APPROACHES TO THE ECONOMICS OF CLIMATE CHANGE: A SURVEY OF LITERATURE

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ABSTRACT

This paper is aimed at providing basic underlying principles in viewing the climate change paradigm, focusing on economic approaches necessary to analyze the issue. Economic approaches include market as well as non-market approaches. This distinction is deemed important as many efforts related to adaptation and mitigation to climate change often neglects the mechanism.

Keywords: climate change, economic approaches, market approach, non-market approach.

ABSTRAK

Makalah ini bertujuan untuk memunculkan konsep/prinsip dasar yang diperlukan dalam menelaah isu perubahan iklim. Penekanan diberikan kepada pendekatan ekonomi, yang mencakup pendekatan pasar maupun pendekatan non-pasar. Pembedaan kedua sudut pandang ini dianggap penting mengingat banyak upaya adaptasi maupun mitigasi terkait perubahan iklim hanya mengacu kepada satu sisi saja.

Kata kunci: *climate change, economic approaches, market approach, non-market approach.*

1. INTRODUCTION

Climate Change is receiving increased attention over the years, in particular after the ratification of the Kyoto Protocol (signed in 1997 and effective in 2005), and after Stern's Review (2006). As such, the climate change phenomenon is being studied from all possible fields of study and fields of research, including economics. The economics of climate change looks and studies how climate change affects the economy and economic activities, as well as how human behavior and economic activities contribute to climate change.

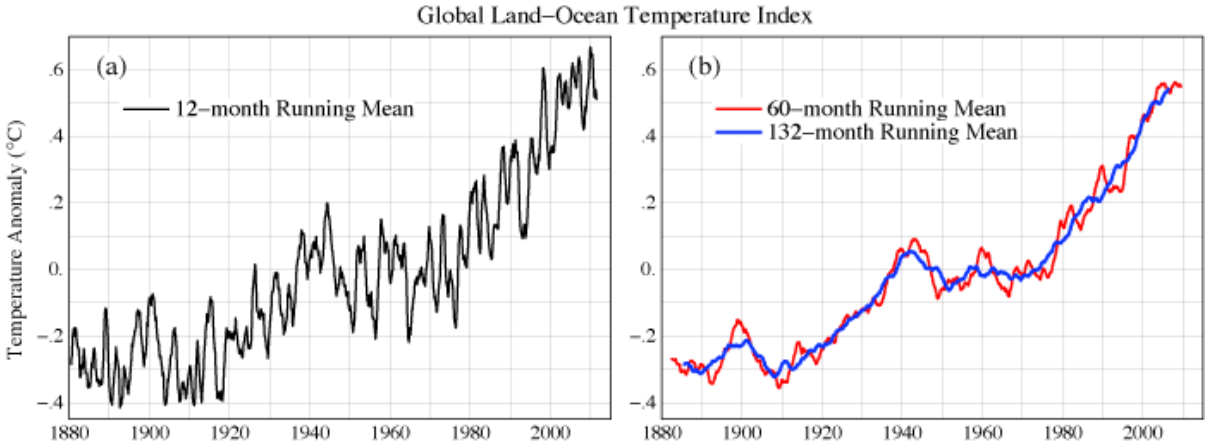
The purpose of this survey is to introduce and document various economic approaches to the issue of climate change. In particular, we highlight market approaches as well as non-market approaches that are linked to the climate change issue. In a broader perspective, we aim to look at the current existing approaches, that can be useful in identifying different paths of action or different approaches to global climate change.

Organization of the paper. The narrative flow is presented as follows: we begin with the definition of climate change and its importance to economic development. We focus on the role of climate change in economic activity and vice versa (the role of economic activity on climate change). Next comes the representation of economic approach in mitigating and adapting to climate change, with sustainability as the long term objective. A section on various real-life behavior in coping with climate change follows. A conclusive summary is presented at the end of the paper.

2. CLIMATE CHANGE AND THE ECONOMY

By definition, climate change is "a significant and lasting change in statistical distribution of weather patterns over periods ranging from decades to millions of years" (Wikipedia.com). Climate change can be caused or influenced by natural processes such as oceanic circulation, solar radiation, as well as volcanic eruptions and fluctuations in temperature and glacial structure at earth's poles. Man-made processes or activities are also important factors that can shape climate change, especially excessive energy consumption, inefficient production, and waste-dumping behavior. The following graph illustrates the fluctuation in earth's mean surface temperature, indicating a global scale warming in process, particularly in the recent decades.

