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Declaration

I, Bojana Arsenovic, declare that this thesis is a result of my research investigations and findings. Sources of information other than my own have been acknowledged and a reference list has been appended.

This work has not been previously submitted to any other university for award of any type of academic degree.

Signature.....

Date.....

Abstract

International community has had little success in solving the problem of governing shared natural resources, of which the changing climate is the most prominent example. I wanted to know why. To answer this question I explored the conditions for achieving collective goals and providing for public goods, using the theory of collective action as a tool for analysis. First I examined collective action conditions in local settings, by looking into research conducted on local level natural resource management. Based on insights from the local settings I further investigated conditions for collective action in the international system. That I did by presenting the fundamental differences between the Montreal Protocol and the Kyoto Protocol, setting out an overview of existing international cooperation on climate change. Due to the anarchical nature of the international system with no central authority to enforce laws, agreements between states cannot be legally binding, which gives the states strong incentive to free-ride. In a system with economy based on competition where states are primarily interested in growth, the prospects for successful joint efforts to curb dangerous climate change seem rather gloomy.

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1.0 Introduction

Human use of natural resources has passed sustainable limits decades ago. Growing population and rapid commercialization of products extracted from natural resources bring rapid changes in natural ecosystems, giving them no time to adapt and regain the natural balance. We deplete natural resources and destroy natural habitats; we change the climate and put holes in the ozone layer, planets precious shield against solar radiation. With today's economy based on competition where all that states want is to grow, world's nations are more or less unable to take into account the side effects of their growth and deal with environmental resilience problems. Environmental systems have capability to withstand human appropriation, but there is some limit to that. Since we often do not know where that limit lays it is essential to come up with effective institutional changes and economy reassessments, so as to release the pressure on the system and avoid potential collapse.

We have been increasing greenhouse gasses for more than two centuries. As the risks posed by the global climate change continue to pressure, issues have been raised about the climate change policy and its effectiveness. I wanted to know why this process is developing at such a low pace, while the longer we wait the more difficult and costly it gets to mitigate climate change. To accomplish this I looked into conditions for achieving collective outcomes on both local and global level. I tried to provide an understanding of what kind of institutional arrangements lay behind the current natural resource management, and how effective those institutions are. A thick description like this provides a good understanding of the problems investigated, and gives basis for further scientific thinking about novel institutional designs to govern commonly owned resources more effectively.

My aim with this text is not to discover a universal solution to environmental problems and save the world, but to summarize the research conducted so far about the difficulty of international cooperation to reduce joint harm such as climate change. I was mainly motivated by the desire to understand the reasons for such a slow improvement in climate change negotiations, to discover something I could not understand before, and the pleasure of solving what puzzled me. Since my professional background is in international relations I am not capable of doing in-depth economic analysis, but I rather give my, rather simplified understandings of the economic

literature reviewed. Further, I am not going to be able to examine all the research yet conducted as the time available and my access to resources such as secret documents are limited. I will be therefore relying on a selection of secondary reference sources. A list over sources I examined can be found under 'Reference list' on the last few pages of this text.

A great number of articles in the available literature conclude with calling for immediate collective action for tackling global issues. Not least climate change issues. But how likely or possible is it that collective action among countries can be achieved to reduce environmental crisis? What kind of lessons can be learned from the collective action goals achieved so far, on both local and international level? How can collective action survive in an 'anarchical' international system? How well have international cooperation and official agreements on climate change been working? How can we adjust institutional arrangements to better motivate effective collective action? The answers to these questions are not obvious. To answer them it is necessary to understand the nature of the commonly owned environmental goods, the social and economical conditions under which they are exploited, and the nature of the strategic interactions between those involved in resource exploitation.

Thereby I structured the paper as follows. Section two provides an overview over concepts and theories used to answer my research questions. Section three gives some interesting insights from natural science, while section four illustrates how our social world is constructed and what kind of institutions govern in it. Section five introduces the property rights based approaches to environmental protection, while in section six I explain the dynamics of resources and goods extracted from them. In section seven I present the criteria for successful collective action, drawing on insights from the game theory. In section eight I examine conditions for achieving collective outcomes on the local level, which I in section nine compare with conditions for international cooperation. Section nine provides a framework for understanding the process of creating international environmental agreements. Further I describe the fundamental differences between the Montreal Protocol and the Kyoto Protocol setting out an overview of existing international cooperation on climate change. Section ten offers my conclusions.

2.0 Theoretical background and conceptual framework

Ever increasing alarming evidence of environmental degradation during the last decades has stimulated much theoretical and empirical work within both economics and political science. Here I provide some explanation of the concepts and theories I chose to use to answer my research questions.

An effective international environmental agreement is in this paper and in the context of international environmental governance understood as one that changes state behaviour in a manner that helps to prevent natural ecosystem deterioration. Yet the definition of an effective agreement can be problematic, and there are several reasons to this.

Due to the natural processes that can happen at the same time as regulation processes, there is the question of how we can determine whether the state of the natural environment has actually improved due to cooperative efforts by states. For example, even if a certain polluting factor can completely be removed from global consumption, it can take decades before we see some improvement in the natural environment (DeSombre, 2007). On the other hand, looking into individual country's effort, measuring and comparing their levels of pollutant emission can be too costly and very difficult to monitor. Further, to properly estimate whether a treaty has succeeded or not, we would have to be able compare the situation in which the treaty exist with an imagined scenario where the treaty has never existed, which is not feasible.

Global environmental issues have been approached by different disciplines. International relations scholars focused on the examining cooperation between states, and how to overcome collective action problems in a system that is anarchical. That international system is anarchical means that it lacks any kind of 'supranational authority', with states having absolute sovereignty over their citizens within their borders (Bull, 1977). The three most relevant international relations traditions that provided theories about environmental cooperation are neo-realism, liberal institutionalism and constructivism.

Realist theorists see international system as composed of sovereign states where there is no overarching authority above them, making the system anarchical. Because of such nature of

international system states are mainly concerned with how to survive in that system, and their main goal is accumulating economic and military power. States are therefore more prone to relationships of rivalry than those of cooperation and partnership. Cooperation would, according to realists, be possible only if controlled by a powerful state - a hegemony, but only as long as it agrees to do so. States are also, according to realists, the main actors in international system, and the role of other actors, such as international organizations and non-governmental actors is secondary (Dunne and Smith 2010).

Neo-liberals are, on the other hand, more optimistic towards cooperation to address collective action problems, claiming that all states have mutual interest and can therefore gain from cooperation. Neo-liberal theorists acknowledge that the international system is anarchical where it is easy for states to cheat on international agreements by free-riding, and collect benefits without bearing any costs. Anarchy is however possible to control according to liberal theorists, by setting up institutions that would monitor compliance, improve transparency and reduce transaction costs for the member states and by that reduce states' incentives to cheat. Unlike realists, liberalists believe that non-governmental actors play an important role in enforcing and monitoring agreements and enhancing cooperation (O'Neil, 2009).

While both neo-realist and neo-liberalists assume that states' preferences are predetermined and stable, constructivists see states' preferences as constantly changing due to introducing new knowledge and ideas and recreating norms. Norms are created to reduce conflict and enhance cooperation, as they are based on human values and help us distinguish between good and bad behaviour. Constructivism then looks into how this new knowledge, ideas and norms affect states' preferences and shape their decision-making processes. Constructivists believe that non-state actors play a big role in the international community as they shape and support these new ideas and norms (O'Neil 2010).

Not only has the development of the international environmental agreements been in focus of international relations and political debates, but it has also been an important subject of economic literature. If global agreements for environmental protection are not efficient, world governments need to find the way to address these types of collective action problems adequately. A great deal of economics scholars working on global environmental issues suggests changing the international system towards more use of markets and less use of state regulations –

international agreements. Others though believe that collective action and voluntary ways of organizing solutions to environmental problems are feasible.

As countries influence each other's behaviour and actions, where the results of what some countries do depend on what all other countries do, economic literature on international agreements focused on what motivates countries' choices. When studying environmental collective action problems, such as providing for local and global public goods, economists have used game theory as a tool of analysis (Stern, 2006). What kind of strategy countries choose can be described as either cooperative game where they to maximise total benefits, or non-cooperative game where they choose individual utility (Vatn, 2005). The non-cooperative strategy is the most usual choice and is often called Nash-equilibrium.

Game theory – Roger Myerson (1997) defines game theory as a study of a conflict and cooperation models between intelligent rational decision-makers. It helps analyse social situations where two or more individuals involve in decision-making that would influence one-another's welfare. As the individuals are both intelligent and rational it is reasonable to expect that they will pursue their own objectives and maximize his/hers own payoffs.

From the standard welfare economist's point of view international environmental problems are described as 'negative externalities' or 'market failures', which are the side effects of one's actions that are imposed on the others, like for example pollution (Chasek et al, 2014).

Environmental problems develop due to a lack of well defined property rights and markets, with no international government that could impose and protect these rights and regulations. Since there is no overarching authority that could force sovereign countries to join environmental agreements, it would be necessary for such agreements to be profitable for all countries, and therefore should be regulated by market.

Neoclassical economists assume that as long as the free market is functioning effectively we will be able to increase economic growth, and that natural resources and the ability of nature to put up with the wastes are unlimited. According to this theory exploiting natural resources will always be rational, as scarcity can be postponed indefinitely thanks to the developing new and better technologies. In that sense neo-classical economists see environment as mainly irrelevant to economics (Chasek et al, 2014). Even though we are now provided with scientific evidence and

are well aware of the fact that unlimited economic growth could cause permanent damage to the environment, this world-view still seems to prevail in many political agendas.

Even if agreements prove to be profitable for countries and they do join in, in number of cases countries tend to cheat after signing the agreement. Such situations are described in the literature as free-riding. In the case of greenhouse gasses reduction agreements this would imply situations where countries do not reduce their emissions as agreed, but enjoy the benefits of reduced emissions by other countries while they simultaneously minimize their costs. The possibility of free-riding decreases the interest of countries to take part in environmental agreements (Miles et al, 2002).

Collective action theory – the term collective action refers to a situation when decisions within a group or an organization are made independently, but the outcomes affect everyone involved. If the decision-makers are only interested in short-term material benefits, the desirable outcomes for all involved cannot be achieved (Ostrom, 2010). Environmental protection is seen as a collective good, which requires cooperative action to reduce costs of mitigating environmental degradation. Collective action perspective of environmental protection is mainly explained through rational choice theory. Since self-centred individuals consider only the individual costs for protecting the environment, and not the costs imposed on the rest of the group or organization, society is likely to end up with damaging the environment (Enevoldsen, 2005).

Since states are mainly self-oriented and pursue their national interest, organizing cooperation to address collective action problems is difficult. Such situations must, as Ellinor Ostrom puts it, be converted from independent decision-making guided by self-interest to one in which cooperative solutions are adopted, serving a broader, common interest. Her work is based on several case studies on the level of local adaption where she shows that in the local context other things are going on. People are able to find solutions that are different from the Nash-equilibrium. The question is whether such mechanisms would work when applied on international scale environmental problems.

Collective action theory examines collective action problems. In the case of international environmental agreements there are two major problems: a) the costs for organizing collective action; b) the conflict of interest that countries meet: the countries that do not participate have a

chance to free-ride and do not share the costs, while the countries that do participate end up in a prisoners' dilemma (Olson, 1982).

Conflicted interests and organization problems can to some extent be resolved as worlds' governments establish different intergovernmental agreements to manage environmental issues. If the intergovernmental cooperation succeeds, the motivation to free-ride would in that case be minimized. Examining the example of how local communities successfully involve in voluntary cooperation while managing public goods, Ostrom (1990) argues that governments could in a similar manner achieve successful cooperation and overcome free-ride problems.

Other theorists, like Mancur Olson are more sceptical, showing little understanding of types of social forces involved when resolving collective action problems. His way of thinking is very much based on the idea that people act as rational individuals who seek to maximize their own utility, which leaves small chances for trust building and voluntary cooperation.

Rational choice theory – explains social phenomena in terms of rational decisions made by self-interested individuals. Individuals are motivated by rewards and profits they can gain (Scott, 2000).

General theory of public goods – according to the public goods theory the willingness of actors to provide goods depend on the type of the goods consumed. In the case of environmental protection and worlds' governments this means that countries' willingness to protect environmental goods is affected by the character of the goods. Environmental protection is presented as international public good in international environmental agreements. Since individual countries cannot solve the problem independently, protecting this public good requires collective international action (Kölliker, 2004).

3.0 Some insights from the natural world

Before I begin the departure of understanding cooperation and the problems of collective action from the political/economical/game theoretical perspective, I would like to mention some important insights from the natural world and the theory of evolution, that could contribute to our

understanding of human cooperation. These insights I borrow from widely known Oxford professor and evolutionary biologist Richard Dawkins.

3.1 Natural economy

Let us start by making a parallel between the world economy and natural economy. Natural economy is based on solar power, as all the energy that drives life comes from sunlight. It starts with the plants, since has it not been for the plants, there would not be any animals either. The energy from the sun is further trapped by the plants and transferred into organic fuels in the process of photosynthesis. These fuels, mainly sugars, are further used for different processes, including plant growth. If we take a tree as an example, it would use a lot of this energy to build up its big trunk. Now, the explanation why trees build such tall trunks is what caught my eye while I was reading Dawkins' *The Greatest Show on Earth*.

