Good Index the USA, EU, Norway, China and in the case of CO2 emissions India have the most advantage from the existence of many coalitions. In the 10 cluster case these countries mostly have no power at all. These countries need the large cluster 1 to split up so that they have most of the decision power. On the contrary, Argentina and Afghanistan which belong to the developing countries lose their power in the 20 cluster case thus they have an advantage of the smaller cluster cases.

Based on the Union Public Good Index in most cluster cases Afghanistan and Argentina have most power and the USA, EU, Norway and China belong to the middle-ranked countries. Bangladesh, Ireland and India have least power in all decision cases.

One could also argue to allocate the costs of climate change according to these indices. At the moment member's contributions to the UNFCCC's budget are only based on the GDP of a country. But should not countries that pay more money and hold more responsibility have more voting power and the other way around? In that case countries like China and India which belong to the most powerful countries based on the Coalitional Solidarity PGI would have to pay most of the UNFCCC's contributions.

They would insist on the principle of 'common but differentiated responsibilities'[3] of the parties. They argue that the industrialized countries hold historically spoken the main responsibility for the climate change and should therefore pay for it. But in that case China and India should have less a say in the decision making process. Other developing countries would also agree on the fact that industrialized countries should pay more because of their history and not based on their decision power. Maybe an allocation of the cost which is based on more than one factor would be a solution, e.g. the power index, historical responsibility, the ability to pay and also something that represents the present situation according to CO2 emissions.

[3] The meaning of 'common responsibility' is understood by analogy with some known and accepted concepts like common good, common interest or common concern of humankind. The 'differentiated responsibility' component can be approached from two perspectives, the different contributions to the causes of environmental harm and the different capacities to respond to environmental threats (Timoshenko, 2003).

There are many other decision topics like *Carbon Capture and Storage* or *Climate Change Technology Transfer* which the conference of the parties has to decide on. It would be interesting to look at the evolving clusters with reference to these topics and the resulting power distribution based on these clusters.

Another interesting aspect could be to assign an underlying voting weight to the countries depending e.g. on the GDP, population, contribution to the UNFCCC and other variables. Up to now, all countries have a voting weight of 1 which is not plausible as some countries are able to apply more pressure on others than other countries. Based on the resulting clusters and the voting weights the decision power could be measured and discussed.

2.A Appendix. 10, 15, 20 cluster case and the cluster dendrogram for decisions on REDD

Table A.2.7: The 10 cluster case: REDD Clusters and their corresponding countries

Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5	Cluster 6	Cluster 7	Cluster 8	Cluster 9	Cluster 10
Rest	AUS	BRAZ	CANADA	CHINA	ICE	JAP	LCHT	RUS	USA
of	FRA				LUX		QAT		
the	GER				NOR				
World	IT				SING				
	MEX				SWE				
	SPA				SWI				
	UK								
	EU								

Table A.2.8: The 15 cluster case: REDD Clusters and their corresponding countries

C1	C 2	C 3	C 4	C 5	C 6	C 7	C 8	C 9	C10	C 11	C 12	C 13	C 14	C15
Rest	ANG	BRAZ	CAN	CHINA	ICE	JAP	LCHT	RUS	USA	AUS	BAHR	FRA	LUX	SPA
of	BANG				SWE		QATAR			EU	E GUIN	GER	SING	MEX
the	BEN				SWI						U AR EM	IT		
World	BOL				NOR						OMAN	UK		
	BOTS													
	BUR													
	CAMB													
	CAMER													
	C AF REP													
	CHAD													
	N KOR													
	D REP CON													
	ETH													
	GUIN													
	GUIN-BIS													
	HAITI													
	INDIA													
	INDON													
	IRAQ													
	MALI													
	MAURI													
	RWANDA													
	SENE													
	SI LEO													
	SUDAN													
	TOGO													
	TURK													
	UZBEK													
	NIGER													
	MONGO													
	NIG													
	P N GUIN													

Table A.2.9: The 20 cluster case: REDD Clusters and their corresponding countries

Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5	Cluster 6	Cluster 7	Cluster 8	Cluster 9	Cluster 10
Rest	ALB	BRAZ	CAN	CHINA	ICE	JAP	LCHT	RUS	USA
of	ALG				SWE		QAT		
the	AN&BA				SWI				
World	ARG								
	BEL								
	BELZ								
	BHUT								
	CHILE								
	COL								
	CROA								
	CZ REP								
	DOM REP								
	ECUA								
	EL SAL								
	EST								
	FIJI								
	GEORG								
	HUNG								
	LAT								
	LITH								
	MAL								
	MALD								
	MALTA								
	MONT								
	MOR								
	NEP								
	NZ								
	PAN								
	PERU								
	PHIL								
	POL								
	POR								
	ROM								

Table A.2.10: The 20 cluster case: REDD Clusters and their corresponding countries

Cluster 11	Cluster 12	Cluster 13	Cluster 14	Cluster 15	Cluster 16	Cluster 17	Cluster 18	Cluster 19	Cluster 20
AUS	BAHR	FRA	LUX	MEX	NOR	CO RI	ANG	AUSTRIA	BAH
EU	EGUIN	GER	SIN	SPA		CUB	BANGL	DEN	BARB
	OMAN	IT				MAUR	BENIN	FIN	BELG
	U AR EM					UK	BOL	IRE	BRUN
							BOTS	NETHERL	CYP
							BUR		GREECE
							CAMB		ISR
							CAMEROON		KUW
							CEN AFR		MON
							CHAD		S KOR
							N KOR		S MAR
							D R CONGO		S ARAB
							ETHIO		SEYCH
							GUIN		SLOV
							GUI-BIS		TRI&TO
							HAITI		
							INDIA		
							INDON		
							IRAQ		
							MALI		
							MONG		
							NIGER		
							NIG		
							PN GUIN		
							RWANDA		
							SENE		
							S LEO		
							SUD		
							TOGO		
							TURKM		
							UZB		