Figure 1. Changes in Land and Ocean Temperature Index



Source: NASA (2011)

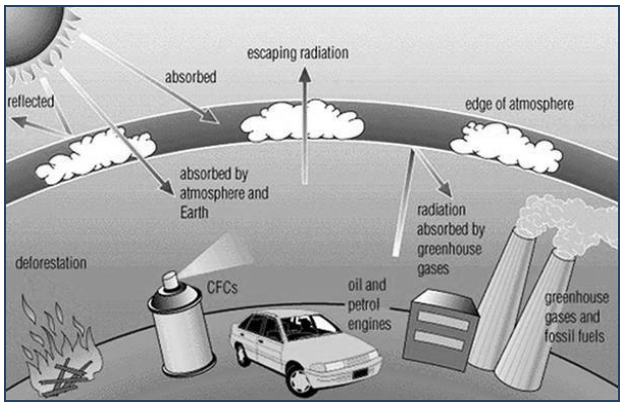
2.1 The Effects of Economic Activities on Climate Fluctuations

Over the years, climate change has been occurring more rapidly, shown by the carbon dioxide concentration in the air, from 190 ppm in the last ice age, to 280 ppm during the last interglacial period, to 390 ppm in our current era. It appears that this rapid change has been brought about by intense industrialization, and as a result, global average temperature has increased by around 0.8°C, giving rise to the CO_2 concentration as well. (Fitzroy & Papyrakis, 2010). Casual observations during the past recent years also provide indications of a warming climate: shorter and milder winters, faster melting of glacial and polar ice, heavier rain showers, which can also have a profound effect on the economic sector. Fitzroy & Papyrakis (2010: 12) further asserts that

> *... At the moment atmospheric carbon dioxide is increasing by about 2.5ppm per year. In terms of carbon content, human activity is adding more than 10 billion metric tonnes of carbon annually to the atmosphere, of which about half, or 5 billion tonnes, is absorbed by the natural environment of the oceans, plant life and so on; the other half remains in the atmosphere. The total stock of carbon in the atmosphere of about 800 billion tonnes is thus increasing by less than one per cent per year. This may seem to be only a modest increase, but is nonetheless alarming because our climate is so close to the threshold beyond which runaway warming and large-scale agricultural collapse become very likely. Anthropogenic carbon emissions are still increasing by about three per cent annually. This is due to growing use of coal in the rapidly developing and most energy-wasteful countries, and these trends have dominated any gradually improving overall energy efficiency.*

A simple illustration below describes the climate change process.

Figure 2. Climate Change Process



It is apparent that human activities (especially economic-related ones) have contributed significantly to the warming. Some examples are:

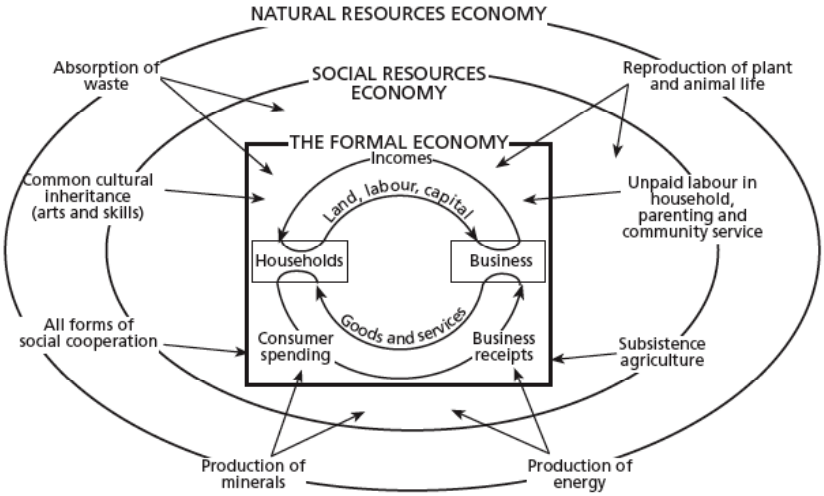
- Deforestation and biomass burning alone contributes more than 20% to the anthropogenic carbon emissions described above.
- Carbon feedback processes:
    - Under a warming ground, organic matters decompose faster, generating even more CO_2 particles, and more greenhouse gasses (GHG).
    - Increased usage of natural resources release higher methane that also contributes to GHG.
- The climate change issue is often underestimated as people adopt a misconception that climate change is equivalent to global warming; while in fact global warming is only one dimension within climate change itself. By doing so, the impacts of climate change are underestimated, and "business as usual" is being conducted without slowing it down.

There is a two-way flow of impact between the economy and climate change. On one side, as argued above, economic activity heavily influences the (rapid) speed of climate change. Economic activities utilize resources and energy and generates waste.