Trees can, just like states in the international system, be seen as competitive. Trees in their natural habitat, a forest, grow tall not to be closer to the sun, but to overtop rival trees and avoid being in shade. No sunlight comes to a tree that is in a shade of another tree. Building a tall enough trunk however requires a great deal of energy production, and is very costly. A tree top would absorb the same amount of energy no matter how tall the trunk is, and would in that sense gain much more if it could lay flat on the ground. Instead, each tree wastes huge amount of energy to build a trunk taller than other trees in the forest. Could all the trees in a forest be able to agree not to grow above a given height and save the energy on building costly trunks, every tree and the forest as a whole would be better-off. This problem is familiar for a number of different human affairs, including the problems of tackling environmental degradation (Dawkins, 2009). Similar to the trees that grow taller and taller in the natural world, so do the states grow in the human world to remain the most powerful ones in the international system. Even though we know that economic and population growth harms the very natural systems we depend on, we still want to grow. The reason to this may be that the costs are not fully obvious at the moment of growing, but will come in the future.

Trees will however not grow further at the expense of everything else, some energy needs to be available for fruits and leaves. The growth will stop at the point where the costs of growing a bit more are higher than the gains from receiving more sunlight by growing that extra bit (Dawkins,

2009). It is the balance between the costs and the long terms benefits that is crucial here. The nature gets this balance right. Do we? There is a however a crucial difference between human affairs economy and natural world economy. The trees cannot design their economy. We can. Should not we then be wiser and able to avoid ending up investing in useless trunks that have no other purpose than competing with other trees?

3.2 On altruism

Another interesting insight I found in Dawkins is his explanation of altruistic behavior. Even though Charles Darwin claimed that the brutal struggle for survival is what drove the evolution on earth, the acts of kindness have been observed in nature, where animals gave something to others on the cost of themselves. Dawkins was puzzled by the question of how animals evolved to be nice to each other, and tried to find roots of altruism in genetics. According to Dawkins the survival of the fittest really means the survival of the genes, as it is only genes that really survive through many generations. The main message of his popular work, *The selfish gene*, is that a gene that did not look after its own interest would not survive. How does he then explain the phenomenon of animals being nice to each other?

Dawkins gives two reasons for selfish genes to support altruism, namely family and reciprocity. He found out that altruistic genes can survive through generations if altruism is directed towards organisms that bare the same genes, that is relatives. Reciprocal altruism on the other hand works on the principle of returning favors – if you scratch my back I will scratch yours. Genes for reciprocal altruism can survive when animals live in groups where they repeatedly encounter each other. Individuals do favors to other individuals they are not related to, but only those who can on another occasion be in a position to pay the favor back (Dawkins, 2006).

But with over 7 billion of us on the planet we humans no longer live in small groups where we are surrounded by family and people who can turn back favors. Still we have a lust to be nice, even to complete strangers, and have an almost uncontrollable urge to help people crying for help. Dawkins compares this urge with sexual desire which is still there because of the genes, even though we deliberately use contraception to prevent the very purpose of having coition from evolutionary point of view. Similarly, writes Dawkins, being nice has been deeply

embedded into us from the time when we lived in small groups of close relatives, surrounded with people we knew, with whom it would pay off to exchange favors (Dawkins, 2006).

Economists Jean-Marie Baland and Jean-Phillipe Platteau were also interested in how altruism and the principle of reciprocity may get people to cooperate. They were especially attracted to cases where people were willing to keep promises even without legal sanctioning for non-compliance. They point out that already David Hume and Adam Smith as well, understood that what sometimes thought to be altruistic behavior actually can have egoistic thinking in the background. They call this type of behavior for ‘selfishness with foresight’. When people do favors to one another they are actually not showing signs of good will, but rather help each other as they expect the favor to be returned in the same way. After all, if it were enough ‘true’ altruism in the world it would not be so difficult to overcome collective action problems such as eradicating poverty and protecting the environment.

Some rules like what kind of genetic material we are going to inherit are determined by nature. Others are human creations. Human behavior is indeed heavily influenced by the cultural norms and other institutions the societies we live in have developed through time. Let us now shift our attention from the natural world and see how economic theory explains how social system is structured and individual behavior understood, by finding out more about social institutions that keep our societies together.

4.0 Social world – Institutions

4.1 Social interactions - how is our social world constructed?

To begin understanding how a problem complex as the one of environmental crisis and climate change is dealt with, I would like to start by saying a few words about how our modern societies work. These understandings I borrow from Arild Vatns work *Institutions and the Environment*, along with personal consultations with the author. We can start by thinking about how we would, for example, explain someone who has never lived in a civilized society how things in our world work, how we run our lives and manage to survive? We would certainly try to teach that person

the language we speak, show how we eat, greet and communicate with each other, but we would also need to clarify the rules and regulations we need to follow, and what happens if we break some of the rules. What we would actually do is to familiarize that person with some of the institutions that structure our lives. That person would, on his/her way to be fully integrated in our society, have to shape his/her behaviour in accordance to a number of different institutions.

If we were to define what an institution is, we could say that institutions are set of norms and regulations that keep societies hang together. They are about how one as individual interact with the rest of a society, how we coordinate our actions within societies, states, organizations, and eventually the international society as a whole. We have for example developed a system of a series of individual transactions to organize exchange of products across the world that we call market. While the market has on the one hand been very helpful for our society's development, market reasoning and values have also influenced us so greatly that our consumption patterns cause severe global problems modern society has to deal with. We influence each other's behaviour and actions, where the results of what we do are dependent on what all other people do. In this process we end up in complex situations where different parts are involved, and to reach the common solution we need regulations to help us coordinate behaviour of often conflicting parts. Institutions are these necessary regulations.

Defining institutions has not however been an easy task. To understand the concept we first need to make distinction between physical world and social world. While physical world is thought to be simply given by nature, social world is constructed by humans and human organizations. Institutions, as a part of our social world, have played a big role in structuring it. Then again, to be able to structure our societies we need to understand human behaviour, and what motivates human action.

Social sciences are therefore divided in two main standpoints. 1. Individualist standpoint – which sees choices we make as purely individual and not influenced by institutions. Choices we make or our preferences are according to this view stable and will not change over time. Individuals are seen as selfish, pursuing personal interests – their main goal is to maximize individual utility. This perspective sees institutions as social constructions that constraint individuals while they interact with each other. 2. Social constructivist standpoint – by creating and changing institutions we form, coordinate or change behaviour. Our preferences are therefore also prone to

change. Not only are our choices socially structured and very much affected by institutions, but also our values, perceptions and capabilities. We learn and develop social skills living in a society we were born in. We create institutions, but we are at the same time very much influenced by those same institutions. They can constrain choices, but they also enable them. This perspective sees humans as social beings, which are willing to cooperate and take into account other peoples' needs. Institutions are what regulate complex situations and facilitate that cooperation.

Correspondingly two economic perspectives have developed. Standard economic theory - neoclassical economics perspective, considers individuals selfish and mainly interested in maximizing individual utility. On the other hand institutional economics perspective considers individuals aware of being a part of community, who take others into account when making decisions. What we consider rational and make choices in accordance with, seen from this perspective depends very much on institutional context.

4.2 Institutions

As mentioned, we created institutions to be able to regulate our modern, overpopulated, and interconnected world. As we influence each others' actions and opportunities, we often find ourselves in situations of conflicting interests. Institutions can both create and protect interests. Different institutions regulate our societies on different levels, and we can divide them in three groups: conventions, norms and legal rules. While conventions and norms regulate situations with little or no conflict, legal rules play a decisive role in handling situations of conflicting interests and maintaining social order.

We can think of conventions as every-day rules, guides to acting properly in every-day life. What they do is to make large group of people behave in a similar manner in specific situations. For example we usually shake hands when we greet each other, and we are aware of traffic rules when we drive our cars.

Norms are different from conventions in a sense that they are based on human values. They help us regulate social interaction as they help us distinguish between good and bad behaviour. Norms are about how we treat each other, and what we should and should not do. For example, we should keep our promises, we should not lie, we should be loyal, honest etc. Norms can be used

to regulate conflict in the absence of a government. People choose to follow norms because they feel that something is a right thing to do, or they may have bad conscience deviating from a norm, but they also decide to follow norms because the rest of community may judge them and exclude them from community activities. Norms are created to enhance cooperation and reduce conflicts, but they can create conflicts if individuals choose not to comply with them, and by that limit the possibilities for other individuals.

Legal rules, as opposed to conventions and norms, are rules that regulate our behaviour deciding on which actions are allowed and which are forbidden. Legal rules are established in highly conflicting situations where external punishment must be implied in order to reach desirable resolutions. They protect interests in form of rights, deciding who has right to do what in a given situation. Numerous legal rules govern all the levels of our modern society, ranging from common law, criminal law to laws regulating how we trade, property rights and so on. These rules are enforced, and breaking such rules would imply a punishment from a third part - legal power, for example a state, or a court. A person breaking legal rules would be forced to pay a fine, or the government could deprive that person of his/her liberty.

5.0 Governing natural resources

To understand why we need rules and regimes to govern relationships between human society and nature, there is a need to emphasize the interconnectedness of human activities and activities naturally happening in the environment. Over seven billion people share the earth today, and every one of us, along with any other species, depends on the quality of earth's ecosystems to survive. As a result of long-lasting human interaction with natural environment and our rapid development, we managed to disturb complex natural bio-geochemical processes that keep the ecosystems functioning. Consequently, we now face numerous environmental problems and resource scarcities that can put our own survival at risk.

As well as we are capable to change the systems so severely, we have also the capacity to study them and learn the best solutions for managing natural ecosystems. Since the situation is such

that so many of us share fewer and fewer natural resources, managing resource use to sustain the needs of constantly growing population has become a challenge. As our lives and resources are interconnected, it is in that sense important to understand how we as a society can coordinate our actions in situations where what we do influences what all other people do. It is norms and regulations that make us act in a specific way, think collectively, and not only about ourselves. That has implications for different solutions when analyzing environmental problems within economics and environmental policies (Vatn, 2005).

Various economic traditions have perceived the environment differently, but most important distinction is between environment seen as interconnected system, versus the environment seen as a set of items or commodities. Neoclassical tradition treats the environment very similar to all other goods, as commodities and items can be defined and replaced. On the other hand, ecologically inspired economics, which are more similar to classical institutional perspective, sees environment as a dynamic system, and importance of natural resources' role in achieving sustainability, rather than just as a set of physical resources.

Environmental policy aspect deals with institutional solutions concerning environmental management, with resource regimes as its main concept. It looks into the role of resource regimes in environmental governance, use and maintenance of natural resources, often called common-pool resources. It decides upon who gets the right to what resources under which conditions, and how that influences the distribution of income.

Environmental policy consists of two elements, one is governance structures, and the other one is resource regimes. Governance structures further consist of actors, with their interests, rights and responsibilities, and institutions or rules. Actors can be divided in political actors and economic actors. While economic actors have rights to resources and act in productive ways, political actors have the role of deciding the rules for the economic process. On the other hand we have institutions that also govern political process, defining what political actors can and cannot do, as well as economic process in form of resource regimes.

5.1 Resource regimes

Resource regimes are then those institutions that govern the action of economic agents. These institutions are operational rules for economic action, and we can again divide them into two

categories. On the one hand we have rules that govern the access to resources and responsibilities related to it – property rights, and on the other rules that govern interaction between the economic actors. These rules do not necessarily need to be formal rights; access to resources can as well be governed by more soft mechanisms such as norms. Interaction rules imply what actors are allowed to do, and how they can interact with other actors concerning the use of a resource, as well as products gained from the resource (Vatn, 2005).

For the market to work properly we assume that the property rights system is established. Then we know who has right to which resources and how resources can be exploited. When property rights are established the person with no property rights needs to pay to the rights holder for using his/her resource. Property rights can then be defined as rules managing access to and use of a resource, together with responsibilities concerning the resource use (Vatn, 2005). They protect access to resources and they are a link between choices and consequences, in a sense that they for example ensure that it is the owner of a specific piece of land that gets the profits from investing in that piece of land. There is no point investing in something if somebody else can take the fruits of your labor and investment from you. In the case of environmental resources though, it is not easy to link action and consequences, because some consequences of our action can be spread beyond our property.

As a property is usually thought of as a thing, it is necessary to first give some clarification of the concept. Frequently used definition describes property as a relation between a property holder and other people who are ‘right regards’, in a situation where there is a third party that gives and protects the right (Vatn, 2005). In other words property right is a structure of the owner, the others that need to respect the ownership, and the third person that can guarantee that the right is protected.

On the basis of resource dynamics or the goods extracted from them, we typically divide property rights in four different types:

- 1) Private property regime is based on individual ownership, and is usually thought of as personal property, owned by a single individual. In terms of corporations though, what person owns is a share in cooperation. It is still called individual private property as individuals own shares and they can sell them.