Dendrogram for decisions on REDD

Figure A.2.1: Dendrogram for decisions on REDDa

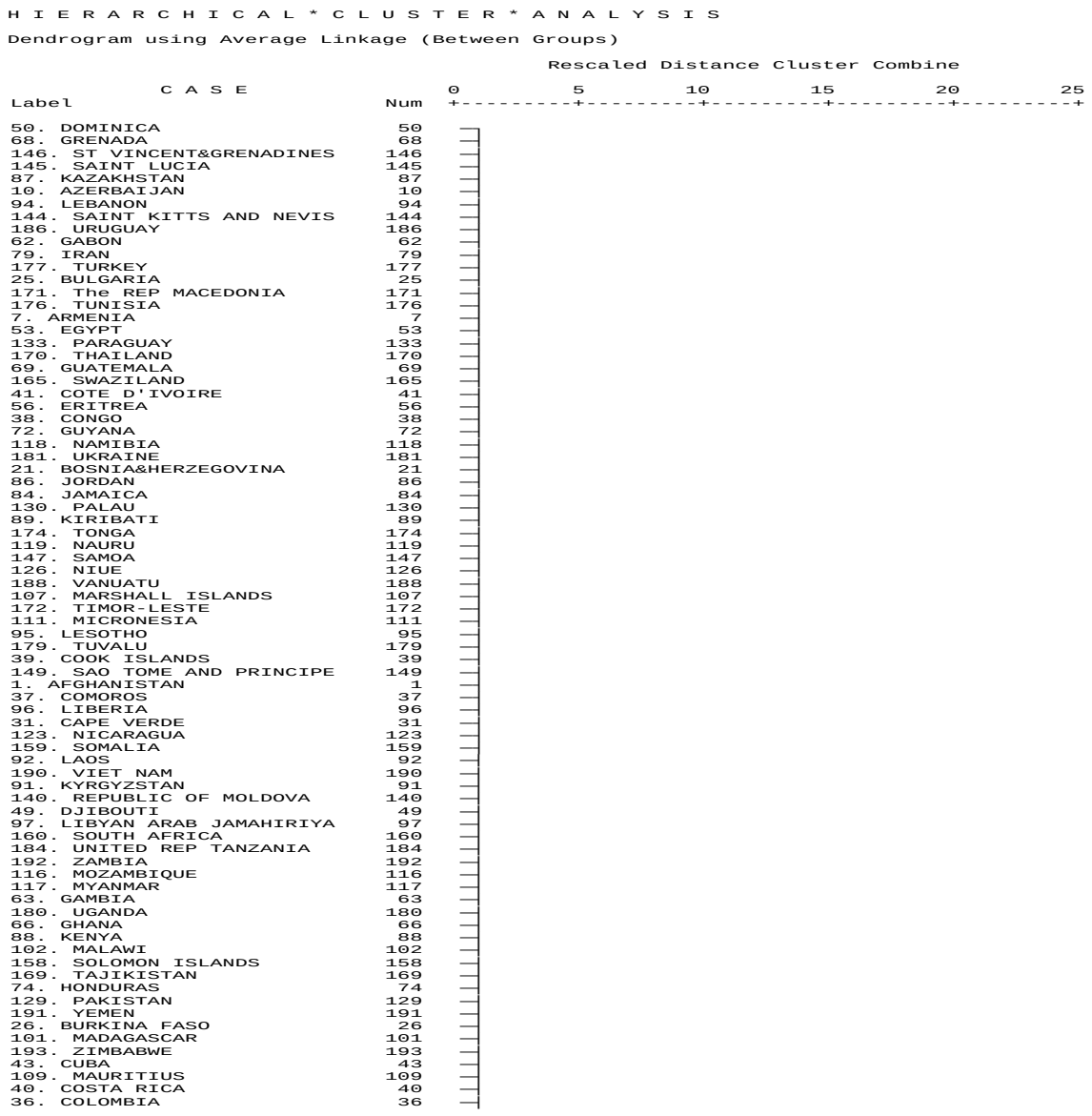


Figure A.2.1: Dendrogram for decisions on REDDb

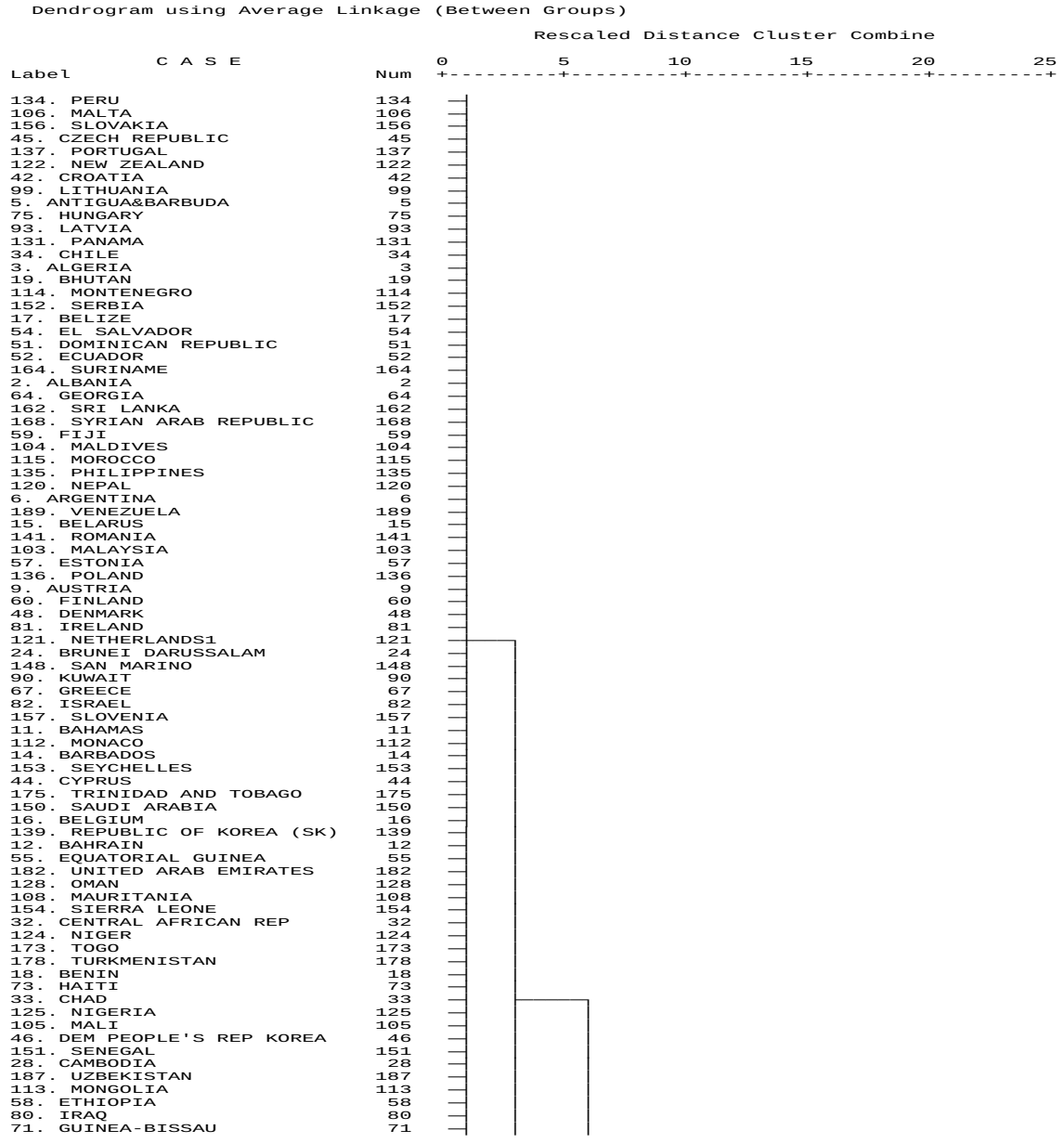
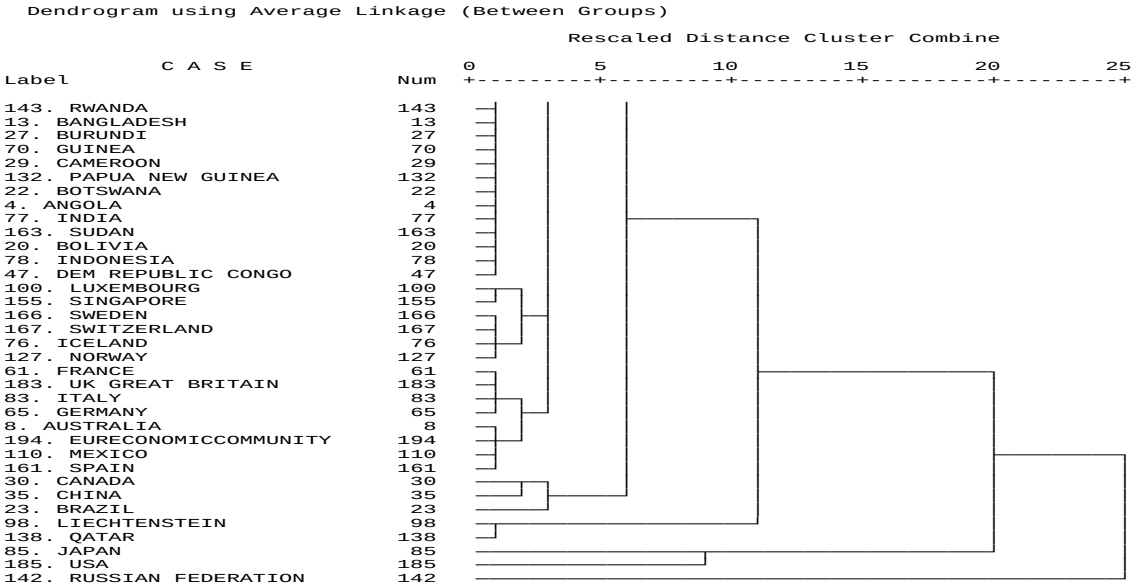


Figure A.2.1: Dendrogram for decisions on REDDc



2.B Appendix. 10, 15, 20 cluster case and the cluster dendrogram for decisions on CO2 emissions

Table B.2.11: The 10 cluster case: CO2 Clusters and their corresponding countries

Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5	Cluster 6	Cluster 7	Cluster 8	Cluster 9	Cluster 10
Rest	AUSTRIA	CHINA	FRA	INDIA	JAP	LCHT	LUX	USA	EU
of	COL		GER	RUS		QUA	NOR		
the	CO RI		IT				SING		
World	CUBA		UK						
	FIN								
	ICE								
	MAUR								
	SWE								
	SWI								

Table B.2.12: The 15 cluster case: CO2 Clusters and their corresponding countries

C1	C 2	C 3	C 4	C 5	C 6	C 7	C 8	C 9	C10	C 11	C 12	C 13	C 14	C15
Rest	ANG	CHINA	FRA	INDIA	JAP	LCHT	LUX	USA	EU	AUS	AUSTRIA	BAH	BAHRAIN	COL
of	BANGL		GER	RUS		QATAR	NOR			CAN	FIN	BAR	E GUIN	CO RI
the	BENIN		IT				SING			NETH	ICE	BELG	OMAN	CUBA
World	BOL		UK							S KOR	SWI	BRUNEI	U A EMI	MAURI
	BOTSW									SPA	SWE	CYP		
	BUR											DEN		
	CAMBO											GREECE		
	CAMER											IRE		
	C A REP											ISR		
	CHAD											KUW		
	N KOR											MON		
	ETH											S MAR		
	GUINEA											S AR		
	GUIN-BIS											SEYCH		
	HAITI											SLOV		
	INDON											TRI&TO		
	IRAQ													
	MALI													
	MAURI													
	MONG													
	NIG													
	NIGERIA													
	P N GUIN													
	RWANDA													
	SEN													
	SI LEO													
	TOGO													
	TURK													
	UZB													

Table B.2.13: The 20 cluster case: CO2 Clusters and their corresponding countries

Cluster 1	Cluster 2		Cluster 3	Cluster 4	Cluster 5	Cluster 6	Cluster 7	Cluster 8	Cluster 9	Cluster 10
Rest	ALB	MORO	CHINA	FRA	INDIA	JAP	LCHT	NOR	USA	EU
of	ALG	NEPAL		GER				SING		
the	ANT&BAR	NZ		IT						
World	ARG	PAN		UK						
	BELA	PARAG								
	BELI	PERU								
	BHUT	PHILI								
	BRAZ	POL								
	BULG	PORT								
	CHIL	ROM								
	CROAT	SERB								
	CZ REP	SLOV								
	DOM REP	S LAN								
	ECUA	SURIN								
	EGY	SYR								
	E SALV	THAI								
	EST	TURKEY								
	FIJI	UKR								
	GEORG	VENE								
	HUNG									
	IRAN									
	KAZA									
	LATV									
	LITH									
	MALAY									
	MALD									
	MALTA									
	MEX									
	MONTEN									