In particular, all economic activities use energy, which is still dominated by fossil fuel, generating a sequence of carbon footprint. For instance, the consumption of a simple meal, for example a cheeseburger, is linked to a very long carbon footprint sequence, starting from cattle farming, bread making, transportation and distribution, factories' use of fossil fuel, the restaurant's operation, consumption of the hamburger, waste created (paper wrap etc), as well as human and cattle secretion (which further releases methane gasses). Internet resources pinpoint the carbon emissions released from one single cheeseburger sums up to 2.85 – 3.1 kilograms of carbon particles. Fitzroy & Papyrakis (2010) asserted the complex interlinkage between the economy and the environment, which makes it particularly difficult to break away from the "business as usual" paradigm in order to create a cleaner surroundings, which is a substantial component in climate change. Economic growth, while at one side is desperately needed to improve living standards, is at the same time the largest contributor of climate change (Fitzroy & Papyrakis (2010: chapters 3 and 4).

The following diagram illustrate the complex interrelationship between the economy and the environment (and hence, climate change as well).

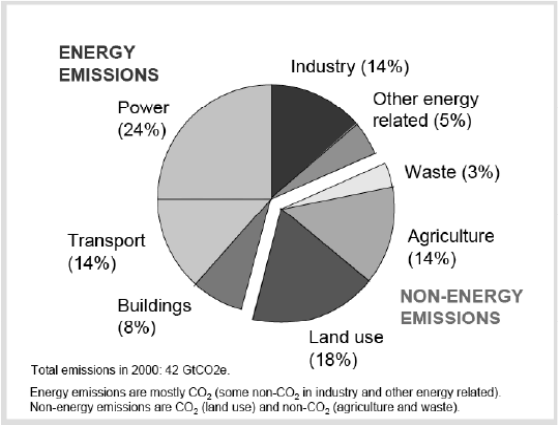
Figure 3. The interrelationship between the economy and climate change



Source: Cato (2009)

Moreover, human social relationships also contribute to the use of resources and energy, as depicted in the diagram above. Network externalities in particular are becoming more and more prominent these days and determine consumer spending substantially, for instance, the consumption of cell phones; many individuals consume them because of the network externality factor, not mere individual rationality. The figure below depicts the composition of GHG at a particular time, where human activities heavily influence particle emissions: the power sector is the largest among all.

Figure 4. Components of global energy emissions

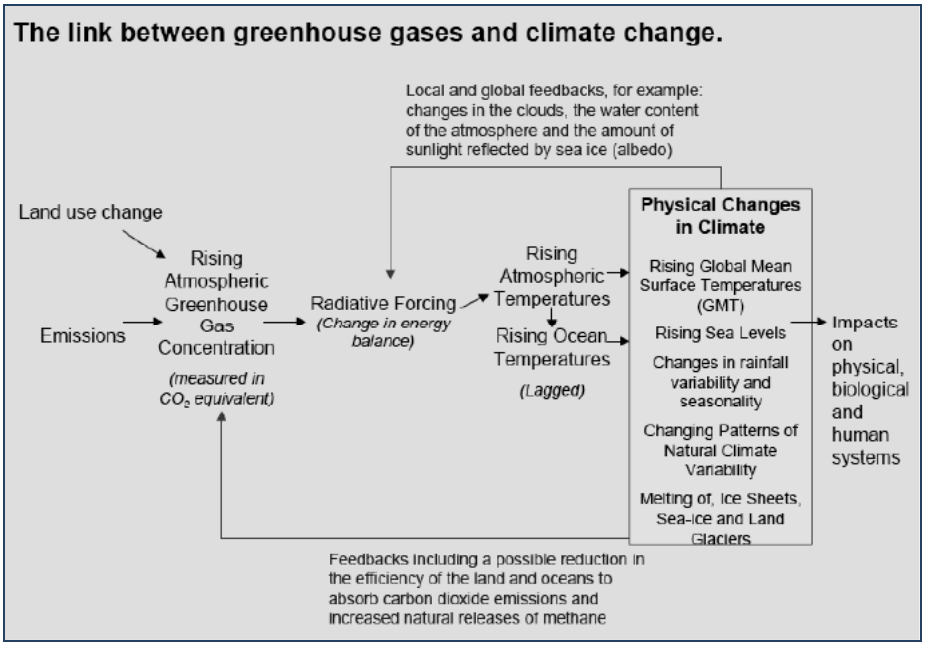


Source: Stern (2006)