- 2) Common property is also a private property but for a group of owners, so that they own a certain resource together, under a set of common rules or norms. The difference between private property and common property is that a person cannot sell his/her part. If a person is a part of a community, when s/he leaves the community s/he also leaves the rights to resources that belong to the community. A person cannot privately sell his/her access to for example a forest. Unlike Norway, for example, where we have the privilege of every-mans right and everybody can enter forests, the rules are much more strict in Tanzania. There are specific rules both regarding under which conditions others than villagers in a given village can enter the forest, and what is allowed to do in the forest once one is allowed to enter.
- 3) State property is also called public property because we can have public property at lower levels other than a state, for example counties or municipalities. It is a type of a common property, but it is more indirect, in a sense that one gets the ownership by being born in a specific country. For example, every Norwegian citizen is granted ownership rights to the Norwegian oil. Citizens do not have right to sell it, but they get benefits from extracting it. In the case of weak and corrupted states we can often find that state property is more like private property for the heads of the state.
- 4) Finally, open access is a situation where there are no protected rights, everybody has access to a resource, and 'everybody's access means nobody's property'. Both state property and open access are in a sense common property, but the main difference is that open access implies no property rules, while state property implies a group of owners who live in the area where resource is available and use it. State property means that every citizen of a state owns a resource, but the resource is typically run by state agencies. In the case of Norwegian state forests with the privilege of every-mans right people can enter the forests and for example pick berries, but they cannot take trees, because they are owned by a state. In the case of open-access people would be allowed to take the trees as well. The state has its own rules on how it uses these resources, in the same way as private owners do.

To exemplify how we usually allocate property rights to different resources we can think of a piece of land which can have different productivity. When it comes to establishing property rights it is more costly to establish private property than open access. Common property is less costly than private property, state property is even less costly than that, and open-access is cost-free. We can have open access for a very high productive land, but it might be ridiculous to have open access to something that is so valuable, and it is not too costly to establish private property. In that case we can shift from open access to private property because the productivity of the land would cover the cost of establishing private property, and it would be possible to earn a profit. In other words the cost of demarcation (dividing a good into properties) is covered by the productivity of land.

But if we have a land that is less productive, it may be too costly to establish all regulations for private property so that we rather go for a common property. If however our piece of land is of such low productivity that it is not possible to institute, then we would just leave to open access. In other words private property regime may be adequate in situations of high governance costs and low exclusion costs, while some sort of common or state property may be a better solution in an opposite situation (low governance and high exclusion costs). Open access would, he suggests, then be unavoidable in situations where either exclusion or governance are exceptionally high, or the resource itself is extremely abundant (Cole, 2000).

5.2 The state or the market?

What kind of institutional arrangements we choose and how we allocate property rights vary however from one environmental good to another. No single regime is likely to work well for every natural resource, and how we assign property rights can largely affect the degree of resource degradation. This relationship between property rights and environmental goods has been thoroughly examined in the economics literature during the last century. It has begun with one of the still very influential and often cited works of Garrett Hardin's, *The Tragedy of the Commons*. In his book Hardin addresses the problem of non-regulated resources, that is the ones to which there is open access.

What is meant by the tragedy of the commons is that every property that is held in common will eventually be depleted. This occurs because while individuals using a resource are primarily interested to maximize their individual benefits, they fail to acknowledge the costs imposed on the whole group of individuals who depend on the resource. In other words, in situations of unregulated resources short-term individual interests are winning over long-term group interests, eventually resulting in resource overuse and even destruction (Olson, 1982). Hardin's Tragedy of the Commons is particularly important because it encouraged further behavior analysis in the field of economics and game theory.

Hardin develops his theory on an example of multiple herders using a pasture, and argues that common property would result into overuse of resources. Therefore some sort of regulation is needed to protect natural resources against overuse and eventual depletion. That is to be done by moving from non-property situation (open access) to establishing some sort of property rights, either private, common or state. Hardin does not however specify which type of property regime should prevail, and as a suggestion to prevent the tragedy of overexploiting resources offers both privatization and government regulation (Cole, 2000).

Numerous scholars have been inspired by and revisited Hardin's work. Even though Hardin's insights have been criticized by many, his main argument seems to remain true - natural resources to which there is open access will most probably be overexploited. Examples of renewable resource having been exploited beyond sustainable development are many. That does not however mean that resources commonly owned necessarily need to suffer the same fate. Political scientist Elinor Ostrom and Balland and Platteau who among others analyzed conditions under which common-pool resources were adequately or inadequately managed, offer numerous examples of adequate regulation of local-level resources held in common. They show us many examples where local communities were capable of cooperating and successfully handling resources they held in common, resources ranging from irrigation networks to forests and pastures.

Ostrom also clarifies distinction between common-pool resources and common property. She criticizes Hardin for mixing up characteristics of a resource with characteristics of a resource regime. The point is that resources can be common-pool, in a sense that it is difficult to divide them into properties, where one most probably cannot establish common property. But there is a

difference between common property and open access, where full deterioration of resources typically occurs. We can take water resources, or more precisely oceans, rivers, and natural lakes as examples of common-pool resources that cannot be owned. One may for example have a right to fish at such place, but water itself is hard to be made into private property.

We can also for instance think of a hundred farmers who live around a lake. They all use the ground water and influence its level. Now, if there are no rules, in a sense of common property regime, that make it possible to keep the use below a certain level, the whole resource can be become exhausted. Open access would imply that everybody can in a sense do whatever they want, while the common property regime is a set of rules concerning how often and how much each household can utilize the resource.

Hardin has been in other words criticized for not making clear distinction between open access and common property and therefore many critics suggested his work would maybe more correctly be named The Tragedy of Open Access. Sometimes however such distinction is not very obvious. Some property systems have weak rules concerning external exclusion and internal management so that common property, and even state property systems, are occasionally close to open access. Such systems simply do not function well due to weak state governance. Most water, air and some land resources are under that kind of a regime. Such resources are not open access - access is somewhat regulated, but regulation is usually not ownership based (Vatn, 2005).

There are a lot of regulations concerning air, such as for example today's global climate regime. Air is in that case turned into property by giving people right to buy and sell emissions, as carbon has become a property in carbon trading. We cannot give a property right to air because with technology available it is not possible, but we can still regulate the actions taken. In a sense nothing is truly open access anymore. Even though rules are maybe not imposed through ownership, at least not to the resources difficult to demarcate, the right to engage with a resource is certainly a type of property right.

Environmental degradation is today commonly regulated by specifying property rights in environmental goods, controlling access to resources via state regulation, or the combination of the two. But the property rights based approach to environmental protection is somewhat

problematic, and opinions on this subject vary within the economics literature. Some articles recommend more state control to prevent resource destruction, while other suggest that privatizing natural resources would solve the problem better. Scholars are mainly divided in two camps, so called free market environmentalism versus traditional welfare economics.

Market environmentalists wish to establish further private property rights and completely privatize environmental goods as a strategy to reduce environmental degradation. Privatizing environmental goods would imply moving from a state regulated approach to access and use of environmental goods, to a one that is strictly market oriented. Market oriented approach would be based on establishing complete private property rights and market transactions of those rights. Proponents of this approach suggest that environmental degradation is a result of inadequate property rights establishment and noncompliance, and that natural resources should be owned privately, either by individuals, corporations or communities (Cole, 2000).

The argument for environmental goods privatization consists usually of two parts. First, without strongly established property rights to protect environmental goods in situations where a group of individuals are using a resource, they give numerous examples of resources have been overexploited and even destroyed. This is because individuals are not capable of considering the detrimental effects they impose on others while exploiting the resource. Further, individuals could be selfishly eager on exploiting the resource as soon as possible to prevent others from benefiting more, even when they are simply wasting the resource. Second, proponents of environmental goods privatization claim that individuals who own natural resources privately would think about maximizing benefits from their properties over time, and use resources in socially most efficient ways as they would fully internalize the costs and benefits of their use (Cole, 2000).

On the other hand there have been conducted many studies that show durable successful commons management that does not involve either the help of state or the market. To take just one example there is a detailed study of Swiss alpine villagers who themselves managed to regulate various commonly owned resources for more than five hundred years. (Taylor, Ostrom, Baland and Platteau). On the other hand examples of capital-hungry private owners who are primarily interested in immediate benefits and thereby overexploit their resources are ever increasing.

The general argument against creating formal property rights - formalizing is that it could make the use of a resource less flexible, in a sense that by formalizing we may disturb different ways to manage certain risks that existed in the original, less formalized systems. If we for example split a pasture land into pieces, we cannot predict the weather pattern - one year a drought can hit one area, and the other year drought can move to another area. If a pasture was kept as common it could be avoided to negotiate under which conditions certain parts could be used and when, and it would be more flexible as owners could move within the resource (Vatn, 2005).

Further privatizing natural resources can sometimes be very difficult. Unlike national parks and forests which can easily be split into parcels and divided among private owners, the atmosphere is very difficult to demarcate. Privatization of air would be too costly, as the cost of imposing property rights would be much higher than benefits to be gained from privatization (Cole, 2000). Maybe air would one day become so scarce or technology so developed that transaction costs (costs of information gathering, making contracts/agreements and securing that agreements are abided by) of privatizing would not matter/be lower than benefits. That is however not the case yet, while the amount of greenhouse gasses released in to the atmosphere is constantly increasing. But even if all environmental goods could be easily demarcated, another problematic aspect of privatizing is the difficulty of putting price on all environmental goods, and capturing all their important values. Market values of goods and services do not always correspond to values of the human society as a whole.

Moreover Baland and Platteau illustrate examples where privatizations led to creation of monopoly when some private owners prevented all others to use a resource. They further point out that market in many cases is not capable of capturing all value of natural resources. Some natural resources characteristics, as for example the beauty of a natural landscape cannot be reflected in market prices. If asked anyone appreciates clean air and natural beauty, but almost no one would be willing to pay for it. Finally they point out that introducing markets in local-level settings has in some cases led to even greater overexploitation of common pool resources. Commercializing products extracted from such resources and the presence of the market contributed to changes in value system in some communities, from traditional ones to those of material wealth. The new opportunities and modes of living opened by the market made local

people want use the resources even harder in order to make more money (Baland and Platteau, 1996).

Private property regime does not necessarily promote efficiency. Privatization as an answer to the resource depletion problems has not however remained as dominant strategy in the literature, nor has it gained broader political support. Various researches, among other those of Ostrom, Baland and Platteau, have shown that in some situations collective, decentralized regimes turned out to be much more successful in resource management than private property regimes. Recently conducted research illustrates both successful and unsuccessful resource management under every kind of regime. Both private owners, village owners and state owners may in situations when under personal/economical/political pressure shift from long-term to short-term use.

General conclusion in the literature is that property regimes should not be thought of as competitive, but should rather be combined and supplement each other to provide for sustainable management of a given resource (Hanna and Munasinghe, 1995). What we can see today however is that neither the state nor the market solutions have solved the problem of overusing resources. Ostrom showed us that public and private institutions are in the field settings often combined and depend on each other rather than compete or operate in isolation. She gives us examples of communities that managed to govern common resources in ways that resemble neither the market nor the state, and calls for developing better tools for regulating resources, solutions that go beyond states and markets. Property rights regimes should therefore evolve over time in accordance with social pressures, environmental changes and technological innovations to minimize human impact on natural ecosystems (Cole, 2000).

There are different reasons to establish different property rights, and they vary across countries. Some societies regulate resources more often through private property regimes, while other rely more on some sort of common ownership. Such variation rests on both political and cultural reasons, but also something as simple as practical reasons. Attaching a specific property right to a certain good or service is in many cases a reflection of the characteristics of the resource in question.

6.0 Resource dynamics

To fully understand why we need different types of resource rights to access different resources we need to look into types and characteristics of resources, and collective goods made of them. These insights I gathered from Vatn, 2005 and Varian, 1992. Two characteristics are important here – excludability and rivalry.

We say that a good is rival when one person's consumption of that good reduces the amount available for others. Such good can in other words only be consumed by one person. If several people are for example to share a bread, each individual piece can be eaten by one person. If you eat your piece then it will no longer be available for me. Exclusion implies that a good can be split into parts (properties) so that it can be divided between individual actors. Others can therefore be excluded from using a good, unless they are willing to pay for the good to the owner who controls it. Had I for example wanted some firewood for my fireplace, I could not walk into somebody else's forest and take the trees myself on their property. Such exclusion can however be costly. For example it is easier (that's is, less costly) to divide goods as cars, tables, books chairs etc., while it would be extremely costly, or even impossible to divide goods such as air, running water, sea, seashore etc.

Depending on which of these qualities goods have, we distinguish between four types of goods.

1) Private goods, as for example books, cars, food etc., are both excludable and rival. That means that it is easy to divide such goods and determine their price. 2) When a good is neither excludable nor rival we call it public good. Such good is provided for everybody and one's consumption of that good does not make the good smaller. An often used example in the literature is the street lights. Since my consumption does not reduce your possibility to enjoy streetlights, streetlights are not rival. Neither can I exclude you from consuming streetlights (Varian, 1992). Other examples of public goods are social order and national defense, police and fire brigade, highways and lighthouses. No less important than peace and security are environmental public goods (also known as natural resources), such as clean air and water and diverse flora and fauna, without which human life would not be possible.

The problem with environmental public goods is that they are becoming less abundant and more rival in character. When increasing number of people is consuming the good, and there is new technology so that each person can consume more, nature's capacity to provide enough goods for everybody decreases. International fishing waters have for example not been regulated until the 1950s. The fish stocks were massive in comparison to the fishermen's fishing capacities so that no regulation was necessary. But with new technologies developing through 1930s '40s and '50s we realized that a resource that was not rival before had become one, and that some sort of regulation was necessary (Vatn, consultations).