Table B.2.14: The 20 cluster case: CO2 Clusters and their corresponding countries

Cluster 11	Cluster 12	Cluster 13	Cluster 14	Cluster 15	Cluster 16	Cluster 17	Cluster 18	Cluster 19	Cluster 20
AUS	AUSTRIA	BAH	BAHR	COL	ANG	ICE	LUX	QATAR	RUS
NETH	FIN	BARB	EGUIN	COS RI	BANG	SWE			
S KOR		BELG	OMAN	CUBA	BEN	SWI			
SPA		BRUN	UAR EM	MAUR	BOL				
		CYP			BOTS				
		DEN			BUR				
		GREE			CAMB				
		IRE			CAMER				
		ISR			C AF.				
		KUW			CHAD				
		MON			N KOR				
		S AR			ETH				
		S MAR			GUIN				
		SEYCH			GUI-BIS				
		SLOV			HAITI				
		TR&TO			INDON				
					IRAQ				
					MALI				
					MAURI				
					MONG				
					NIG				
					NIGERI				
					PN GUIN				
					RWAN				
					SENE				
					SI LEO				
					TOGO				
					TURKM				
					UZBEK				

Dendrogram for decisions on CO2

Figure B.2.2: Dendrogram for decisions on CO2a

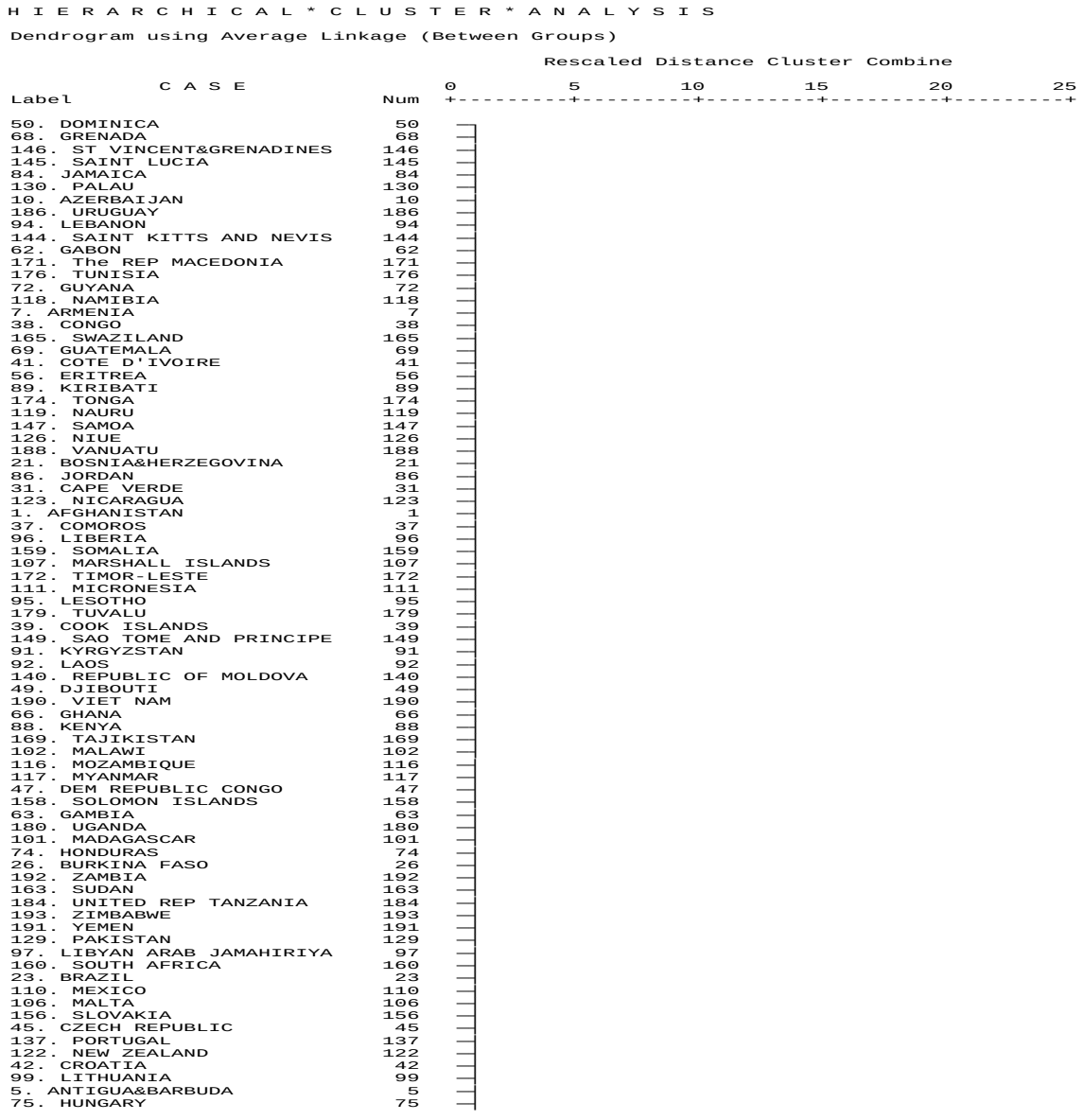


Figure B.2.2: Dendrogram for decisions on CO2b

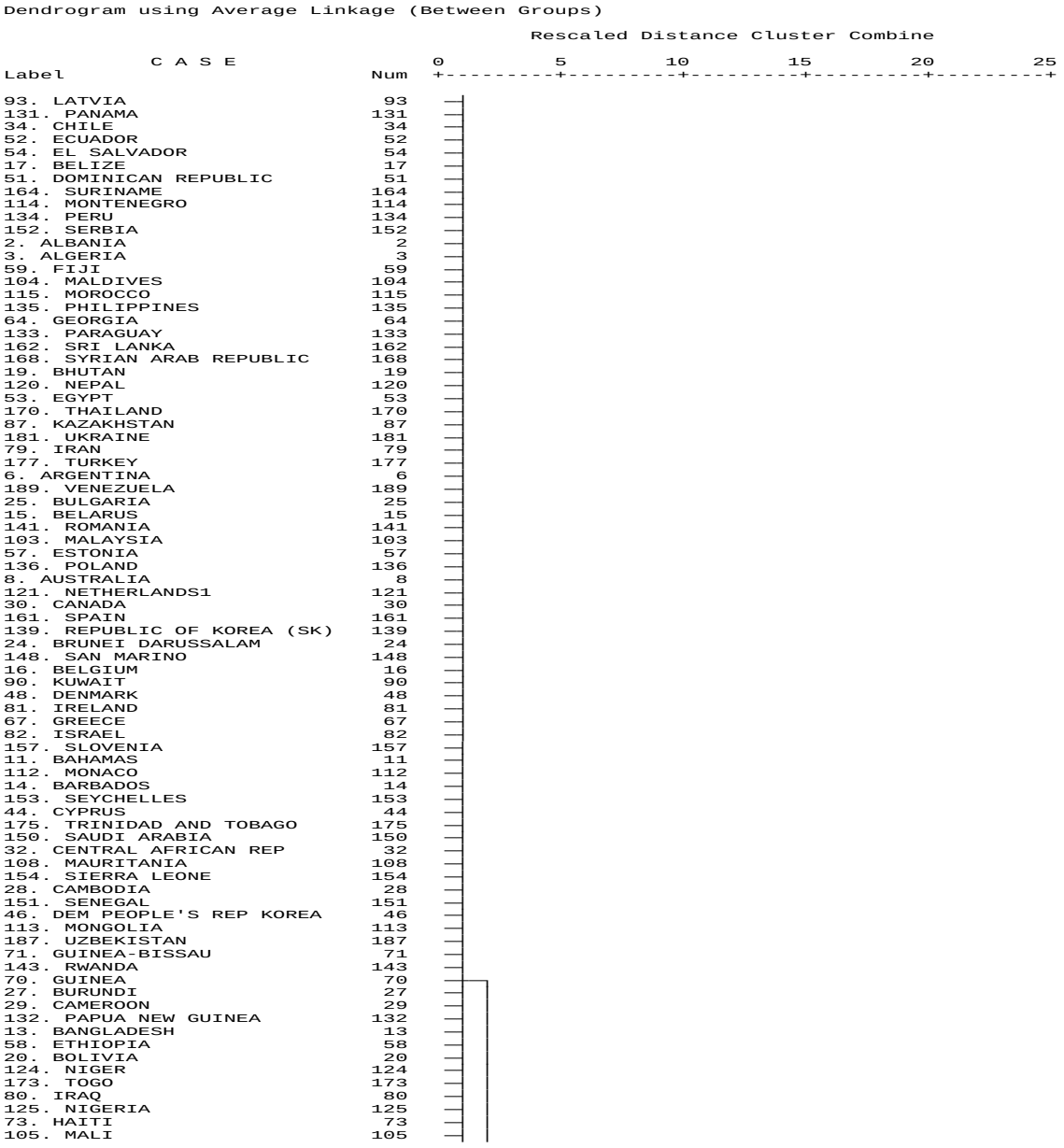
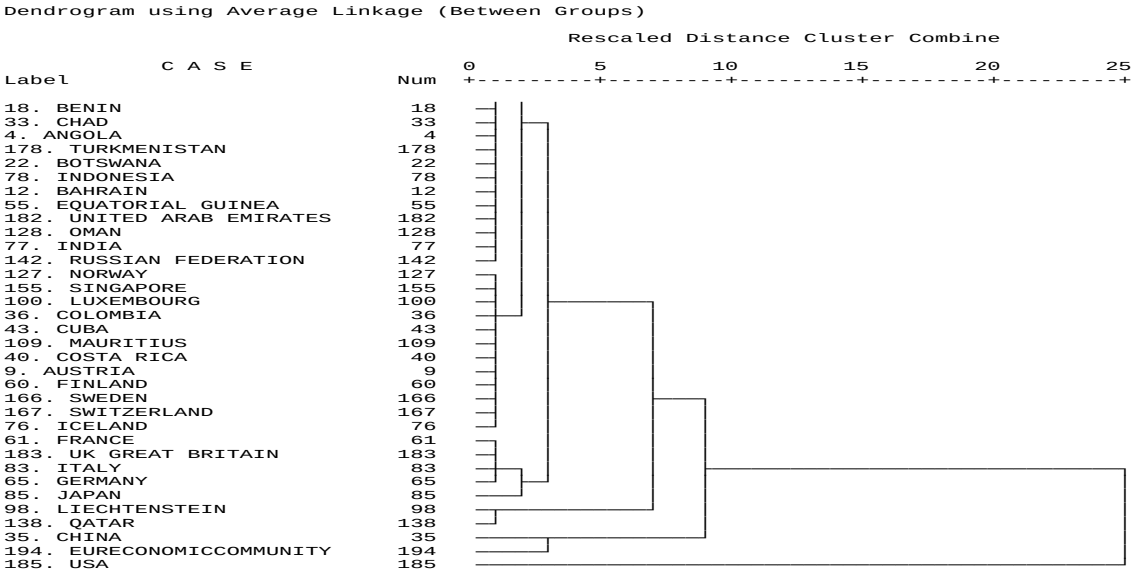