2.2 The Effects of Climate Conditions on the Economy

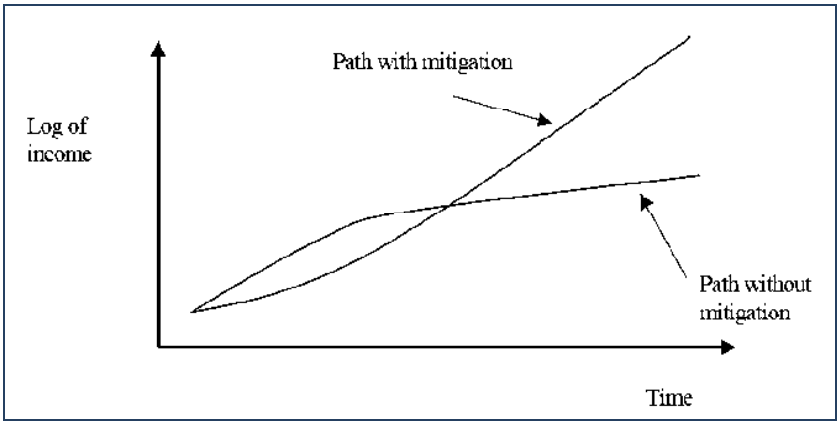
From the reverse point of view, we can also assert that climate change itself poses significant influence on human / economic activities. As the climate becomes warmer, it creates potential extra constraints to production, to consumption, and to growth / development path as well. Production costs as well as opportunity costs increase, so do consumption costs. In turn, as production and consumption become more expensive or more constrained, the society's development and growth paths will also be subject to those extra constraints. The interlinkage between GHG and climate change is presented below:

Figure 5. Greenhouse Gasses



It is therefore understandable why understanding climate change is a substantial and important aspect for growing economies: first, it can pose a threat (or constraint) to economic activities. Second, as it implicitly affects the development path, mitigation/adaptation responses will in turn also affect *how* climate change will impact that path, as illustrated here:

Figure 6. Development Paths

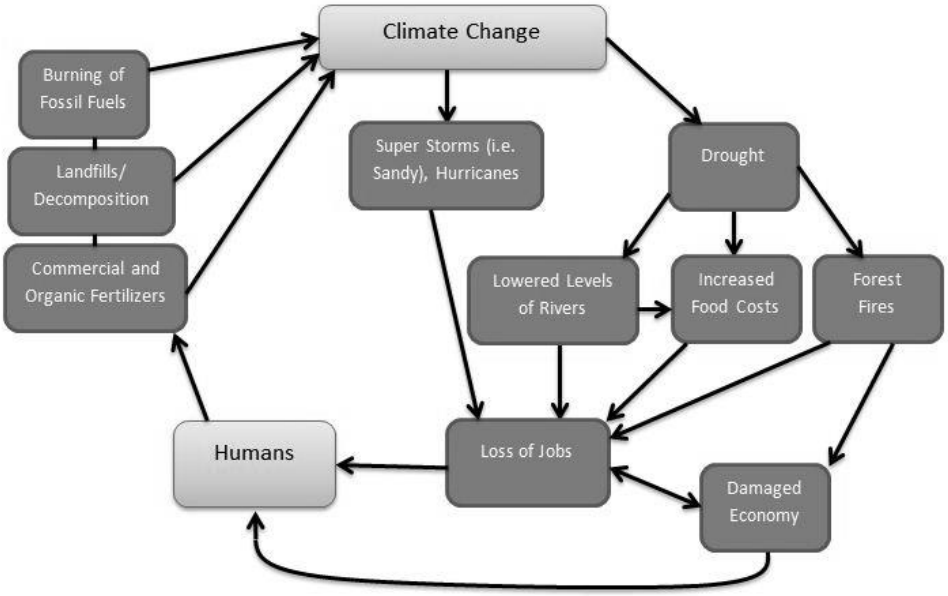


This diagram illustrates that climate change mitigation will be beneficial for development, as mitigation carries the potential to preserve income growth. Without it, income growth will flow lesser in its growth path. In other words, mitigation serves as a development tool and hence should be adopted as an economic policy. The sooner the economy incorporates the mitigation into their development plan, the greater economic growth can be retained.

Many studies have indicated that developing country and poor nations are the ones most vulnerable to climate fluctuations (Bretschger & Valente (2011), De Villemeur & Leroux (2011), Fitzroy & Papyrakis (2010), Ravindranath & Sathaye (2003), and Tanner & Allouche (2011)). In essence, climate fluctuations allow developed countries and multi-national companies to push for more access to the resources in the developing countries, making their residents (especially

the poor and low-income classes) more and more dependent on foreign capital. Moreover, as their resources are being extracted, more environmental degradation is being created, contributing even further to the climate fluctuation. The following diagram illustrate the mechanism of interlinkage between the economy and climate change in a more realistic-pragmati description.