3) A good can also be non-rival but excludable. Such goods are named club goods. A typical example is television or internet signals sent by air today. One's consumption of TV signal does not reduce the amount of it, but only a group of people (or we can call it a club) willing to pay for a decoder can enjoy it. 4) Goods that are not excludable but are rival in use are called common goods. That implies that anyone can use such resources, but one's consumption reduces the amount of the resource available for others. Goods in this category are often called common pool resources. That they are not excludable means that it is not easy or it is too costly to split them into properties for each individual actor. A good example would be a fish stock or a pasture. As our world population does not seem to stop increasing and new technology enables us to extract natural resources more effectively, many environmental public goods are becoming common pool resources, with the danger of depletion (Vatn, 2005).

As said, non-exclusive means that it is too costly to split the good into individual properties, assign rights to the owners and exclude other consumers. But only because it is costly does not mean that the good or a resource should be left to open access – unregulated. That kind of good could for example be owned commonly, and we shall see that some communities managed to successfully hold resources in common.

7.0 Collective action

7.1 Public goods and externalities

Let us now turn back to property rights and look into this rather simplified example of how property rights work: If I need firewood for my fireplace I go to a nearby farmer who owns a piece of woodland and I pay him a price for my firewood. I cannot simply walk into the wood and take the trees myself. By paying for the firewood I am also paying for the farmer's costs of maintaining his woodland, cutting the trees, transportation etc. In other words I am not paying only for the raw material or the resource itself, I am paying for the final product.

The same happens when I for example buy fuel for my car. I am paying for the oil extraction, refinery maintenance, making gasoline from oil, transportation etc. What I do not pay for, either to the farmer, oil companies or anyone else, is the consumption of another resource – the atmosphere. I am paying nothing for the deforestation I am contributing to, or the greenhouse gases I emit by burning fuel. Neither does the farmer, oil companies or anyone else. However the farmer, oil companies, I, and everyone else have equal right to clean natural atmosphere. The problem is that even though the atmosphere is vast, nobody owns it, and access to it is free the atmosphere is not an unlimited resource. It is in fact becoming scarce.

A problem like this, where social costs and benefits are not integrated in the price of the product, is in the economics called externality problem. We have a problem of externality when our individual economic decisions affect the welfare of others who do not take part in those decisions. In other words we are confronted with such situations when individuals are pursuing own welfare without taking into account well-being of others, or the costs and benefits of a society as a whole (Vatn 2005). But we live in a world where we influence each other's behaviour and actions, where the results of what we do are dependent on what all other people do, and where the logic of doing what is appropriate relates to what is best for the group, or for others.

Air pollution is a typical example of an externality that results from burning fossil fuels. The main argument of the above discussed supporters of natural resources privatization is exactly internalizing externalities and reducing transaction costs of managing a resource, in other words,

avoid both excessive consumption and administration costs. Externalities and public goods provision are together with market control and incomplete information in economic theory explained as market imperfection or failure. Market failures emerge when producer or consumer of a good imposes negative or positive consequences on others that are not paid for, that is when prices do not fully reflect the value of goods produced (Sandler, 2004). Climate change is the example of the greatest market failure ever occurred. Overcoming market failures that lead to insufficient provision of public goods are further typically studied by theory of collective action (Stern, 2006).

7.2 The problem of free-riding

Collective action emerges when efforts of two or more individuals, firms or institutions are required to achieve an outcome. It implies a situation where individuals are mutually dependent on each other so that actions of one individual affect the actions of other individuals, implying that individuals therefore must coordinate their actions (Sandler, 2004). Collective action theory examines the difficulty of getting individuals within a group to pursue their common interests as opposed to pursuing individual interests (Ostrom, 1990). It likewise studies circumstances under which individuals can be motivated to pursue their common well-being. It is therefore suitable for studying problems which arise around use of resources held in common or to which there is open access, problems of negative externalities and public goods provision.

The main problem with providing for public and common goods (especially non-regulated ones) is the problem of free-riding. As such goods are not excludable we cannot prevent an individual from consuming a good once it is produced. The individual then gets a chance to free ride on the efforts of others; or in other words consume the good that is provided by others without contributing to its provision. How likely it is that that person becomes a free-rider is something to be looked into. The main question is under what conditions a group of people would be willing to cooperate to provide for a common or a public good, a good they all have interest in providing for.

Individual preferences in public goods interactions were first studied by Mancur Olson in his widely known and in recent decades most cited economics book *The Logic of Collective action*. When deciding whether or not to contribute to the provision of a common good within a group

an individual estimates the cost and benefits of making the contribution. Olson's main argument is that rational, self-interested individuals within a group would not act so as to contribute to gaining a common interest unless the group is very small, there is a third party to force them to do so, or some sort of compensation for their efforts is offered (Olson, 1982). In other words for cooperation to work there has to exist either sanction for non-compliance or reward for contribution not available to those who did not participate (Stern, 2006). An individual has almost no reason to voluntarily make efforts to contribute to provision of a good if he/she cannot be excluded from gaining the benefits once the good is produced anyway. Such person is rather motivated to free-ride on the efforts of others than contribute to the common goal (Ostrom, 1990).

Political scientist Michael Taylor points out on the other hand that resource degradation does not necessarily need to be a problem of collective action. Being a single owner to a resource does not prevent the individual to manage the resource so as to maximize his/her self-interests and thereby destroy it. It can therefore not be said, as Taylor puts it, that if a lake and all the industry around it were owned by a private owner he would treat his wastes before discharging them into the lake (Taylor, 1976). His argument has to do with discount rate.

Every resource owner compares immediate use values with expected future benefits. They do so by discounting estimated future benefits to tell how much future benefits and cost are worth today. Higher discount rate means low present value of future payoffs. The resource would then normally be preserved if the discounted future value is higher than present value, otherwise it would be consumed without delay (Cole, 2000). It is therefore rational for the owner to maximize his payoffs and consume the resource presently. By doing so he might 'rationally' ruin the resource itself, even without help of other exploiters (Taylor, 1976). The only difference is that he would not have somebody else to blame for his actions.

7.3 The game theory

Challenges of collective action, such as provision of public goods and management of resources to which there is open access, are in the economic literature generally analyzed using the game theory, and presented in the form of Prisoners' Dilemma. Prisoners' Dilemma game has been used to describe situations when the logic of what is best for the individual is opposed to logic of what is best for the group. Even though individuals within a group act rationally in regard to their

personal needs, they end up with an outcome that leaves them worse off than if they were able to cooperate (Stern, 2006). Outcomes that seem rational from individual viewpoint in other words become irrational when seen from the perspective of all involved.

Prisoners' Dilemma game (*figure 1*) is played between two individuals, where individuals A and B can choose between two strategies. They can in the light of what is best for them either cooperate or produce a unit of a public good (C), or defect (D) by not producing any of the public good. We have then four possible outcomes: neither individual A nor B contributes, only A contributes, only B contributes, and both A and B contribute. Let us assume that the costs of providing for a unit of a good are 10, while (since the benefits are going to be shared as it is not possible to exclude others from using a public good) individual benefit is 8. That can be illustrated as followed.

Prisoners' Dilemma game

		Individual A	
		Defect	Cooperate
Individual B	Defect	Nash equilibrium (Pareto-inferior) B: 0 A: 0	B: 8 A: -2
	Cooperate	B: -2 A: 8	Pareto-optimal B: 6 A: 6

Figure 1: Prisoners' Dilemma game.

The situation is such that if no one contributes neither player receives any benefits or costs. If however individual B cooperates and contributes a unit while A defects then the costs for player B exceed the benefits gained and he ends up with a negative payoff of -2 ($8 - 10 = -2$). Player A at the same time gains 8 on B's efforts. In the opposite situation, when B free-rides on A's efforts, A receives a negative payoff of -2 while B gains 8. If both players decide to cooperate they earn together a payoff of 16, but less individual cost of cooperation the payoff for each is 6 (Sandler, 2004).

The best obvious choice for each player is to defect because payoffs are higher if he/she chooses strategy D than strategy C, regardless what the other player chooses. To receive a payoff of 8 is better than receiving 6, similarly as zero payoff is better than -2. D is said to be the dominant strategy for each player as it provides a greater payoff no matter what the other player chooses. When both players choose the dominant strategy, that is the strategy that gives most payoffs given the strategy of the other player, Nash equilibrium occurs. This situation is the third best result for both players where neither player would regret and change his/her individual decision, no matter what they expect the other player would do (Ostrom, 1990).

There is however another outcome which would provide a higher payoff for both players if they both change their dominant strategy. If the players could agree to cooperate each would then receive 6 in payoffs, rather than earning nothing. If both players managed to cooperate they would have reached an outcome called Pareto-optimal, which is an outcome where it is not possible to further increase somebody's utility without reducing the utility of somebody else (Vatn, 2005).

Unfortunately there is a catch: player A cannot trust that player B would keep the agreement and choose cooperation if B knew that A was going to cooperate. If player B knew that A was going to cooperate B would again be better off to defect and gain payoff of 8, than risk a negative payoff in case of A not keeping the agreement. If the players are not able to communicate and make agreements, or if those agreements are not binding then the game is high likely to be non-cooperative where both players go for the dominant strategy (Taylor, 1987).

In social life however interactions usually involve more than two individuals. In the case of n-person Prisoner's Dilemma game more than two individuals play the game. The situation when

several individuals play the game seems to be very similar to one in two-person game. The best social outcome is obtained if everybody cooperates, while it is still more beneficial for each individual to free-ride, especially if all others choose to cooperate. Non-cooperative behaviour of one individual discourages further other player's willingness to cooperate. Doing nothing remains the dominant strategy and the game again results in the Nash equilibrium, regardless the number of players (Taylor 1987, Baland and Platteau, 2000, Sandler 2004, Barrett, 2003).

We can think of the climate change problem and world's nation's willingness to cooperate to reduce greenhouse gases emissions as an example. Even though socially optimal solution would be achieved and the whole planet would be better off if all the countries of the world cut GHG emissions, not all the countries are willing to sign legally binding agreement and commit themselves to cooperative strategy. Further if one player offers to legally bind himself to cooperate, the only rational strategy for others would be to stick to free-riding.

There seems to be a general tendency in the literature to equate collective action problems with the structure of the Prisoner's Dilemma game. This aspect most probably originates from Hardin's Tragedy of the Commons where he claims that collective action problem and the Prisoners Dilemma is the same thing. Mancur Olson seems to be using the same logic in his work, but even though there is no doubt that all Prisoner Dilemmas are collective action problems, the opposite statement is not true – not all collective action problems take form of a PD game. Even though Olson's suggestions are not universally legitimate, PD game scenario seems to be empirically true for very many everyday world problems (Ostrom, 1990). Still Olson has further encouraged many of his readers to challenge his assumptions and find alternative solutions to help understanding problems of collective action. Most collective action problems are in fact not structured as PD game, but a variation of many other game forms for collective action theorists later developed.

Ostrom warns that framing real life situations in models (such as tragedy of the commons, Prisoner's Dilemma game, collective action logic) is very helpful for our understanding of different problems, but that doing so can also be dangerous. She implies that when using these models for the purpose of analysis we tend to generalize and think about given constraints as fixed. The prisoners in the famous dilemma, as she puts it, cannot change the rules of the game as they are in jail, but that does not mean that all natural resource users are in a similar situation.

No single set of rules fits all collective action failures, and institutional rules can be designed and adjusted so as to enhance collective action. When applied properly institutional rules can provide motivation to overcome collective action failures, and make a difference between global collective action and inaction (Sandler, 2004).

While the standard game-theoretical model shows that cooperation is unlikely to be achieved in situations of one-shot prisoner dilemma situations, many authors showed that the conditions for cooperation change substantially in a repeated (PD game Taylor 1987, Baland and Platteau, 2000, Sandler 2004, Barrett, 2003). Moreover Ostrom shows that cooperation can even be achieved within small groups, whose members know each other and care for the future of the resource they depend on. They also confirm that public good problems need not necessarily be presented only by PD game, and that alternative game forms for collective action exist. Many cases of public goods problems are better represented by Chicken or Assurance games. Unlike PD game, public goods interactions represented by these games show some possibility for voluntarily cooperation.

7.4 Alternative game forms

Unlike the Prisoner's Dilemma scenario where one player's contribution tempts the other to free-ride so as to gain the highest profit, we see that preferences suddenly can change in a game of Assurance (*figure 2*). Assurance game is applied in situations when efforts of both players are required if any of the public good is to be provided. For example if the air quality had become so poor that life on earth became threatened, all the worlds' nations would have to react as efforts of one or only few would not be enough. If we now assume that the cost of contributing one unit of a good is 5 and the benefit of a public good to each player is 10, when both the players decide not to contribute there is of course no costs, no public good provided or payoffs gained. If one of the players contribute and the other free-rides then the contributor loses the cost of his contribution (-5), without gaining any benefits.

Assurance game

		Individual A	
		Defect	Cooperate
Individual B	Defect	Nash equilibrium B: 0 A: 0	B: 0 A: -5
	Cooperate	B: -5 A: 0	Nash equilibrium B: 5 A: 5

Figure 2: Assurance game.