Figure B.2.2: Dendrogram for decisions on CO2c



2.C Appendix. 10, 15, 20 cluster case and the cluster dendrogram for decisions on water shortage

Table C.2.15: The 10 cluster case: WATER Clusters and their corresponding countries

Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5	Cluster 6	Cluster 7	Cluster 8	Cluster 9	Cluster 10
Rest	BHUT	FRA	GUYA	ICE	JAP	LCHT	LUX	USA	EU
of	CONGO	GER				QATAR	NOR		
the	GABON	IT					SING		
World	LIB	UK					SWED		
	PN GUI						SWI		
	S ISL								
	SURIN								

Table C.2.16: The 15 cluster case: WATER Clusters and their corresponding countries

C1	C 2	C 3	C 4	C 5	C 6	C 7	C 8	C 9	C10	C 11	C 12	C 13	C 14	C15
Rest	AUS	FRA	GUYA	ICE	JAP	LCHT	LUX	USA	EU	NOR	AUSTRIA	BAHR	BHUT	CONGO
of	BELG	GER				QATAR	SING			SWE	BELI	E GUI	GABON	LIB
the	BRU	IT								SWI	CHIL	OMAN	SURI	PN GUI
World	CAN	UK									COL	U A EM		S ISL
	DEN										COS RI			
	GREE										CUBA			
	IRE										CZ REP			
	ISR										ECUA			
	KUW										FIJI			
	NETH										FIN			
	S KOR										MALTA			
	S MAR										MAURI			
	SLOV										NZ			
	SPA										PAN			
											PER			
											PORT			
											SLOV			

Table C.2.17: The 20 cluster case: WATER Clusters and their corresponding countries

Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5	Cluster 6	Cluster 7	Cluster 8	Cluster 9	Cluster 10
Rest	AUS	FRA	GUYA	ICE	JAP	LCHT	LUX	USA	EU
of	BELG	GER				QATAR	SING		
the	BRUN	IT							
World	DEN	UK							
	GREE								
	IRE								
	ISR								
	KUW								
	NETH								
	S KOR								
	S MAR								
	SLOVE								

Table C.2.18: The 20 cluster case: WATER Clusters and their corresponding countries

Cluster 11	Cluster 12	Cluster 13	Cluster 14	Cluster 15	Cluster 16		Cluster 17	Cluster 18	Cluster 19	Cluster 20
SWE	AUSTRIA	BAHR	BHUT	CONGO	ANG	LIBY	CAN	CHINA	NOR	P N GUI
SWI	BELI	E GUI	GABON	LIB	BANG	MADAG	SPA			
	CHIL	OMAN	SURIN	S ISL	BENIN	MALA				
	COL	U A EM			BOL	MALI				
	CO RI				BOTS	MAURI				
	CUBA				BURK	MONG				
	CZ REP				BURUN	MOZAM				
	ECUA				CAMBO	MYAN				
	FIJI				CAMER	NIGER				
	FIN				C AF	NIG				
	MALTA				CHAD	PAK				
	MAURI				NO KOR	RWAN				
	NZ				DR CONG	SENE				
	PAN				ETH	SIE LEO				
	PER				GAMB	S AFR				
	PORT				GHAN	SUDAN				
	SLOVA				GUIN	TAJIK				
					GUIN-BIS	TOGO				
					HAITI	TURK				
					HOND	UGAN				
					INDIA	UR TANZ				
					INDON	YEM				
					IRAQ	ZAMB				
					KENYA	ZIMB				