Figure 7. Climate Change, Economic Activity, and Human Condition



Source: Mellette Forestry Group (2013)

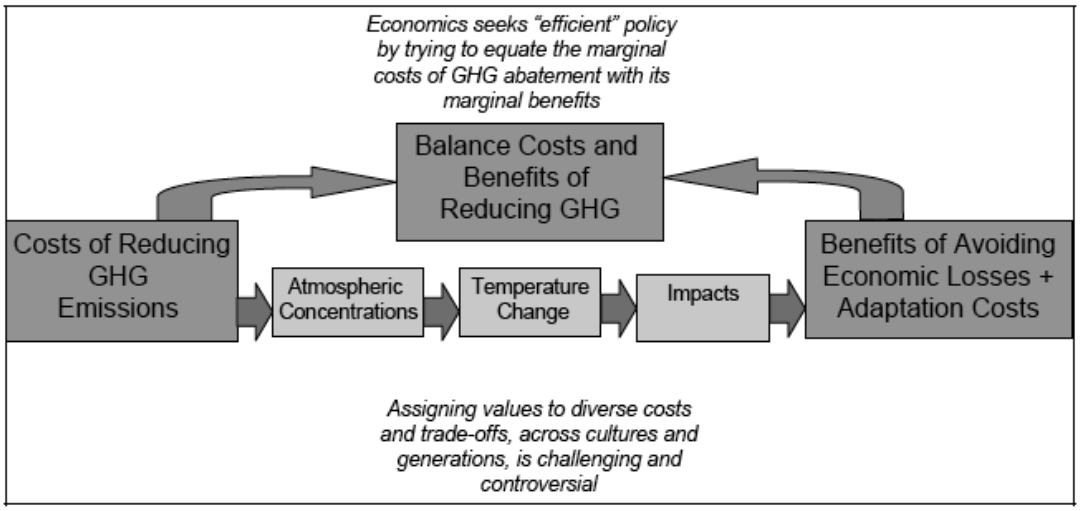
In that light, increased mitigation and adaptation strategies and actions are being called for, which requires global action and global cooperation. We can clearly see that mitigation to climate change is a superior choice to no mitigation. In order to design the optimally sound mitigation (or adaptation), the characteristics and mechanism of climate change need to be fully understood.

3. ECONOMIC APPROACHES TO CLIMATE CHANGE

3.1 The Economic Efficiency Approach

The term "economic efficiency" is widely accepted to refer to the maximization of resource use. Pareto Efficiency is the concept used to describe the situation in which more production corresponds to a resource trade-off. In a slightly different terms, efficiency is also measured in terms of the lowest cost attainable from certain level of production (i.e. lowest opportunity cost); in this "static" definition of efficiency, the marginal cost equals the marginal benefit. A production process is considered efficient when the marginal cost from producing equals the marginal payoff (e.g. revenues) from selling the output. In this sense, waste and depreciation are natural consequences that arise. Logically, this approach does not factor in the intertemporal discount rate and only concerns the current (today's) allocation of resources. Cost – benefit approach also lies within this category; a certain resource allocation is acceptable when the marginal benefit = marginal cost criteria is satisfied (Leggett (2011)). Leggett further asserts the so-called economics-centric approach as depicted below:

Figure 8. Economic Efficiency



Source: Leggett (2011)

Recent development revolves around the importance and characteristics of the discount rate. More concerns regarding uncertainty that is where the discount rate is built upon. Leggett (2011) states that

> *"The importance of the discount rate arises because greenhouse gases persist in the atmosphere for a century or more, and therefore mitigation benefits must be measured on dramatically different timescales from those of ordinary environmental problems. A prescriptive approach links the discount rate to subjective judgments about intergenerational equity as indicated by a pure social rate of time preference.*

The uncertainty lies in this social rate of time preference. A more "realistic" approach is the Dynamic Efficiency approach, in which not the current benefits are being maximized, but rather the net benefits. This approach takes into account the discount factor; in other words, it concerns both present and future costs of resource allocation. Future net benefits (or net costs) are to be discounted in order to determine the current ones. For environmental / climate definitions, we need to incorporate all user costs (anything that affects the current valuation of future consequences); in other words, one cannot neglect environmental degradation generated from current (excessive) use of resources. Intertemporal resource allocation is then deemed efficient if the marginal net (intertemporal) benefits equal the marginal net (intertemporal) costs.