The interesting detail is that the other player does not receive any benefits from free-riding either, since the efforts of the one who contributes alone are not enough to produce the good. If however both players cooperate each receives a payoff of 5 (total benefit of 10 minus investment costs of 5 is 5). In that manner there is no dominant strategy in an Assurance game and it has two Nash equilibriums (C, C) or (D, D) but only one of them is social optimum (Sandler, 2004). Collective action can still fail if the players choose the other equilibrium, but since the assurance game is usually applied in situations where players need to work together against a common threat (D, D) scenario is not an expected outcome.

On the contrary to Assurance game, players in a game of Chicken (*figure 3*) can produce a public good individually but prefer the other one to do the job. If however no one contributes the players would be confronted with drastic consequences. So even though each player prefers free-riding to mutual cooperation, either of them would do the necessary work if the other had not

(Taylor, 1987). Payoffs and costs in this game resemble those in PD game except that payoffs in the case of both players doing nothing are no longer zero but negative.

Chicken game

		Individual A	
		Defect	Cooperate
Individual B	Defect	<p>Nash equilibrium</p> <p>B: -4</p> <p>A: -4</p>	<p>Nash equilibrium</p> <p>B: 8</p> <p>A: -2</p>
	Cooperate	<p>Nash equilibrium</p> <p>B: -2</p> <p>A: 8</p>	<p>B: 6</p> <p>A: 6</p>

Figure 3: Chicken game.

Like in an assurance game there is no dominant strategy here, and there are two equilibriums. None of them is however a social optimum because common efforts would provide benefit of 12 while individual provides only 8. Achieving social optimum in the game of chicken is unlikely because it is in the best interest of each player to hold out and force the other player to cooperate. The possibility of making collective failure is high as players may wait for too long expecting that the other one will react and end up in the worst-case scenario (Sandler, 2004).

As we have seen other game forms demonstrate that problems of collective action are not necessarily structured as the Prisoners Dilemma model and should not, as many researchers (Taylor 1947, Ostrom 1990, Baland an Platteau 1996, Sandler 2004) warn, be treated as a

general model for collective action analysis. The possibility of cooperation depends on how individuals value the good they are about to provide for collectively. If the individuals involved in the public good provision estimate the value of the public good to be lower than their private goods, their interaction will most probably result in Prisoner's dilemma scenario. If however the public good value for an individual is so high that he/she is prepared to provide for it even though others contribute nothing (but would certainly contribute less if others contributed something) then the interaction takes form of a Chicken game. Finally if the value of the public good for an individual is such that he/she would not provide for it alone but would contribute some if others contributed first, the game is one of Assurance (Taylor, 1976).

So far we have looked into so-called a one-shot games, in the light of there is no tomorrow scenario, but whether a game is played only once or repeatedly significantly influences the possibility of cooperation. Let us then see what happens when individuals exploiting a common interact and make decisions about resources on several occasions, or even indefinite number of times. When the game is repeated it is usually called a supergame. Supergame is simply a series of games where it is possible for the players to make decisions in accordance with earlier decisions of other players (Taylor, 1976). As we have seen if the PD game is to be played only once players would normally choose non-cooperative strategy. Even if the game is to be played twice the expected behaviour is the same. Situation however suddenly changes when the PD game is to be played repeatedly, especially for unknown number of times.

When interactions between individuals that use a common are repeated, the logic of what is individually rational suddenly changes. Since the payoffs gained from free-riding in the first round would eventually diminish as other players free-ride as well, it becomes more rational for individuals to cooperate and ensure a continued payoff for all. The logic of what is rational shifts perspective from one that favours current usage or consumption and immediate payoffs, to one of sustainable consumption and secure payoffs to be received in future (Sandler, 2004).

Socially optimal equilibrium in repeated games can be achieved under certain conditions, if the players go for so-called tit-for-tat strategy. Barrett describes this strategy as starting with cooperating and then 'do whatever the other player did in the previous period, while always punishing defection with defection.' (Barrett, 2003) The benefit of repeated games is players' opportunity to observe behaviour of others and recall their previous strategies. In that manner if

both players choose cooperation in the first round it is likely that the cooperation will continue in every round. Such cooperation is called conditional because it will happen only if the player to act first, the leader, initiates it by being the first to choose cooperation. Leaders therefore play a crucial role in conditional cooperation. It is further necessary that players do not know or ignore knowing that the interaction is going to come to an end. If the interaction is however finite, the number of games to be played is limited and players are aware that, it is again most profitable for an individual to free-ride in the last round of the game. Thus mutual non-cooperation becomes the only equilibrium (Baland and Platteau, 1996).

This scenario depicts most of the current environmental problems, including climate change. The key problem here is that benefits to be gained from interaction regarding use of natural resources, (for example limiting the overexploitation of certain resource) are in most cases not to be gained in the lifetime of individuals interacting in the current time period. Put differently, the main problem with managing natural resources is that it is not possible for the current generations to negotiate with the future generations, and it is not profitable for the current to do something about it. Taking measures to conserve resources may involve high costs while the benefits are to be gained in distant future. Developing institutions that would adequately affect the performance of economical and political systems so as to make cooperation beneficial is therefore the main task and the biggest challenge. In the words of Baland and Platteau such institutions would have to impose a payoff structure where choosing noncooperation is so costly that cooperation becomes the only equilibrium strategy.

Some efforts are made on the international level in form different form for international environmental agreements which I am going to look further into. I am however going to start with examining efforts made on the local level, by comparing conclusions of several researches that conducted studies about collective action capabilities in local settings. Thereafter I am going to compare the efforts made to address similar problems on international level.

8.0 Lessons to be learned from the analysis of local level common-pool problems

Elinor Ostrom studied the possibility of organizing collective action when providing for local public goods on cases of inshore fisheries, small grazing areas, irrigation systems and communal forests. She has found out that in some cases individuals managed to organize themselves to efficiently govern common-pool resources over longer time periods, while in others they have not. Comparing these cases provided an insight into key mechanisms and institutional arrangements that could lie behind successful governance of commonly owned resources.

The common characteristics investigated regarding the communities' success to govern natural resources were the following: Group size - how many individuals involved? Group homogeneity - how similar their interests are? How depended are the community members on the resource? The relationships between the members - have they developed a sense of living in a community? Do members trust each other? Have they managed to establish moral norms as mutually respected guidelines for behaviour? Let us first look at situations where individuals were able to organize themselves voluntarily to manage commonly owned resources and sustain their productivity and value without the involvement of an external authority.

8.1 The cases of adequately organized collective action

Regarding group size, the number of members involved has been stable for longer periods of time. That gave the members the opportunity to get to know each other and establish relationships that build on shared moral norms such as keeping promises, caring about one's reputation, and being honest and reliable. Their interests were further fairly similar as there were no great variations in ethnicity, race, knowledge or socioeconomic status. Since the members depended heavily on the productivity of given resources and counted on that the future generations of their families would as well, their discount rates were generally low.

Baland and Platteau likewise conclude that the repeated PD game has better chances of occurring in smaller groups where individuals know each other well, and can easily observe each other's behaviour. In situations where individuals interact with one another repeatedly and their actions

are visible to everybody else, they tend to develop common codes for good and bad behaviour, or in other words common moral norms. These norms make individuals motivated to care about their reputation and keep agreements agreed upon, which further lead to developing the feeling of mutual trust. In that manner individuals involved develop the 'feeling of sameness and togetherness' which is an important advantage of smaller groups (Baland and Platteau, 1996).

Baland and Platteau seem to support the argument that small and homogenous groups are generally more prone to cooperation, but they point out at the same time that group being heterogenic does not necessarily have to be a hinder to collective action. This is especially true in cases of economic inequalities when the rich or more powerful can take a leadership role and take initiative for organizing collective action. As we have seen in the terms of game theory, leadership role is especially important, as the presence of a leader is crucial to initiate and sustain cooperation in repeated games.

The communities have, on the basis of the above described characteristics, managed to establish institutions that helped govern the resources effectively. The rules for using the resources embodied in institutions were however not quite the same among the cases. That is according to Ostrom what lies at the hearth of success of these communities. There is no universal set of institutions that would when applied solve the problem of resources held in common. Each case is indeed unique in regard to the dynamics of a given resource, members' cultural views and their relationships. The cases she examined shared however some of the principles, such as defining resource boundaries and rules, members participation, monitoring, and sanctioning.

The first principle for organizing effective collective action in examined cases was to determine clear boundaries of given resource, and specify which individuals are allowed to use the resource. In that manner individuals involved did not risk that somebody else gains the benefits of their efforts. Second, the rules regarding resource use need to be created in accordance to resource characteristics. The communities in a given region have used slightly different rules to manage irrigation water shortage; some places water storage system has been used, while in other some sort of rotation system was more adequate. It is also important for these rules to be revised and adjusted in accordance to changing resource characteristics over time. No less important are the shared experiences and lessons learned from those in similar situations. Therefore all the

individuals affected need to get the opportunity to participate in rules creation and consider them to be fair (Ostrom, 1990).

Defining and establishing good rules does not however imply that the rules will be followed, which is why they have to be enforced. Even though the members of these communities like I said before shared the norms such as keeping promises and cared about good reputation, they have not managed to develop continued cooperation. Therefore institutions of monitoring and sanctioning needed to be introduced to prevent free-riding, and establishing such institutions is usually costly. These institutions have not however been introduced by an external, third-part authority in these cases, but internally by the community itself. Instead of hiring a third party or relying on the state, resource users managed to enforce the rules they used themselves, and punish those who broke them.

Ostrom also emphasises how important norms are for suppressing opportunistic behaviour. In an environment where there exist no shared norms, as for example keeping promises, each individual would expect all the others to free-ride all the time. It would be difficult to establish abiding commitments in such an environment, and expensive monitoring and sanctioning systems would have to be created. Baland and Platteau similarly stress the importance of shared moral norms that in successful local setting they examined served as effective tool for monitoring and discouraging cheating. In some cases breaking the agreed upon rules for preserving common resources was seen as the one of the worse offences to the community, which deserved severe punishment such as being excommunicated from the community.

Further, on the contrary to general view the costs of monitoring in the successful cases were low because monitoring occurred as a side product of well functioning rules established. The rules were set up so that the community members could use the resources in turns, and they were highly motivated not to be taken advantage of when their turn came. They therefore made sure to be at the place on time and ward off any previous users who were not willing to finish. The very presence of both users on the resource location at the same time was monitoring enough, and did not involve any additional costs. Once discovered and made public, rules violation would bring the individual embarrassment, loss of dignity and social status. Situations of broken rules and necessary sanctions were as a result in these cases rare.

Baland and Platteau acknowledge Ostrom's example of rotation system of access to fish resources as an example of well functioning decentralized ways of monitoring in small communities, but also stress the possibility of manipulation in such settings. Small communities are according to the authors prone to developing negative feelings of jealousy and rivalry that can further lead to unfair accusations and fail sanctioning. They therefore suggest that such situations state control and external sanctions may be preferable.

8.2 The less successful cases

Ostrom has on the other hand noticed that the cases of failed resource government in local settings had to do with the size and complexity of a given region, together with the number of individuals involved. In the cases Ostrom describes as failed a large number of individuals was involved. The community consisted of settlers who had little attachment to the land they lived on. Discount rates were as a result high. Their diverse cultural and ethnical backgrounds made it difficult to develop relationships of trust, shared norms and establishing the sense of community. Socio-economic differences between community members were in addition considerable. The regulation existed was imposed on individuals involved externally, rather than they took part in creating their own, internal institutions to govern shared resources.

Unlike above described successful cases, individuals in these settings did not manage to agree upon establishing effective institutions for governing their resources such as well functioning monitoring and sanctions. And as the size of the resource and the number of individuals using it increases so does the costs of controlling and sanctioning. But although the resource complexity and the number of people involved matter, Ostrom believes that commonly understood and accepted fact that doing nothing will cause harm to everybody, low discount rates together with low costs of regulating, and developed social capital are the main preconditions for successful common pool resources regulation.

In the concluding part of his study, Taylor similarly emphasises that increasing number of individuals involved makes the possibility of cooperation less likely. He acknowledges that organising voluntary collective action in larger groups is more challenging, especially because it gets more difficult to monitor the behaviour of others. Apart from the group being small, he nevertheless points out that the established good relationships between group members and

applying both positive and negative sanctions is a good recipe for successful cooperation. As he is criticizing the arguments for the necessity of the state to govern common resources, he sees the state a mediator in interactions between individuals. Individuals eventually come to be so dependent upon the mediator that they become unable to develop bonds and feeling of interdependence, thereby leaving little incentive for voluntary cooperation and altruistic behaviour (Taylor, 1976).

Taylor further distinguishes between two solutions for collective action problems, which he calls internal and external. By internal solutions he means possibility of spontaneous cooperation through altruistic behaviour or other internal sanctions like the feeling of guilt/shame for not conforming to a norm/performing one's duties, loss of self-respect. On the other hand by external he means establishing regulating institutions imposed by the state, some other external agency or selected members of a community. External solutions can further be centralized or decentralized depending on how decision-making is distributed among the members. Centralized solutions lie typically in the hands of few and are associated with the state, while decentralized solutions involve the majority of members and represent a community (Taylor, 1976).