Dendrogram for decisions on WATER

Figure C.2.3: Dendrogram for decisions on WATERa

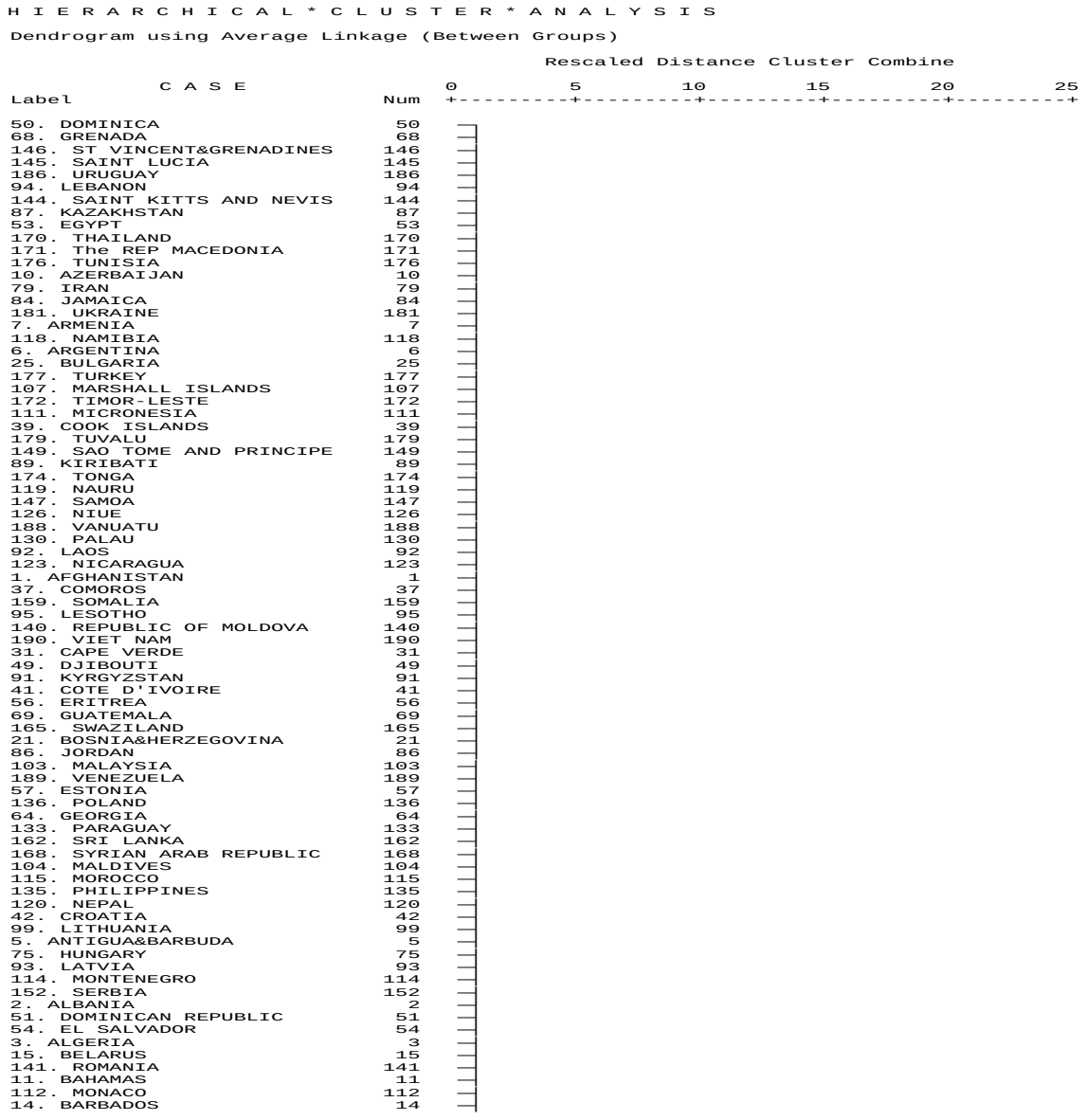


Figure C.2.3: Dendrogram for decisions on WATERb

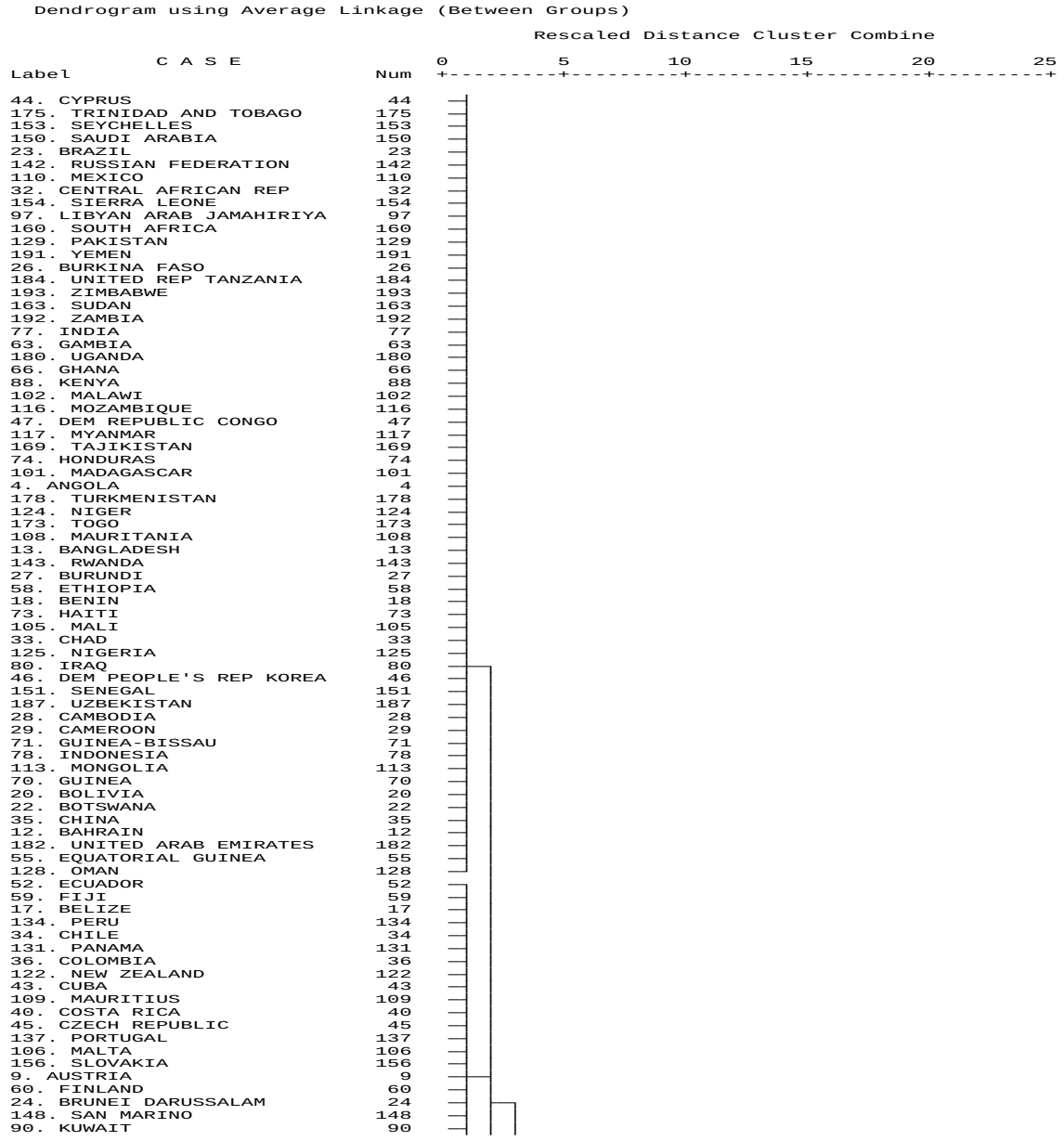
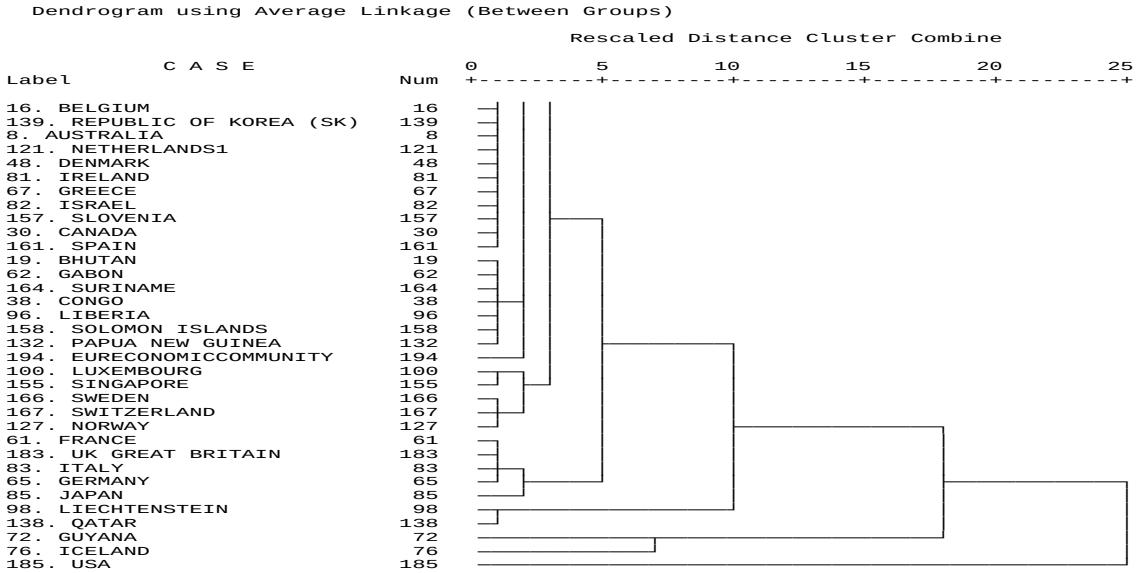


Figure C.2.3: Dendrogram for decisions on WATERc



Chapter 3

Voting Weights and Power Measures within Climate Conventions

Abstract The ability of the United Nations Framework Convention on Climate Change to function effectively is limited. The one–country/one–vote system of decision making is unrealistic, bearing no relationship to the actual distribution of power amongst the world's nations. Therefore, its decisions are mostly only recommendatory rather than binding. Weighted voting has been suggested as one possible solution to the problem of representation in the conference of parties. We calculate voting weights based on population, contributions to the UNFCCC regular budget, GDP, the Environmental Performance Index, and a measure of the equality of sovereign states. These factors are assigned different weights in order to formulate three sets of weighted votes. After this, we calculate the a priori voting power based on the Solidarity Public Good Index and the Union Public Good Index for three different decision topics (topics on CO2, Reducing Emissions from Deforestation and Degradation, and water shortage).

Keywords environmental policy, weighted voting, power measurement, Public Good Index

JEL Classification C7, D7

3.1 Introduction

In the beginning, the most important challenge within the climate change policy was simply to make governments, managers, and the public aware of the problem. Today, awareness exists and the central problem to action is the lack of a feasible architecture for international institution. For more than a decade governments have been building such a framework. A result is the United Nations Framework Convention on Climate Change (UNFCCC) which was adopted in 1992 and entered into force two years later.

One problem with the decisions taken within the UNFCCC – and generally within the United Nations – is that most decisions are only recommendations at a time when many people and nations believe that real governance is needed to address problems such as global warming. To be specific, Schwartzberg (2004) argues that the one–nation–one–vote system of decision making which is presently used in the General Assembly of the UN – and many other international organization such as the UNFCCC – is unrealistic and bears no relationship to the actual distribution of power. It reflects the principle of the equality of sovereign states, as codified in the UN Charter (Chapter I, Article 2). However, there is the UN Security Council (See Shapley and Shubik, 1954).

Dixon (1983) argues that member states representing less than 4% of the world's population can constitute a simple majority and only about 8% need to be represented in a two-thirds majority. The situation concerning budgetary contributions is even worse (Schwartzberg, 2003). As of 2010, some forty-one member states paid the arbitrary minimum of 0.001% of the total UNFCCC budget each, and the sixty-eight smallest contributors which paid from 0.001% to 0.004% each, collectively contributed only 0.117% of the total, while 122 member states, each assessed less than 0.040%, collectively paid just 1%.

The key to the proposed reform is the adaption of a coherent system of weighted voting by nations in the conference of parties. Weighted voting has long been used in a variety of institutional settings, e.g. the World Bank and the International Monetary Fund. There have been plenty of proposals for a more realistic weighted voting system within the UN decision making. Schwartzberg (2003) suggests that members' votes should be

weighted according to population, UN contributions and the legal principle of the 'the equality of sovereign nations', according to which all nations are counted equally[1]. In the nomenclature of the international financial institutions, he is advocating the use of 'basic votes'[2]. Dervis (2005) proposes weighted voting system in which votes are allocated based on population, national product, contribution to global public goods (UN contributions), and military capabilities (contribution to peacekeeping).

Strand and Rapkin (2010) base their proposed weights on UN contributions, population and the equality of sovereign states. In contrast to Schwartzberg they formulate three sets of weighted votes assigning each factor a different importance. They state that voting weights could be apportioned with alternative, asymmetrical weightings for the component factors. Strand and Rapkin argue that the wealthier members who contribute most to the UN budget will most likely not agree to an arrangement in which basic votes are as important as contributions. Instead, they would insist greater weight be given to the contributions.