A substantial and often ethical set of criteria is needed to conduct such comparison and measurement, namely the positive and normative criteria. Under the positive criteria the decision on resource allocation is based on the "what is" situation (*das sein*), or based on facts. For instance, conducting "business as usual" can be justified based on productivity benefits that it entails. Under the normative criteria, on the other hand, resource allocation decisions are based on criteria that carry various value judgments or "what should be" (*das sollen*). For example, "business as usual" should be evaluated on the basis of dynamic efficiency, not merely on static efficiency. In the field of climate change, the approach has taken both sides, where many remain on the positive side in which climate consequences are often neglected – many developing nations are still in this path of action. Normative criteria approach does appear to occur in the global setting, such as the emergence of Kyoto Protocol and the establishment of UNFCCC.

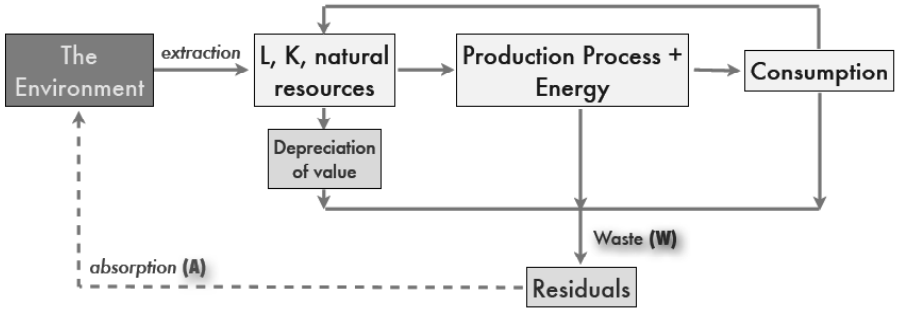
3.2. The Holistic Approach

The holistic view on the interlinkage between the economy and the environment stems from the Law of Thermodynamics. This law states two important characteristics, namely

a. The sum of energy in an isolated system is constant (the law of entropy).
b. Energy can be changed or transformed into different forms, usually lower-level or less usable.

The following diagram illustrates the holistic linkage between the economy and its surrounding environment. Economic activities have to extract resources from the environment in order to complete those activities, whether they be consumption or production. In the process, some of the resources lose part of their value (the depreciation). Moreover, all those generate waste, which is the residual (lesser energy) form of the output. In some instances these residuals can be re-used and re-cycled into the production-consumption system, and some cannot. The latter are then being dumped again into the environmental system. The issue at hand in this matter is the limited capacity of the environment's absorption ability. It is often the case where the absorption capacity is less than the creation of the residuals, which then forms into pollution, environmental damages, and in a more global sense, climate change.

Figure 9. The Holistic Approach



Considering this complex system of interdependency, it is further necessary to incorporate not only the types of economic activities, but also individual behavior that in essence shapes and provides direction to those activities. The behavior is especially important to take into account, since any mitigation and adaptation measures will be applied to individual behavior[1].

4. EFFICIENCY AND SUSTAINABILITY

When we consider a longer time period or intergenerational allocation, sustainability becomes an important matter that needs to be compared and contrasted to that of (dynamic) efficiency.

The term "sustainable development" was introduced in 1980. At the very basic understanding, sustainability is defined as *meeting the needs of the present without compromising the ability of future generations to meet their own needs* (Gibbs (2002)). In other words, it is an attempt to reach a better inter-generational welfare-improving resource allocation. It takes into account the ramifications and/or impacts that current economic activities have onto that of the future generation's. Obviously here the concept of static efficiency as we discussed earlier has little or no significance; instead, we need to rely solely on dynamic efficiency to achieve sustainability goals. In 1992, The Earth Summit held in Rio de Janeiro by the

[1] By "individual" we mean any person / persons, firm entities, as well as state governments and their subsidiaries.

United Nations explicitly place the notion of sustainable development in policy making agendas across the globe. This indicates the importance and urgency of controlling economic consumption as well as production in the current period, thereby preserving the necessary resources for use of the future generation. The emphasis of sustainability approaches are mainly to increase environmental efficiency, i.e. reducing the negative impact from economic activity on the environment (Gibbs (2002)). In the context of spatial development, sustainability is often linked to the "think globally, act locally" notion- calling for individual and local-level initiative to reduce environmental impacts.