He believes that if collective action problems are to be solved it is to be done through threats and offers of sanctions, either centralized or decentralized. In his work, *The Possibility of Cooperation* Taylor goes further into discussion of the necessity of a strong state to govern the commons, and together with many other researches (Ostrom 1990, Baland and Platteau) gives examples of successfully governed commons on local level without state intervention. He goes as far as to claim that the presence of a government hinders voluntary cooperation and altruistic behaviour as individuals become more dependent upon state.

I found a similar argument in Baland and Platteau who apart from examples of communities that succeeded in governing their resources self, also give examples of those who failed. Such resources, as for example local forests and fisheries, were regulated externally, that would say controlled by the state. Instead of letting local people find their own ways of dealing with problems of monitoring and sanctioning, institutions such as taxes, fines, subsidies and quotas were introduced. Valuable experience, knowledge and opinions of local people were not taken into considerations when making decisions, and the rules were rather imposed on local communities. Under such a regime community members started to look at their resources as

something owned by the government instead of something they owned self. That made it difficult for community members to identify themselves with the resource they used, and undermined their willingness to conserve them. Many World Bank supported projects that applied this centralized approach to governing local resources rather disappointed than made any improvement (Baland and Platteau, 1996).

While I agree that decentralized ways of governing resources proved to be much more effective than government control in various local settings, it rather seems that such success would not be repeated when applied on international scale problems. For the first, yes, states can be corrupted and still go for personal interests, but so can community representatives. Second, while local people are far better familiar with dynamics of resources their livelihood depends on than a central authority, the question with problems global in scope is how well the public is informed about the alarming environmental changes, and motivated to initiate action. Finally, as community members know each other better they have an advantage of better and cheaper monitoring capabilities than a central agency, as well as imposing sanctions more correctly. Relying on states to voluntarily report emission reductions on regular basis without being policed by a central authority is a risky business. The problem of monitoring is in the context of international issues, as we shall see, one of the greatest challenges for international cooperation.

I am in the later sections going to further look into what makes international cooperation difficult, as I examine what efforts to fight climate change have been made on the interstate level, and how well collective action is practiced when solving problems global in character. As we are about to see, one of the factors that make it difficult to get worlds nations to work together for a common goal is precisely the anarchical nature of the international system, and the lack of a central authority. It is difficult to achieve any efficiency without a central authority to force the states to participate.

So even though we have seen examples of successful collective action and common resources managed adequately on local level, global collective action by independent sovereign nations is much more challenging. The problems of commitment, monitoring and sanctions get even bigger on the international scale. Moreover, altruistic behaviour and moral norms seem to erode in capital-hungry societies, especially when resources become scarce. This scarcity only grows bigger as world's population reaches its peak and increases pressure on natural resources. With

no supranational authority to govern all worlds' nations, international law provides weak tools for enforcing cooperation to tackle the problems global in scope (Stern, 2006)

That implies that if we think of the world as a big international community we would have to rely on some sort of decentralized, self-enforcing solutions since we do not have one superior state or authority to impose sanctions on others. In other words, contracts between states – treaties must be self-enforcing. But how has this been working so far? Can decentralized mechanisms based on self-enforcing punishments be satisfactory on international level? The analysis local level cooperation and provision of local public goods laid the basis for understanding the strategies developed so far for the provision of international environmental public goods and cooperation. I would further like to focus on international environmental treaties as institutional arrangements used to enhance global collective action to fight environmental problems, particularly climate change.

9.0 International collective action

9.1 How is global collective action different from local?

The collective action theory has been widely used as a tool for analysing interactions between countries in international affairs and international cooperation. All the collective action principles presented so far also apply on international system, where sovereign states are the main actors. Interactions between states in the international system are governed by the principal of reciprocity that rewards the behaviour that contributes to the group's wellbeing, and at the same time punishes the behaviour that pursues individual interests and has detrimental effect on the group (Goldstein and Pevehouse, 2014). However, just like individuals in the local settings, every country would profit more as a free-rider, and would rather the others take the burden of providing for the common public good.

States operate in a system in which they influence each other's behaviour and actions, where the results of what one country does are dependent on what all other countries do. Emissions that arise from economic activities in one country do not recognize political borders, but rather travel

around the globe and damage all countries (Sandler, 2004). Such situations are in the economics named transnational externalities, or transnational public goods. Sustainable natural environment and the global climate stability are examples of global public goods. These transnational disadvantages and benefits cross countries borders and generations, and contrarily to most local commonly owned resources there is no way of restraining access to them. Every single country emits greenhouse gases, similarly as all the countries would benefit from unpolluted atmosphere. Other examples of transnational public goods and externalities are acid rain, loss of biodiversity, peacekeeping, disease control etc.

A nice illustration of the difference between domestic and transnational externalities and public goods I found in Barrett (2003). The domestic ones can, as he puts it, be corrected by the state while dealing with transnational would require efforts of at least two states. Similarly transnational public goods and externalities cannot be dealt with through local community action, they require cooperation between governments. Most of the environmental public goods are therefore managed through international environmental agreements. Countries make decisions on the basis of other countries' contributions, and what is rational for one country depends on the expected actions of other countries. Only if large enough number of countries agrees to comply with an agreement, will a given country decide to contribute itself. Whether a country would contribute or not depends also on socio-economic conditions within each country, the structure of costs and payoffs involved, and the nature of the public good in question (Montero and Perrings, 2011).

Unlike local settings where individuals as community members take part in creating the rules of the game, states are collections of individuals who take part in a treaty negotiation process as represented by their governments. Every state in the world is a part of the international system, where states have absolute sovereignty over their citizens within their borders. However, unlike individual states that are run by their governments, there is no overarching world government that could run the whole international system and enforce agreements between countries. Moreover, on the contrary to domestic affairs, international law gives states much more autonomy than domestic law in a country gives to its citizens. Further, the decisions of the International Court of Justice are not binding, and cannot be enforced as the international system lacks a centralized authority (Barrett, 2003). That is why the primary means of governance in the

international system are international agreements or treaties. Due to the nature of international system treaties must be self-enforcing, and abiding to them is voluntary.

Some realist thinkers however believe that the only way to preserve order and stability in the international system is the existence of a global hegemony, a single state that would be the dominant world power (Burchill, 2009). The US would obviously be a good candidate, with enough power to sustain cooperation by making other countries contribute. But being a hegemonic state can be both difficult and detrimental. Influencing the behaviour of other states is not always possible, and what is in the interest of the United States is not necessarily in the interest of the whole world. Apart from the Montreal Protocol where the US took the leadership role, US as environmental hegemony has not helped too much regarding the success of other environmental treaties (Miles et al, 2002).

Even though Elinor Ostrom showed us that in some cases of locally managed common resources state intervention can be detrimental, I agree with Barrett that the agreements enforced by a third party tend to be more successful. Otherwise we would not have so many institutions such as courts, the police and jails that effectively regulate our daily lives. Even if the state does not intervene, just the possibility that it might do can also change behaviour (Barrett, 2003). Such an authority does not however exist in the international system. With the principle of sovereignty and no supranational authority to govern all the worlds' states, the international system is described as anarchical. Though there exist supranational organizations such as United Nations, World Bank, International Monetary Fund, NATO, and the EU with their respective sub-organizations, states are not legally bound and often not willing to surrender their sovereignty to such organizations. That means that all the efforts to fight common problems are voluntarily based, and the treaties states potentially sign would have to be self-enforcing. International community nevertheless relies upon multilateral institutions and treaties or a leadership by a dominant nation to govern the dangers of environmental changes.

9.2 Environmental treaty-making; how do international environmental regimes work?

9.2.1 Global environmental politics

Environmental issues emerged in 1970 in international politics as a problem of collective action, putting pressure on governments to find ways to cooperate and decrease pollution and resource depletion. The use of natural resources and environmental problems became part of the international politics in 1972 at the Stockholm conference held by United Nations, but it is in the second half of the 20th century that concern over environmental degradation came to be fully recognized and eventually became part of decision-making processes (O'Neil, 2010). The use of globally shared natural resources is typically regulated through global environmental governance.

Global environmental governance is based on cooperation and consists of international environmental agreements. These agreements are in the literature referred to as treaties, conventions, protocols, covenants, compacts, agreements, charters and acts (Barrett, 2003). This variation usually signals different stages in the negotiation process. Global environmental governance involves adopting regimes and meeting obligations, but also developing new rules, organizations, norms and decision-making skills when dealing with environmental issues. Put differently we can say that global environmental governance is about establishing and constantly adjusting institutions to improve sustainability and longevity of natural resources. One can get a better understanding of how environmental governance works by looking closer at the process of making a regime.

Commonly cited definition of a regime is one by Stephen Krasner, who describes regimes as set of principles, norms, rules and decision-making procedures upon which actors agree to regulate a specific area of issue in the international arena. A regime can consist of several different agreements, as for example the biodiversity regime includes Convention on Biological Diversity, World Heritage Convention, Convention on Migratory species, Convention on International Trade in Endangered Species with other (O'Neil, 2010).

International regimes are created through the process of multilateral agreements. In order to get states representatives to gather around negotiating table, anticipated outcomes of the negotiations must be seen as positive. In other words, states would not participate in any negotiations if they are not convinced that they would otherwise be better off. Negotiation happens in stages. The

opening agreement is usually called framework convention, where the emphasis is on understanding the problem, and directions of future negotiations are outlined. No specific obligations for states are given in a framework convention, and it serves more like a guideline for further action.

Negotiations on environmental protection are however difficult and time-consuming due to conflicts of interest, values and priorities of the actors involved. If the negotiation succeeds the next stage in the process of creating regimes is usually establishing binding agreements. The most common type of binding agreement for global environmental issues is a convention or a treaty. Treaties are documents that define rights and obligations that are binding for the states that sign them. Examples of such obligations are reporting requirements, emission reduction targets, technology transfer mechanisms and plans for the future of the treaty regime. Such obligations are binding to the states that signed the treaty, and they are called hard international law. On the contrary, non-binding agreements are known as soft law and are used as guidelines for behaviour (O'Neil, 2010).

For the treaty to enter into force signatory states need to ratify the treaty by implementing and enforcing these rights and regulations domestically, so that they become part of their domestic law. This is the hardest part of the negotiation process. Signing an agreement in itself does not legally bind the state to ratify it. States can still, due to the principal of sovereignty and the anarchical structure of the international system, sign treaties without intending to comply with them, and leave the treaties they ratified without any formal punishment. States cannot be required to sign agreements, nor can they be forced to appear before international courts and tribunals for breaking them (DeSombre, 2007, Hovi et al. 2013). In that sense a country's decision to participate in a treaty is voluntary. After a convention is established, the regime is strengthened by a more detailed agreement, usually called protocol. Protocol includes more specific information on the norms and rules that are going to be applied, with concrete goals and targets that signatory states need to meet. (Chasek et al, 2014). The convention-protocol model was first used in acid rain management negotiations, and later applied to ozone negotiations. The Vienna Convention was followed by Montreal Protocol, where the convention simply identified the problem, while Montreal Protocol determined specific targets for reducing CFC production. After the agreement has become a part of the domestic law the means of implementation such as

quotas, tradable permits, taxes, product regulations and further voluntary agreements are discussed in detail. The treaty model was further changed in 1994 Oslo reformation. A new mechanism was introduced that allowed states to reduce their emissions jointly, by trading their excess emissions with other states that polluted less. This mechanism was called joint implementation (Barrett, 2003).

These stages in the negotiation process can however take long time. For example the 1985 Vienna Protocol for the Protection of the Ozone Layer was after two years followed by 1987 Montreal Protocol on Substances that Deplete the Ozone Layer (O'Neil, 2010). And in the case of wildlife protection, until 1970s none of the treaties for wildlife conservation implied binding commitments, until 1973 Convention on International Trade in Endangered Species of Wild Fauna and Flora (Chasek et al, 2014).

After the regime has been adopted, the signatory states, together with interested observers, meet every one to five years at the Conferences of the Parties (COPs) to discuss the effect and further development of the regime. Regimes usually have a secretary that organizes these conferences, while it also supervises negotiation process and states' compliance after the treaties are signed, ensuring that regimes are properly implemented. However, apart from the Montreal Protocol, not so many treaties require reporting treaty compliance information, while very few include enforcement mechanisms to handle non-compliance (Miles et al, 2002, Barrett, 2003). Before I go further to explain the main actors in the treat-making process, I would like to say a few words about what is meant by self-enforcing treaties.

9.2.2 How can a treaty be self-enforcing?

A treaty can change the incentives of the players in the game. In other words, a treaty can, by changing the governance structures, transform the game so as to make cooperation between states a desirable strategy. A treaty changes the governance structures by changing payoffs and thereby modifying state behaviour (Montero and Perrings, 2011). For example the outcome of a PD game can be changed by introducing a fine for non-cooperative behaviour. If two players agree that the one that plays Defect must pay the other a fine, the payoff structure changes. If one player defects and the other one cooperates the standard PD payoffs suddenly reverse, making cooperation desirable strategy no matter what other player does. In that sense the dilemma is

overcome (Barrett, 2003). Now, introducing a fine and enforcing such an agreement would work just fine when regulating domestic problems, as the government in a given country has the power to enforce such agreements. This problem is however much more challenging in the international system, where such an authority that could enforce agreements between countries is absent.