This article addresses the question in which way voting weights would affect the voting power of member states of the UNFCCC. Voting weights are based on population of UNFCCC members, paid regular contributions to the UNFCCC regular budget, GDP, the Environmental Performance Index, and basic votes. Moreover, we calculate three sets of voting weights derived from different weights of each of the factors.

With these three different sets of voting weights we analyse the status of the parties involved in regulating climate conventions and treaties and allocate power to the countries measured by the Solidarity Public Good Index (Alonso-Meijide et al., 2010a) and the Union Public Good Index (Holler and Nohn, 2009). By applying power measures, we estimate the potential impact of the various agents in these contractual or instrumental arrangements with the possibility of a priori unions within the sets of decision makers.

[1] That is the nation's unit share of the total membership (1/194 or 0.515 percent).

[2] For example, the IMF, World Bank, African Development Bank, and Inter-American Development Bank all provide members 'basic votes' in addition to the weighting of votes on the basis of economic criteria.

The paper is structured as follows. In section 3.2 we provide the analytical tools such as simple games, the Public Good Index and simple games with coalition structures. Section 3.3 describes the voting weights and the factors they are based on. The a priori unions and three decision problems are introduced in section 3.4. We measure the impact of a priori power based on the Union Public Good Index and the Solidarity Public Good Index and discuss the results in section 3.5. Finally, in section 3.6 we conclude and summarize the paper.

3.2 Preliminaries

In the paper we consider the class of simple games. In this setting values are referred to as power indices. They are quantitative measures to express power.

The power index we base our calculation on is the Public Good Index (PGI) introduced in Holler (1982) and its extensions to a priori unions. The PGI assumes that coalitional values are public goods and only minimal winning coalitions are relevant. It assigns power proportional to the number of minimal winning coalitions a player belongs to.

As we consider the possibility of a priori unions or a coalition structure within the player set we make use of the Solidarity PGI introduced by Alonso-Meijide et al. (2010a) and the Union PGI introduced by Holler and Nohn (2009) to measure power in these settings (See Section 1.2.1–1.2.4, page 9.–12.).

3.3 Voting Weights

Weighted voting proposals for the UN decision making procedures have been suggested by a number of observers over the past 60 years. In particular, the UNFCCC's unanimity decision rule and the one-country/one-vote principle undermines the ability of the institution to operate effectively. Schwartzberg (2003) says that it is hardly surprising that decisions are only recommendatory rather than binding. Accordingly, reform must begin with abandonment of the one-country/one-vote principle which is used within the United Nations. A weighted voting system should reflect the actual size, ability to act,

and importance of the participating nation-states (Dervis, 2005).

Therefore we define voting weights by additively combining the following component measures: percentages of the total population of UNFCCC members, paid regular contributions to the UNFCCC regular budget, GDP, the Environmental Performance Index, and states' unit shares, that is, basic votes equivalents.

These factors are based on four principles for representation: (1) the present legal principle of the the equality of sovereign nations, (2) a population-based demographic principle, (3) a capability principle based on contributions and GDP which are a function of national wealth, and (4) the willingness to establish environmental policy goals.

3.3.1 Population

First, there should be a demographic element to weighted votes (Dervis, 2005, Schwartzberg, 2004). Measures of population are often proposed to be included in weighted votes. A strong case can be made that a foremost international organization like the UNFCCC should somehow take population into account in the formal apportionment of influence.

To give an example: in the UNFCCC, the Cook Islands with a population of just over 11000, has the same formal influence as China with a population of about 1.3 billion. The sources for the data are the worldbank and the CIA Factbook 2010.

3.3.2 Contribution to the UNFCCC and GDP

A second motivation for weighted votes is based on the idea that states which contribute a larger share of the UNFCCC's budget should have a greater say in the organization's operations. Schwartzberg (2003) suggests the use of contributions paid to the UNFCCC. This criterion largely derives from national product.

Dervis (2005) argues in favour of using both GDP and contributions to the UNFCCC's regular budget as the budget contributions are not a direct function of GDP. The most important divergence involves the United States: its contribution is 22% but the U.S. share of global GDP is over 30%. Furthermore, the financial contributions of most developing countries are smaller than their shares of GDP. Thus, any shift toward a

closer correlation between GDP and contributions would shift votes toward developing countries (Strand and Rapkin, 2010).

3.3.3 Environmental Performance Index

The fourth factor within the weighted index is the Environmental Performance Index (EPI)which was developed by Yale University (Yale Center for Environmental Law and Policy) in collaboration with the World Economic Forum and the Joint Research Centre of the European Commission.

The index ranks 163 countries on 25 performance indicators tracked across ten well-established policy categories including environmental health, air quality, water resource management, forestry, agriculture, biodiversity and habitat, fisheries and climate change which covers both environmental public health and ecosystem vitality. These indicators could provide a gauge at a national government scale of how close countries are to established environmental policy goals.

As the UNFCCC is an environmental institution it is plausible to give more weight to countries which act more sustainable.

3.3.4 Equality of Sovereign States

The one-country/one-vote decision rule reflects the principle of the equality of sovereign states, as codified in the UN Charter (Chapter I, Article 2). Schwartzberg (2004) suggests to use a set proportion of the total weighted votes that would be divided equally among all members, regardless of size or power.

Thus, while weighted voting on the one hand reduces the importance of the equality of sovereign states in UNFCCC decision rules, using it in the calculation of weighted votes would retain it in a reduced form, although important.

3.3.5 Asymmetrical Weightings for the Factors

Why should population, contributions, GDP, EPI and basic votes (especially the latter) count equally with regards to the allocation of votes and influence? Strand and Rapkin

(2010) argue that voting weights could just as easily be apportioned with alternative, asymmetrical weightings for the component factors. Furthermore, it is unlikely that the wealthier members who contribute most to the UNFCCC budget would agree to an arrangement in which basic votes are as important as contributions. Instead, they would insist that greater weight will be given to contributions to the UNFCCC's budget.

In this paper similar to Strand and Rapkin (2010) we will use asymmetrical weightings for the component factors. We therefore define three sets of voting weights. The first set of voting weights (VW1) uses equal weights for population, contributions, GDP, EPI and the equality of sovereign states. The second set of weighted votes (VW2) is computed with contributions and EPI weighted at 35% and population, GDP and basic votes 10% each. The third set (VW3) is calculated with population and GDP set at 35% and contribution, EPI and basic votes at 10% each.

Table 3.1 shows selected countries and their different voting weights. These three formulas of weighted voting produce very different distributional outcomes. Not surprisingly, the United States has more voting weight using the formulas 2 and 3 which emphasise contributions and EPI; and population and GDP (10.2% and 10.9%) than using the first formula (9.4%). The EU for example would not benefit from a formula where the emphasis is on contributions because the European Commission has to contribute just a small part of the UNFCCCs budget compared with their EU members. Under the formula VW3 the EU would almost double its voting weight compared to VW1. India and China, which are both one of the most populated countries in the world, have less voting weight in VW2 where the contributions and the EPI are emphasised, but much more weight in VW3 where population and GDP are important. Under the first formula very small members would hold larger voting weights compared to the last voting weight formula. For example, Laos (not presented in Table 3.1) would have almost twice as much voting weight under VW1 (0.227%) than under VW3 (0.136%). Germany has its largest weight under formula 2 where the contribution and the EPI factor are emphasised. This is due to the fact that Germany's contribution to the UNFCCC regular budget is quite large compared to its GDP, and furthermore its EPI factor is also rather high.

Table 3.1: Selected Voting Weights Under VW Formulas

Country	Population	GDP	Contribution	EPI	Sovereign equality	VW 1	VW 2	VW 3
USA	4,239	20,576	21,451	0,561	0,515	9,468	10,237	10,938
EU	6,750	22,463	2,500	0,616	0,515	6,569	4,063	10,588
Germany	1,121	4,542	7,818	0,647	0,515	2,928	3,58	2,88
Norway	0,067	0,503	0,849	0,717	0,515	0,53	0,657	0,407
India	16,062	1,82	0,521	0,427	0,515	3,869	2,171	6,405
China	18,358	5,653	3,109	0,433	0,515	5,614	3,692	8,81
Sweden	0,129	0,602	1,037	0,76	0,515	0,609	0,754	0,487
Cuba	0,154	0,086	0,069	0,69	0,515	0,303	0,341	0,212
Bahrain	0,017	0,027	0,038	0,371	0,515	0,194	0,199	0,108
Ireland	0,061	0,319	0,486	0,593	0,515	0,395	0,467	0,293
Finland	0,074	0,319	0,552	0,66	0,515	0,424	0,515	0,31
Australia	0,306	1,358	1,885	0,581	0,515	0,929	1,081	0,88
Bangladesh	2,04	0,117	0,01	0,389	0,515	0,614	0,407	0,846
Argentina	0,554	0,371	0,28	0,539	0,515	0,452	0,431	0,457
Afghanistan	0,472	0,018	0,004	0,509	0,515	0,303	0,28	0,274

Note:VW = voting weights. Values are expressed in percentage of world share.GDP is 2005 data; contributions, population and EPI are 2010 data.