Sustainability itself comes in an array of conditions or states. Turner (1993, in Gibbs, 2002) asserts that there are at least 4 types of sustainability states, namely

a. Very weak sustainability, where there is a "complete substitution" between human and natural capital, and there exists an "essential link between willingness to pay and the sustainability"
b. Weak sustainability, where some of the natural capital is acknowledged as being critical and not substitutable.
c. Strong sustainability, where economic valuation cannot be applied to many functions of the ecosystem, implying that it recognizes the inadequacy of the economic system to account for the losses of those natural capital.
d. Very strong sustainability, in which the economy reaches its steady-state by implementing the complex system of environmental constraints and thermodynamics laws. Here, the tradeoffs between development and the environment is no longer a viable issue.

It is then quite understandable that sustainability terminologies, initiatives as well as movements brings along a range of skepticisms and ambiguity. Moreover, at this time the global tendency to prioritize industrialization, free trade and international movements of resources are still counter-effective to the sustainability notion. Although low-developing countries are the ones most susceptible to environmental impacts, they have little to say about where the global economic activity is heading to- at the current state directives are more in the hands of the big players, namely the industrialized nations.

5. PROPERTY RIGHTS AND OTHER NON – MARKET APPROACHES

Property rights is generally defined as the allocation mechanism of economic goods, that consists of four aspects, namely the right to use the good, the right to earn income from the good, the right to transfer the good to others, and the right to enforcement of property rights (source: Wikipedia). Property rights determine who has the right over factors of production as well as the right of usage (or consumption) on a certain resource. Furubotn & Pejovich (1972) asserts that property rights are essentially an extension to the production and exchange notions.

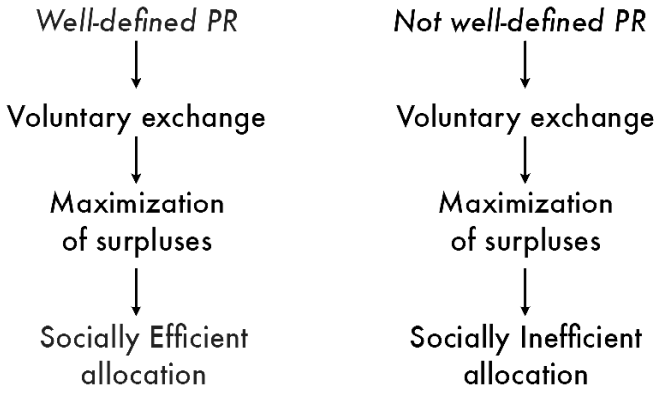
Property rights can further be distinguished into broad categories as public rights and private rights. Moreover, further categorization is possible, namely open access, state property, common property, and private property. This grouping provides smoother and clear division regarding the accountability over resources. For example, the right to own, use, sell, create income form a shirt is considered a private right (because the shirt entitles the owner private property rights). Similarly, some resources such as a lake or a forest entitles public property, giving everyone yet no one to own, privately use, or make money of, that particular resource (public property rights). Deeper breakdown of rights can then be defined based on the other three categories (state, common, or open)[2]. It is then understandable that common property resources generate property rights issues among economic agents. Environmental cleanliness or degradation and

[2] Meinzen-Dick & Knox (1999) mentioned slightly different classification on property rights, namely *use rights (including access)* and *control rights (including management)*.

climate condition all have the characteristics of non-private properties. It has been and will always be debatable whether they belong to state, common, or open-access resources.

Coase (1960) has stated that well-defined property rights are the necessary conditions for improving economic efficiency in the presence of externalities. This is to say that externalities can be traded between economic agents as long as it is clear about who has the property rights over the disputed resources. In reality, property rights are not well-defined, which makes it difficult to solve externality and /or public goods problems. "Tragedy of the commons" is a well-known phenomena in which economic agents compete for the rights to claim certain resources, as efficient bargaining is not facilitated by the absence of well-defined property rights. The absence of well-defined rights then calls for government's role in establishing institutions (rules of the game) that minimize transaction costs, initially generated by inefficient bargaining. Coase's idea was straightforward: externalities emerge because there is always more than one agent or one party involved in the competition over the resource (or conflict). Therefore the problem needs to be understood as an interdependency problem rather than a one-sided problem. To keep transaction cost at minimum, necessary institutional setups need to be created. User contracts are examples of such institutions. In this context we can describe these institutional setups as part of the non-market approaches, since market- and price- based options are usually not possible.

Figure 10. Property Rights and Allocative Efficiency



Well-defined property rights facilitate efficient market processes toward efficient allocation of resources. When each economic agent are granted his or her rights, voluntary exchanges can occur with minimum transaction costs, and allow for the creation of maximum economic surpluses (both consumer's as well as producer's). Basic economic theory dictates that when surpluses are maximized, resource allocation are efficient since no deadweight losses are present. On the contrary, property rights that are not well defined are linked to the creation of economic losses, that stems from the existence of non-zero transaction costs. Obviously with the presence of economic losses, efficient allocation is constrained.