Another example of restructuring the game suggested in the literature is introducing side payments. If countries make an agreement that those who gain most out of the agreement pay the losers as a way to compensate for their efforts, every country would be motivated to cooperate and maximize shared profits. Such an agreement however still needs to be enforced or the countries that gain most would otherwise have an incentive not to compensate the losers (Aldy et al, 2003).

Another attempt to make cooperation more attractive in a system without central authority is the allocation of transferable property rights in emissions, or in other words emission trading. This system allows countries that agreed to reduction commitments to trade their emission rights. Countries able to reduce emissions more than the required levels can sell their extra rights to pollute. In that manner countries that do not meet the emissions reduction requirement can then buy the right to pollute more. The great benefit of allowing buying and selling emission rights proved to be useful for minimizing the total costs of reducing emissions. It has however not been so effective to actually reduce emissions and has mainly contributed to their relocation. Many countries refused to use this system because of the lack of secure property rights in emissions and the uncertainty about developing a well-functioning emissions market (Cole, 1999). The economic value of the rights to be traded is low because states voluntarily engage in agreements and can, due to the anarchical nature of the international system, leave an agreement at any point of time.

9.2.3 Actors in the environmental policy and governance

Since the main characteristics of environmental problems are complexity, uncertainty and long time horizons, governing environmental risks has not been an easy task. Although states are the primary actors in the international system and their role in creating and governing international regimes is essential, they are certainly not the only ones. Many different kinds of actors are engaged in international environmental politics and governance, and looking into their roles, activities and interactions would help us better understand why it has been so difficult to address

global environmental change. Actors taking part in environmental governance are multiple, and besides national governments include intergovernmental organizations, treaty secretaries, expert groups, non-governmental organizations and corporate sector.

As states are the only actors with sovereign authority and power to enforce regulations on their population, they are still the most important actors regarding creation and implementation of regimes. States can though have different goals and interests, and can therefore play various roles in each issue. They can lead a regime, support it or oppose it. What role a state would take depends usually on the situation of domestic politics, the costs-benefit analysis of the regime in question and the effect on country's global image in the international arena (Chasek et al, 2014).

While every nation has similar preferences regarding environment exploitation, their willingness to protect it differ from case to case. Everyone would benefit from protecting the environment, even if they do not put any effort themselves. Similarly to local settings, the agreement between countries needs to be perceived as fair. The ongoing debate between Northern and Southern countries about who is responsible and who should take the primary initiative for environmental protection is prolonging treaty negotiations, consuming the precious time for taking action to address the problem itself. Similarly to local settings countries taking part in agreements are highly concerned for the fairness of a given agreement. The big question for developing countries is who will pay for the global environmental problem solving. Developed countries, on the other hand, cannot bear the burden alone.

Intergovernmental organizations (IGOs) are established by states. Their main role is to manage international problems, providing scientific information to states, and implementing and monitoring binding policies. They can also provide financial support for development and environment-protection projects (O'Neil, 2010). A specific type of IGOs are treaty secretaries which are established by the treaty to manage daily activities of the of the treaty regime. Secretaries arrange meetings of the Conference of the Parties, analyze available information and prepare reports, give guidance and monitor compliance with treaty obligations (Chasek et al, 2014).

Given the complexity of environmental problems, scientific and expert knowledge plays a major role in global environmental governance. It is the information provided by scientific

communities that identify environmental problems such as climate change, thinning ozone layer or biodiversity loss, making the decision-makers and public aware of the scope of the problems. Scientific knowledge is incorporated in the regime creation process in form of panels. Panels bring new knowledge to regime negotiations, and become part of policy recommendations. The best known example of such a panel, even awarded with a Nobel Prize, is the Intergovernmental Panel on Climate Change. It is an organization of 3 000 scientist who published scientific information about the causes and impact of climate change since 1988, and helped both the policymakers and the public understand that the changes in climate are human-induced (O'Neil, 2010, Hovi et al. 2013).

Scientific knowledge must be objective, and should not be shaped by any political context. There are though many that question the scientific knowledge legitimacy claiming that it can be a subject of manipulation due to national interests or lobbying by economic interests, bringing the element of uncertainty to it. Uncertainty is a huge hinder to the interstate cooperation.

International community has therefore agreed that in the cases of uncertainty precautionary principle is going to be applied when addressing environmental problems. This principle suggests that scientific uncertainty should not prevent measures taken to prevent environmental degradation in the cases of threat of permanent damage (DeSombre, 2007). Even though this principle has not become a part of customary international law, evidence exist that it has been applied among international environmental regimes (Miles et al. 2002). The example of the Montreal Protocol showed that cooperation was possible to sustain even though the uncertainties about the potential actions and outcomes were present (Barrett, 2003).

Further, reliable scientific knowledge is specifically important as it can be used to shape the public opinion and make the decision-makers take necessary actions to deal with the problem. It can inform about consequences, help change beliefs and attitudes and encourage adequate action. Political entrepreneurs have a big potential in persuading and changing beliefs, as well as they are in such position to have both the power and necessary resources to lead to appropriate action. When choosing cooperation they act as role models for good behaviour, who powerfully influence people's sense of responsibility and doing what is right. Proper leadership is very important for conditional cooperation in game-theoretical terms as we have seen it is the main precondition for sustained cooperation.

The number of non-governmental organizations who take part in addressing international environmental issues has been constantly increasing for the last four decades. For example number of NGOs participating in 1972 Stockholm Conference was about 400, while around 40 000 NGOs participated in The World Summit on Sustainable development in 2002 (DeSombre, 2007). One of the major roles of environmental NGOs is informing and raising awareness about environmental problems, both domestically and globally. Apart from that they influence environmental regime creation by attracting press attention, supporting regime ratification and implementation by monitoring actor's compliance, and facilitate implementation in developing countries. They can also lobby governments to make them take more action to solve the problem, or organize consumer boycotts to put pressure on corporations and private sector (Chasek et al, 2014).

One of the advantages that NGOs have, compared with state actors, is that as DeSombre puts it "they do not share the time horizons of politicians, who primarily think of the next election". Non-governmental organizations chose rather to influence citizens of particular states to put more pressure on their own governments than trying to get governments to negotiate with governments (DeSombre, 2007). As the most of the world's governments are democracies, this tactic should make sense. One of the NGOs that has been especially influential in environmental politics is the International Union for the Conservation of Nature and Nature Resources (IUCN). Together with Worldwide Fund for Nature (WWF) and Ozone Action, IUCN had a big influence on actions taken to protect wildlife and ozone layer.

Finally the role of private actors such as firms, corporations and business has been the most debated one, as this sector is primarily responsible for resource extraction and pollution, and enforcing environmental measures would affect their economic interests directly. They can, according to their interest, and using their financial and technical resources and access to decision-makers, influence the development of environmental regimes both negatively and positively. Powerful corporations can fund the research so that it suits their interests, influence public opinion through advertisement, and lobby governments to support their interests (O'Neil, 2010). As they refuse to include pollution prevention measures in their cost-benefit analysis, corporations usually oppose environmental policies that would put extra costs on them. There is indeed evidence of businesses working against environmental regimes, such in cases of ozone

and whale protection, climate change mitigation, and disposal of hazardous wastes, and fisheries regulation (Chasek et al, 2014).

There is on the other hand evidence of corporations supporting environmental regimes, but only when they were able to see some positive/profitable outcomes, or at least no additional costs. We can see such developments among insurance companies for example, who are becoming more concerned about the damage caused by climate change and extreme weather conditions. Other examples can be the corporations willing to accept voluntary eco-labelling or certification to show their positive attitude to environmentalism. Such measures are usually taken as a result of corporations constantly experiencing pressure from both their governments, and not least international community (Envoldsen, 2005).

9.3 International action to mitigate ozone depleting substances and greenhouse gasses

Writing a treaty however is the easier part of the job; creating institutions that get countries participate and comply with treaty obligations is what has been challenging. The question of how to get the protocol implemented and deal with non-compliance still remains unanswered for the Kyoto negotiators, as well as for many other unsuccessful international environmental treaties.

Still, in some cases where the submission of states authority required was not so great and the gains obtained from it were high enough, states managed to cooperate with no big complaints. Such cases illustrate that collective action is under some conditions possible on the international level (Sandler, 2004). One such case can be the Montreal protocol, which is known as the most successful example of international collective action so far. Many have thought that the Montreal Protocol can serve as a model for other treaties, especially Kyoto Protocol, but as we shall see that idea was not quite right. Even though both ODSs and GHGs are in a sense similar, as they are both atmospheric pollutants, the collective action required to solve these problems is not. And although we can learn from other treaties' failures and success, as we have learned from the local settings, each treaty must be unique and carefully designed to adequately address the nature of the underlying problem. But before begin telling the story about the difficulty of climate change negotiations let us first look at the success story of the Montreal Protocol.

9.3.1 How did the Montreal Protocol succeed?

Among the numerous agreements designed to tackle environmental issues in the last decades the Montreal Protocol is the most successful one yet achieved. Indeed the agreed emission cuts were met, the ozone layer is now on its recovery path, and is expected to reach its preindustrial level by 2100. After the Montreal Protocol proved to be a great success, many thought it should serve as a model for other environmental treaties. Such success has however not been widely repeated while dealing with other environmental issues.

The main purpose of the ozone layer is to protect the earth and its living organisms by absorbing harmful radiation of the sun. As it gets thinner due to human use of ozone depleting substances (ODS) so does the risks of extinction of species, skin cancers, immune system deterioration, and cataracts (Sandler, 2004 Barrett 2003). As not a single country would be spared, while every country would benefit from protecting it, the ozone layer is in that sense a non-excludable and non-rival good. As we have seen from the analysis goods dynamics, this is the most difficult goods category to manage, mainly because of the problem of free-riding. Now, how did the global community prevent free-riding in the case of ozone depletion? What is so special about Montreal that made it succeed, while many other agreements failed? Let us now look what has been emphasized in the literature as a key to the Montreal protocol success.

Firstly, the number of ozone depleting substances (ODS) emitters was small. Just twelve countries were responsible for 78% of all emissions (Sandler, 2004). As we have seen from the local resource management analysis, the size of the group is an important matter according to collective action theory, and a group being small is favourable to the cooperation. Second, no country would gain from disappearing ozone layer and increased radiation. Quite contrary, the increased radiation posed a risk to public health. The major benefit from protecting the ozone layer was the number of illnesses and cancer deaths that would be prevented had the agreement succeeded. It was predicted that this number is high as 245 million cancer cases, and more than 5 million cancer deaths, that would occur due to radiation exposure by the year 2165 (Barrett, 2003).

Third, the quick discovery of substitute substances and favourable market conditions made it possible for producer countries to gain from decreasing ODSs production. The benefits to switch

to substitute substances proved to be higher than costs, even if acting alone. The net benefits for the United States alone were estimated to be 3 554 billion \$US at the year of 1985, and the costs of implementing Montreal were low (Barrett, 2003). The United States as the major producer therefore took the leading role in phasing out ODSs, and made others comply. US leadership role as a major producer of ODSs in the case of Montreal Protocol many believe (Sandler 2004, Barrett, 2003) was crucial, as efforts by some other small polluters would not bring about the same effect. The developing countries were further supported by industrial ones, as they covered for the developing countries' additional costs of phasing out CFCs.

Finally both the risks imposed by damaging the ozone layer and the benefits from protecting it were easily observable both for the public and decision-makers. The health concerns raised by the negative impacts of increased radiation were in the centre of the public attention. The effects of protecting the ozone layer are both short and long term, as we are already receiving the benefits of the efforts taken, and will do so in the future.

In the game theoretical terms the participation in Montreal protocol could reflect a kind of a chicken game. Strategic moves made under the Montreal Protocol seem to have the structure of chicken game, as a response to a common threat and threatened survival. Each country would prefer others to take the burden and carry the costs of mitigating ozone depletion, but neither would risk its population being wiped out by horrible illnesses. As soon as humanity got threatened by and seen cases of nasty medical conditions caused by radiation coming from holes in the ozone layer, the action has been taken. Crisis conditions tend have positive impact on international cooperation, which can be seen in the cases of joint efforts to fight against terrorism and spreading various epidemics (Sandler, 2004).

Would the same effect be achieved had the Montreal Protocol never existed is difficult to say, but many authors think that cutbacks in ODSs would have occurred even without an agreement. Sandler for example acknowledges that the Protocol enhanced cooperation as it allowed more time for the developing countries to comply, and threatened trade restrictions as punishment for non-compliance. Hovi et al. give examples of taken measures to curb climate change even in the absence of an international agreement, but point out that such measures are usually not sufficient.

9.3.2 Did it work for the global warming?

Another at the first sight similar global public good, mitigation of the climate change, has been negotiated under the Kyoto Protocol. Unlike the Montreal Protocol, the Kyoto Protocol for climate change 1997 has not yet entered into force. Despite negotiating for more than two decades, little progress have been made on cutting down on greenhouse gas emissions (GHG). According to World Metrological Organization (WMO) the GHG concentrations in the atmosphere reached a new record in 2013 and are expected to continue increasing. Global CO₂ emissions were in 2013 2.3% higher than in 2012, and 61% higher than in 1990, the Kyoto Protocol reference year (www.wmo.int). As reported by Global Carbon Budget released in September 2014, growing CO₂ emissions in 2013 were dominated by China that was responsible for 28%, The United States 14%, the EU 10%, and India with 7%. The emissions continued to grow in all of these countries other than EU that managed to reduce emissions by 1.8% (Global Carbon Budget, 2014).