3.4 The A Priori Unions for three Decision Problems

In Holler and Wegner (2011) the UNFCCC was analysed according to its power and responsibility distribution amongst its member states. For the calculation the following existing coalitions/a priori unions were considered: the European Union, the Umbrella Group, the Environmental Integrity Group, the Group of Central Asia, Caucasus, Albania and Moldova, the Open Balkan Group, the Group of 77 and China, the Least Developed Countries Group, the Alliance of Small Island States, the League of Arab States and the African Group.

In Wegner (2011) the author analyses the UNFCCC under the assumption of no pre-existing coalitions. This assumption is reasonable because members of one group do not always have the same opinion on certain decision topics and would be much closer in their perspective to a country from another a priori union. Furthermore, new decision topics are coming to the table and coalitions are likely to be formed that are not considered in Holler and Wegner (2011). Wegner (2011) makes use of a hierarchical cluster analysis to identify the a priori unions/coalitions within three different decision topics (reduced emissions from deforestation and degradation (REDD), CO2 emissions, water shortage). For this undertaking the average linkage cluster analysis and – as a distance measure – the squared euclidean distance are used. To cluster the member states according to the decision topics, three *decision-fixed* variables (GDP per capita based on purchasing power parity, contributions to the core budget of the UNFCCC, Environmental Performance Index) and in each decision case one *cluster-identifying* variable (Forest area, CO2 Emissions, Renewable internal freshwater resources per capita) for the three different decision situation go into account. The decision-fixed variables are the same in every decision topic. The cluster-identifying variables describe the decision topic, e.g. CO2 related topics.

In this paper the a priori unions which were calculated in the cluster analysis for the 20 cluster case according to the three decision problems (see Wegner, 2011, and Appendix 3.A–3.C) are applied.

3.5 A Priori Power Measures

We compute two a priori versions of the PGI to analyse the UNFCCC, the Union PGI and the Coalitional Solidarity PGI. The UNFCCC decision making requires unanimity. We calculate the passage probability[3] by dividing the number of winning coalitions by the number of possible coalitions. For the UNFCCC there is just one possible winning coalition and that is the one containing all the member states. The passage probability and thus the decision making efficiency is minimal. Therefore, the ability to assert decisions compared to the status quo is minimal in the UNFCCC. For that reason a two-third majority rule was considered in Holler and Wegner (2011) as in the decision process of the UNCCD. This paper makes the same assumption. We consider 194 players (member states). As the voting weights are in percentage of member states' share we need 67% of votes to get a decision passed. A priori unions for the three decision topics will be considered and based on the three different sets of voting weights the Union PGI and the Coalitional Solidarity PGI will be calculated.

In Table 3.2 selected member states of the UNFCCC and their Solidarity Public Good Index as well as their Union Public Good Index, both based on decisions on REDD, are presented. In all three voting weight cases the USA, Norway and China hold most power considering the Solidarity PGI. With the emphasis on contribution and EPI China loses a lot of his power though it still belongs to the three most powerful countries. Under the voting weight system 3 (VW3) which puts more weight on population and GDP China gains 20% of power compared to VW2. The USA is the most powerful country under decisions based on REDD. It gains more power under VW2 and even more under VW3 which is reasonable as it emphasizes population and GDP. The least powerful country in Table 3.2 considering the Solidarity PGI is Afghanistan. It benefits from the equally weighted variables. Germany would gain power under VW2 as its contributions and its EPI are comparatively large. Based on the Union Public Good Index Afghanistan which was the least powerful country under the Solidarity PGI is now the most powerful one in

[3] Baldwin and Widgrén (2004) refer to the passage probability for measuring the EU's decision making efficiency.

voting weight system 1 and 2 followed by Bangladesh, India, Argentina and Germany. In the VW3 case the USA and the EU join India and Bangladesh in being most powerful. Norway holds least power in that scenario. It gains a little bit of voting power under VW3. Overall based on decisions on REDD, the USA will profit from a voting weight system which emphasizes population and GDP based on both a priori power indices. Countries like China and Bangladesh will gain power under VW3 as well. Afghanistan will instead profit from equally weighted variables.

Table 3.2: REDD: Selected member states and their power

	REDD					
Country	Solidarity			Union		
	VW1	VW2	VW3	VW1	VW2	VW3
USA	0.05586	0.05795	0.06126	0.00430	0.00467	0.00525
EU	0.02757	0.02519	0.03091	0.00425	0.00406	0.00530
Germany	0.01407	0.01508	0.01481	0.00434	0.00486	0.00508
Norway	0.04234	0.04093	0.04032	0.00326	0.00330	0.00345
India	0.00191	0.00182	0.00214	0.00457	0.00455	0.00568
China	0.05137	0.04864	0.05905	0.00396	0.00392	0.00506
Sweden	0.01603	0.01542	0.01466	0.00371	0.00372	0.00377
Cuba	0.01529	0.01484	0.01389	0.00354	0.00359	0.00357
Bahrain	0.01161	0.01110	0.01075	0.00358	0.00357	0.00368
Ireland	0.00972	0.00958	0.00929	0.00374	0.00386	0.00398
Finland	0.00972	0.00958	0.00929	0.00374	0.00386	0.00398
Australia	0.02757	0.02519	0.03091	0.00425	0.00406	0.00530
Bangladesh	0.00191	0.00182	0.00214	0.00457	0.00455	0.00568
Argentina	0.00150	0.00161	0.00151	0.00450	0.00505	0.00503
Afghanistan	0.00115	0.00104	0.00089	0.00667	0.00626	0.00572

Table 3.3 shows countries and their power distribution based on decisions dealing with CO2 related problems. In this case based on the Solidarity PGI the USA, the EU, India and China are the most powerful countries. The US gains more power under VW2 and even more under VW3. As for the three other countries, they will loose power under the formula that gives weight to contribution and EPI but gain power under VW3. The US is the most powerful one in all three voting weight schemes. Argentina, Afghanistan and Bangladesh belong to the group of countries with least a priori decision power.

Table 3.3: CO2: Selected member states and their power

	CO2					
Country	Solidarity			Union		
	VW1	VW2	VW3	VW1	VW2	VW3
USA	0.05748	0.05989	0.06338	0.00448	0.00470	0.00519
EU	0.05305	0.04925	0.06196	0.00413	0.00387	0.00507
Germany	0.01474	0.01490	0.01521	0.00459	0.00468	0.00498
Norway	0.02243	0.02296	0.02184	0.00349	0.00360	0.00357
India	0.05126	0.04779	0.05436	0.00399	0.00375	0.00445
China	0.05261	0.05088	0.05864	0.00410	0.00400	0.00480
Sweden	0.01540	0.01575	0.01541	0.00360	0.00371	0.00378
Cuba	0.01187	0.01165	0.01134	0.00370	0.00366	0.00371
Bahrain	0.01133	0.01127	0.01060	0.00353	0.00354	0.00347
Ireland	0.00324	0.00330	0.00316	0.00404	0.00415	0.00413
Finland	0.02293	0.02309	0.02185	0.00357	0.00362	0.00358
Australia	0.01292	0.01295	0.01451	0.00402	0.00407	0.00422
Bangladesh	0.00190	0.00188	0.00200	0.00430	0.00428	0.00475
Argentina	0.00159	0.00156	0.00150	0.00594	0.00589	0.00588
Afghanistan	0.00109	0.00109	0.00100	0.00589	0.00588	0.00563

Table 3.4: Water: Selected member states and their power

	Water					
Country	Solidarity			Union		
	VW1	VW2	VW3	VW1	VW2	VW3
USA	0.05266	0.05401	0.05961	0.00379	0.00396	0.00453
EU	0.05088	0.04968	0.05733	0.00366	0.00364	0.00436
Germany	0.01305	0.01365	0.01466	0.00375	0.00400	0.00446
Norway	0.04606	0.04658	0.04526	0.00331	0.00341	0.00344
India	0.00133	0.00118	0.00150	0.00458	0.00415	0.00548
China	0.05120	0.04907	0.05408	0.00368	0.00359	0.00411
Sweden	0.02313	0.02423	0.02309	0.00333	0.00355	0.00351
Cuba	0.00300	0.00306	0.00293	0.00367	0.00381	0.00378
Bahrain	0.01210	0.01202	0.01166	0.00348	0.00352	0.00355
Ireland	0.00432	0.00432	0.00412	0.00373	0.00380	0.00376
Finland	0.00300	0.00306	0.00293	0.00367	0.00381	0.00378
Australia	0.00432	0.00432	0.00412	0.00373	0.00380	0.00376
Bangladesh	0.00133	0.00118	0.00150	0.00458	0.00415	0.00548
Argentina	0.00105	0.00106	0.00090	0.00657	0.00673	0.00597
Afghanistan	0.00105	0.00106	0.00090	0.00657	0.00673	0.00597

They would even fall behind under VW2 and VW3, except for Bangladesh due to its large population. Based on the Union PGI most of power is distributed to Afghanistan, Argentina, Germany and the USA, and under VW3 also to the EU. Even though Afghanistan and Argentina hold most power, other than the US, they benefit from a voting weight formula that emphasises all variable equally. The least powerful countries based on the Union PGI are e.g. Norway, Bahrain and Cuba.

Table 3.4 presents the power results for decisions on water shortage. Based on the Solidarity PGI, the USA, EU, China and in addition Norway are the most powerful

countries. Argentina and Afghanistan are in the same a priori union and therefore have the same decision power and furthermore the least. Measured by the Union PGI, Norway holds least power and it benefits from the voting weight formula VW3. India and Bangladesh belong to the same cluster and are next to Argentina and Afghanistan members of the most powerful group of countries. They also benefit from VW3. Argentina and Afghanistan gain power under the formula that emphasises contribution and EPI.

3.6 Conclusion

This paper deals with the problem of giving adequate influence within the decision making process to member states of the United Nations Framework Convention on Climate Change which hold greater responsibility and can largely control the implementation of the decisions.

We simulate the a priori voting power of member states of the UNFCCC under three different weighted voting schemes applying the Union Public Good Index and the Solidarity Public Good Index. First, we calculate the voting weights based on contributions to the UNFCCC regular budget, GDP, the Environmental Performance Index, and states' unit shares for every country and then offer three weighted voting formulas.

It is noticeable that the five gaining member states (India, China, Japan, USA, EU) presently only have 3% of all votes in the Conference of the Parties. But they account for 47% of the world's population and 40% of the contribution of the UNFCCC's budget. Under all proposed new voting weight formulas VW1–VW3 their combined voting weight would be about 30% which is much more reasonable. Together with the additional nations that would gain from the proposed weighted voting scheme, they would account for about 65% of the population and contribute almost 80% of the UNFCCC budget. Therefore the majority of the world's population would be better off under the new framework than under the one–country/one–vote principle.

Another problem with the existing one–country/one–vote rule is the adaptation to future changes as the world's political map is forever in flux. Until now, when it comes to a union of two countries their two votes became one (North and South Yemen). That

also holds for the opposite side. When two countries split up, they will each get one vote (Pakistan out of India, Bangladesh out of Pakistan). Consequently one region will get extra or even lose some of their voting strength. This problem would be significantly eased under the proposed system of weighted voting.

We do not bring up the political practicability of a weighted voting decision making. We provide the calculation of a priori voting power based on a system that several observers have recommended over years. There will be no voting scheme that all members would accept as optimal (Dervis, 2005). Schwartzberg (2004) even suggests to start with equally weighted factors which determine the voting weights and then require reconsideration of the weighted voting formulas after a specified period of about fifteen years. He suggests to double the relative weight of both population and contributions and correspondingly reduce the original formula's substantial bias in favor of small and microstates. In another fifteen or so years, he says that another change might be made, whereby population would become the principal determinant of voting strength. Strand and Rapkin (2010) state that implementing a weighted voting scheme for the UN, or in our case a specialized agency of the UN, would be an intensely political process, subject to manipulation by powerful members. But we think that nations should acknowledge the UNFCCC's incapability to deal with many cross-national problems and that a reform of the decision making process amongst other things is necessary.

3.A Appendix. 20 cluster case for decisions on REDD

Table A.3.5: The 20 cluster case: REDD Cluster and their corresponding countries

Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5	Cluster 6	Cluster 7	Cluster 8	Cluster 9	Cluster 10
Rest	ALB	BRAZ	CAN	CHINA	ICE	JAP	LCHT	RUS	USA
of	ALG				SWE		QAT		
the	AN&BA				SWI				
World	ARG								
	BEL								
	BELZ								
	BHUT								
	CHILE								
	COL								
	CROA								
	CZ REP								
	DOM REP								
	ECUA								
	EL SAL								
	EST								
	FIJI								
	GEORG								
	HUNG								
	LAT								
	LITH								
	MAL								
	MALD								
	MALTA								
	MONT								
	MOR								
	NEP								
	NZ								
	PAN								
	PERU								
	PHIL								
	POL								
	POR								
	ROM								

Table A.3.6: The 20 cluster case: REDD Cluster and their corresponding countries

Cluster 11	Cluster 12	Cluster 13	Cluster 14	Cluster 15	Cluster 16	Cluster 17	Cluster 18	Cluster 19	Cluster 20
AUS	BAHR	FRA	LUX	MEX	NOR	CO RI	ANG	AUSTRIA	BAH
EU	EGUIN	GER	SIN	SPA		CUB	BANGL	DEN	BARB
	OMAN	IT				MAUR	BENIN	FIN	BELG
	U AR EM					UK	BOL	IRE	BRUN
							BOTS	NETHERL	CYP
							BUR		GREECE
							CAMB		ISR
							CAMEROON		KUW
							CEN AFR		MON
							CHAD		S KOR
							N KOR		S MAR
							D R CONGO		S ARAB
							ETHIO		SEYCH
							GUIN		SLOV
							GUI-BIS		TRI&TO
							HAITI		
							INDIA		
							INDON		
							IRAQ		
							MALI		
							MONG		
							NIGER		
							NIG		
							PN GUIN		
							RWANDA		
							SENE		
							S LEO		
							SUD		
							TOGO		
							TURKM		
							UZB		

3.B Appendix. 20 cluster case for decisions on CO2

Table B.3.7: The 20 cluster case: CO2 Cluster and their corresponding countries

Cluster 1	Cluster 2		Cluster 3	Cluster 4	Cluster 5	Cluster 6	Cluster 7	Cluster 8	Cluster 9	Cluster 10
Rest	ALB	MORO	CHINA	FRA	INDIA	JAP	LCHT	NOR	USA	EU
of	ALG	NEPAL		GER				SING		
the	ANT&BA	NZ		IT						
World	ARG	PAN		UK						
	BELA	PARA								
	BELI	PERU								
	BHUT	PHILI								
	BRAZ	POL								
	BULG	PORT								
	CHIL	ROM								
	CROAT	SERB								
	CZ REP	SLOV								
	DOMREP	S LAN								
	ECUA	SURIN								
	EGY	SYR								
	E SALV	THAI								
	EST	TURKE								
	FIJI	UKR								
	GEORG	VENE								
	HUNG									
	IRAN									
	KAZA									
	LATV									
	LITH									
	MALAY									
	MALD									
	MALTA									
	MEX									
	MONTEN									

Table B.3.8: The 20 cluster case: CO2 Cluster and their corresponding countries

Cluster 11	Cluster 12	Cluster 13	Cluster 14	Cluster 15	Cluster 16	Cluster 17	Cluster 18	Cluster 19	Cluster 20
AUS	AUSTRIA	BAH	BAHR	COL	ANG	ICE	LUX	QATAR	RUS
NETH	FIN	BARB	EGUIN	COS RI	BANG	SWE			
S KOR		BELG	OMAN	CUBA	BEN	SWI			
SPA		BRUN	UAR EM	MAUR	BOL				
		CYP			BOTS				
		DEN			BUR				
		GREE			CAMB				
		IRE			CAMER				
		ISR			C AF.				
		KUW			CHAD				
		MON			N KOR				
		S AR			ETH				
		S MAR			GUIN				
		SEYCH			GUI-BIS				
		SLOV			HAITI				
		TR&TO			INDON				
					IRAQ				
					MALI				
					MAURI				
					MONG				
					NIG				
					NIGERI				
					PN GUIN				
					RWAN				
					SENE				
					SI LEO				
					TOGO				
					TURKM				
					UZBEK				

3.C Appendix. 20 cluster case for decisions on water shortage

Table C.3.9: The 20 cluster case: WATER Cluster and their corresponding countries

Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5	Cluster 6	Cluster 7	Cluster 8	Cluster 9	Cluster 10
Rest	AUS	FRA	GUYA	ICE	JAP	LCHT	LUX	USA	EU
of	BELG	GER				QATAR	SING		
the	BRUN	IT							
World	DEN	UK							
	GREE								
	IRE								
	ISR								
	KUW								
	NETH								
	S KOR								
	S MAR								
	SLOVE								

Table C.3.10: The 20 cluster case: WATER Cluster and their corresponding countries

Cluster 11	Cluster 12	Cluster 13	Cluster 14	Cluster 15	Cluster 16		Cluster 17	Cluster 18	Cluster 19	Cluster 20
SWE	AUSTRIA	BAHR	BHUT	CONGO	ANG	LIBY	CAN	CHINA	NOR	P N GUI
SWI	BELI	E GUI	GABON	LIB	BANG	MADAG	SPA			
	CHIL	OMAN	SURIN	S ISL	BENIN	MALA				
	COL	U A EM			BOL	MALI				
	CO RI				BOTS	MAURI				
	CUBA				BURK	MONG				
	CZ REP				BURUN	MOZAM				
	ECUA				CAMBO	MYAN				
	FIJI				CAMER	NIGER				
	FIN				C AF	NIG				
	MALTA				CHAD	PAK				
	MAURI				NO KOR	RWAN				
	NZ				DR CONG	SENE				
	PAN				ETH	SIE LEO				
	PER				GAMB	S AFR				
	PORT				GHAN	SUDAN				
	SLOVA				GUIN	TAJIK				
					GUIN-BIS	TOGO				
					HAITI	TURK				
					HOND	UGAN				
					INDIA	UR TANZ				
					INDON	YEM				
					IRAQ	ZAMB				
					KENYA	ZIMB				

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Eidesstattliche Versicherung

Hiermit erkläre ich, Wenke Wegner, an Eides statt, dass ich die Dissertation mit dem Titel

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selbstständig und ohne fremde Hilfe verfasst habe.

Andere als die von mir angegebenen Quellen und Hilfsmittel habe ich nicht benutzt. Die den herangezogenen Werken wörtlich oder sinngemäß entnommenen Stellen sind als solche gekennzeichnet.