Despite the success with addressing the ozone depletion problem, little has been done to address global warming. The greenhouse gases (GHGs) layer in the atmosphere has the opposite effect. As it prevents the radiation from the sun to be reflected back to the space, it thereby increases the mean temperature on earth. The advantages with reduced GHG emissions are both non-rival and not excludable. Effects of reducing atmospheric pollutants would spread to all countries, and one country's consumption of cleaner atmosphere does not limit it for others. It is also not possible to exclude non-contributing countries from benefiting. The negative effects of growing GHG emissions in the atmosphere and changing climate are many (higher temperatures, weather extremes, changing landscapes and habitats, rising seas, loss of species, economic loss to mention only few) but very few of them directly visible. Even though the effects of changing climate can be seen around the world today, the impacts would be much more severe for the coming generations.

To begin with, unlike thinning ozone layer, the layer of greenhouse gases getting thicker does not pose such severe or direct threat to present generations' health. Nor can the benefits from tackling the problem be collected from the present generations who have to invest in it, as CO₂ remains in the atmosphere much longer than ODS (Sandler, 2004). In that sense, present generations' efforts to reduce current emissions while at the same they earn very little back,

would then be an act of pure altruism towards future generations. However, scratching your back without the possibility of you scratching mine seems a rather gloomy scenario for the likelihood of altruistic behaviour.

Second, the cost-benefit ratio for fighting against climate change is not nearly as profitable as for phasing out CFCs. Even though the economics of ozone protection policy gave United States and other countries strong incentive to participate, that was no case when curbing CO₂ emissions. As we have earlier learnt from the game theory, the negative cost-benefit ratio leads to dominant strategy of non-cooperation. The US economic advisers estimated that mitigating climate change by the year 2100 would cost the United States between 800 billion and 3.6 trillion \$US. The costs are thus estimated to be 35-150 times higher than mitigating the ozone layer depletion (Barrett, 2003). The US considered an agreement that did not require the developing countries to contribute to emissions reduction as unfair and damaging for the US economy. It thereby withdrew from the Kyoto Protocol in 2001. Due to exemptions granted many developing countries, including China and India which are among major polluters, the US has no interest to participate. Canada followed in 2011 claiming that goals set up by Kyoto are impossible to achieve without US and China in board (Hovi et al, 2013). The major GHG producers are still not willing to sign the protocol. Lacking support of the biggest polluters significantly slowed down the Kyoto Protocol negotiation process, which is up to present day still in progress.

Third, unlike ODSs whose cutbacks affected relatively few activities, reduction in GHGs, and especially CO₂, would imply radical changes in every countries economic activities. To substitute away from fossil fuels is certainly much more challenging and costly than finding substitutes for ozone depleting substances. Again to the contrary to most other environmental problems that do countries damage, some of them can actually benefit from a warmer climate, at least in short term. While warmer climate in some parts of the world (generally the poorest) brings losses in biodiversity and agricultural yields, melting ice can bring higher agricultural yields and easier access to fossil fuel resources in other (mainly richer). Such nations are commonly less willing to adopt incentives for reversing globally negative consequences of climate change.

Further, scientific knowledge regarding climate change is somewhat uncertain when compared with the ozone depletion case. Holes in ozone layer were clearly created as a consequence of

human activities, while changes in the atmosphere as heat waves and cold waves took place several times through earth's climate history. This introduced a dose of scepticism about human induced climate change, and additionally slowed the negotiation and mitigation processes.

Then again the strong leadership role is absent in the case of Kyoto Protocol. At the very beginning of the Kyoto negotiations the EU were eager to put new proposals on the table and commit strongly. As it expanded eastwards, the new members were reluctant to accept strong climate policy, and internal conflicts drew EU away from taking leadership role to fight climate change. Now again, in October 2014, EU has adopted ambitious climate policies by agreeing to reduce domestic greenhouse gas emissions by at least 40% relative to 1990 level, by 2030 according to 2030 Framework for Climate and Energy Policies (ec.europa.eu).

Moreover, what has been perceived as fair under the Montreal Protocol has however changed under the Kyoto negotiations. That the industrialized countries must take the main responsibility for the most CO₂ reductions has not met the same acceptance as in the case of reducing ODSs. As the costs of reducing CO₂ emissions increase rapidly with time and many developing countries' economies are continually growing, the notion of what is fair has changed. For an international agreement to be successful it has to be perceived as fair by all the countries, developed, underdeveloped and developing. However, historical emissions responsibility varies greatly among countries. Historical responsibility has become a huge debate between industrialized and developing countries that has significantly slowed climate change negotiations. The dispute has been most notable between the US and China where China refused to commit to GHG reductions until developed countries, namely the United States, takes on emissions commitments. The US on the contrary refuses to sign an international climate agreement that exempts huge GHG emitters from the developing world, namely China (Hovi et al. 2013).

Finally, regarding the emissions distribution and the size of the group in the case of climate change negotiations Hovi with colleagues comes with an interesting insight. Even though virtually every country in the world emits GHGs, only seven countries were responsible for 73% of the total CO₂ emissions in 2008. Of those seven only two were responsible for whole 42% of the global CO₂ emissions, namely the US and China. 42% is a large share, which means that the efforts of only two countries could have a huge effect on curbing the global CO₂ emissions. Since both US and China are at the same time world's leading economies they would have

enough power to make other countries join. If the US and China could somehow join forces then the problem of the group size would be overcome (Hovi et al 2013). Unfortunately an agreement like that has never been achieved between the US and China. This also illustrates Barrett's point that for some collective action problems even when number of players is not too large and the game is repeated does not suffice to achieve cooperation.

As we have seen from the analysis of local resource management, there is no universal solution that solves the problem of resources held in common. The same applies here. While something can certainly be learned from the Montreal Protocol the dynamics of the public goods Montreal Protocol and Kyoto are trying to regulate are simply not the same. Montreal is an example of how adequate institutional innovations can transform a game with a PD structure into one of successful collective cooperation. The strategy to trade restrictions (negative incentives) together with instituting cost-sharing and creating a multilateral fund (positive incentives) to facilitate developing countries' participation made what first was failed cooperation into successful one (Sandler, 2004 Barrett, 2003). The Kyoto Protocol has not managed to transform the game and modify state behaviour. What it did was only to specify targets and timetables for addressing the climate change.

To summarize the global warming problem is much harder challenge than ozone depletion was, and requires improved institutional solutions. Those institutional changes would have to slow down economic activities and impose limits on this ever growing system of ours. But how we establish such a system in a competitive world (than not very different from animal world) that has, may I say, since the industrial revolution been obsessed with economic growth, still puzzles us. It is however certain that economics of the ozone protection policy played a crucial role in shaping the negotiation process. It seems that positive cost-benefit analysis was the key to Montreal success. Apart from that was the deadliness of the ozone depletion itself, which is not that high in the case of a warmer climate. Not yet.

9.4 What can improve global collective action?

As we have learned from the game theory, the possibility of game being repeated influences greatly the chances for cooperative outcomes. We have also learned that it is essential that the game is repeated for unknown number of times, or that the players do not know when the game

ends. Apart from the game being repeated and infinite, transparency and monitoring are just as in local settings crucial factors for maintained cooperation between countries. However, an endless repetition of the game itself is not enough to sustain long-lasting cooperation, and every country would free-ride on the signed agreement when given a chance. Several institutional changes that can restructure the incentive system and make states willing to cooperate regardless what other do have therefore been introduced in the literature. They are sometimes effective, but they also have some weaknesses.

Many authors mean that each treaty must provide for both positive and negative incentives, or in other words introduce mechanisms for both punishments and rewards to make cooperation dominant strategy. The main message of the Scott Barrett's *Environment and Statecraft* is exactly that treaties must include both positive and negative incentives to give the countries reason to contribute to providing for a greater good. The losers must be compensated and the breakers of the rules punished. That can be achieved by combining trade sanctions and financial assistance to developing countries for their participation, in form of multilateral funding and side payments. The negative side of introducing punishments and rewards is the problem of the so-called second order dilemma, because providing for the new rules likewise requires collective action, and is just as difficult as providing for the public good itself.

Additionally, cooperation may fail because punishing the non-contributors is often very costly for the co-operators to implement, which makes them reluctant to punish the defectors. Trade sanctions for example hurt the countries that impose them in the same way as they harm the countries to be punished for non-compliance (Barrett, 2003). The trade restrictions in the case of the Montreal Protocol made ODS substitutes economically attractive on the market, and accelerated the process of developing the substitutes. Even though it is not possible, banning all the products whose production emits CO₂ would imply stopping almost all economic activities for all the world's countries, and would according to trade officials be extremely distorting for the international trade regime (Esty and Ivanova, 2003). Sanctions can also take other forms such as stopping development assistance or exclusion from a collective security pact (Aldy et al, 2003). Some analogy to local settings and people being excommunicated from the community losing their status and prestige can be seen here (Ostrom, 1990)

Sanctions in form of trade restrictions may however not be encouragement enough for the big economies with large and growing domestic markets to support cooperation. Another institutional suggestion to enhance cooperation is arrangements such as side-payments and cost-sharing. While Sandler sees splitting the costs of providing for a public good as a more practical and effective institutional solution that does not, on the contrary to sanctioning, require presence of a strong authority and where the large number of participants is actually to advantage (the more countries involved the lower the cost each needs to cover), Barrett sees this as problematic. He claims that as long as states are free to choose whether to sign the agreements or not, cost-sharing is not going to be effective arrangement for sustaining cooperation.

Regarding the compensation for participating in an agreement, side payments alone according to Barrett have little effect on collective action. While the payment recipients become more willing to participate, the payoffs for the donor countries decrease, making them less willing to participate. He concludes that for the side payments to have a positive influence on cooperation of the states involved, states must, as he puts it, be highly asymmetric. Barrett shows us how differences between the payers and the receivers, as in terms of how they are affected by a given environmental problem and their capabilities to deal with it, can have a positive effect on cooperation. Even though this was the case for the countries involved in Montreal Protocol negotiations, side payments should not be thought of as a remedy for the problems of international cooperation.

10.0 Conclusion

To conclude one could say that the problem of unsuccessful multilateral treaties that address global issues lays in the unwillingness of sovereign states to hand over their autonomy to international institutions and agreements. The dominant non-cooperative strategy presented by game theory also stands when applied to analysing interactions of the states in international affairs. Game theoretical assumptions in that sense follow the tradition of the realist approach to international relations. States as main actors in the international community will remain to perceive multilateral treaties as surrendering their sovereignty to supranational institutions, and

object to them, as long as benefits from such an act are lower than costs (Sandler, 2004). We have seen that under some circumstances institutional changes can suppress free-riding, making benefits from contributing lower than costs, as in the case of the Montreal Protocol. Such changes were not sufficient to alter state behaviour sufficiently in many other cases, the Kyoto Protocol being just one of many examples.

So how do we establish a mechanism that both allows for great economic activities and at the same time reduces the negative impacts on the environment in such a complex international system? What does it take institutionally to construct an economy that is less dependent on carbon? Would a non-carbon economy imply only technological changes, or is it also an institutional question? It seems to me that a system with economy based on competition, where states are main and independent actors primarily interested in growth, is a system that is more or less unable to take into account the problems of resilience. If dynamics of a given system is growth, such a system is in a sense doomed, as growing per definition ends at the point where the system breaks. Technological change would allow us to continue on the growing path for some more time, but it is difficult for me to see how we are in the future going to be able to actually maintain the kind of economic structures we now have, within the boundaries of the natural environment.

This is a very radical position for sure, but the world's biggest economies first moves made towards greener economy indicate the seriousness of the problem. The risks and the costs of handling possible permanent damage are real as the quicker the system grows the bigger the chance of getting out of the boundaries, and facing possible irreversible destruction. Insurance against such a scenario would be to put all efforts into growth of those who need it, and then stop growing or even retract in the rest of the economy. Understanding what kind of alternative institutional design would be needed to slow down economic growth and at the same time preserve the relatively harmonic climate in the international society, is a deeply intellectually demanding task. Some more radical measures would have to be taken to construct a system that would get individual decision-makers act in such a way that takes into account the side effects of their actions.

The efforts made by the world's nations to reverse the negative impacts of climate change have so far been insufficient. It will be interesting to see whether a change in moral norms and values,

a leadership by a dominant nation, the more strict sanctioning system or some other, novel institutions and financial arrangements are going to succeed in restructuring the relations among the world's nations, and curb the incentive to free-ride in the future. The time will tell whether new EU commitments to stabilize emissions are going to come to life, make the EU an international leader on climate change mitigation, send positive signals to other big economies and the rest of the world, and induce cooperation. With the latest news that US and China finally agreed to commit to emission reductions, the fate in the Kyoto Protocol seems to be coming back. It will be interesting to see how the progress to avoid dangerous climate change is going to develop on the upcoming Kyoto meeting in Paris 2015, and whether the United States China can adopt policies to suppress their emissions growth.

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