In the field of environmental economics and climate change in particular, assignment of property rights can potentially serve as a remedy for the (negative) externalities generated. Externalities are defined as non-compensated economic output or side effect(s) that are consumed by the society; for example, pollution from a factory dumped into a nearby river damages water quality and deteriorates life quality of residents along the river. That deterioration is considered externality when there are no compensations taking place by the polluting firm to the residents. Once the firm issues a compensation scheme, the externality is being internalized, thus no longer present (although the negative effects are still being

acknowledged). In the absence of well-defined property rights (as it usually is), the river is a common resource and does not belong into any specific agent's possession. Hence, the right to use (or dump waste) is difficult and more often impossible to define. The polluting firm then has the ease of dumping into that river claiming that it is a free resource. However, the residents can similarly claim that they have the "right" to use the river as well, by enjoying cleanliness (the classic problem of *the tragedy of the commons*). When property rights on that river can be defined, it will facilitate proper market bargaining between the firm and the residents, regarding accountability for using the resource (the "polluter pays" principle).

The case of climate change is a parallel example to the one stated above. In our current global state, the assignments of property right to use (or dump waste) to the ambient air (and furthermore, climate) is clearly not well-defined. Economic agents are using the environment in an irresponsible manner, causing climate changes without "compensating" accordingly for their actions[3]. The (hypothetical) assignment of rights will allow for realization of such compensation[4].

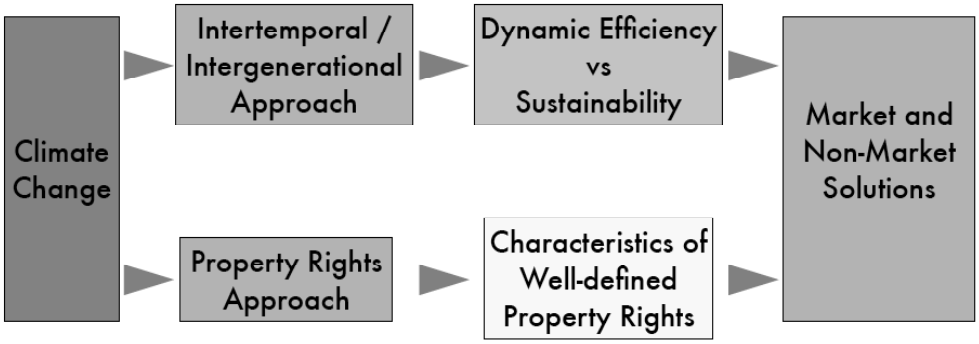
6. CLIMATE CHANGE POLICIES AND COPING STRATEGIES

Coping strategies to climate changes are usually categorized as either mitigation strategies and adaptation strategies. Mitigation involves actions to reduce environmental impacts onto the climate, such as activities to limit GHG emissions, promoting alternative fuels or researches on recyling[5]. Adaptation involves action to adapt to, or to tolerate, changes in climate, such as altering life style, and climate financing (the World Bank employs various adaptation financing programs[6]). Adaptation is essentially changing the vulnerability to cope with changes in climate, and its efforts are closely related to the welfare state and economic growth of the particular society or nation; low-developing countries are known to be the most prone to climate changes, thus adaptation is extremely important to carry out, yet their limited resources and income constrains their adaptive capacity.

From conceptual economics perspective, any coping strategies should take into account sustainability goals, dynamic efficiency measures, as well as property rights assignments, discussed earlier. Furthermore, one needs also to incorporate the current set of global as well as local approaches already made, such as the Kyoto Protocol and the Stern Review (global) and household initiatives and national dissemination of information (local). Those are the basic entities that form the institutional architecture for coping mechanisms. A renewed vision of a "green" growth path should follow that will direct further implementation of those coping strategies. In a simple depiction, the process will look as follows:

[3] Many popular media have also indicated this pattern, such as "The Inconvenient Truth" film by Al Gore.
[4] Current global initiatives serve as means to move towards that direction, e.g. ratification of protocols calls for private (individual countries) actions in defining their responsibilities (as a flipside to "rights")
[5] IPCC along with the International Atomic Energy Agency and International Energy Agency have stated that as part of the portfolio of low-carbon energy technologies, nuclear power will continue to play a role in reducing greenhouse gas emissions.
[6] http://climatechange.worldbank.org/content/adaptation-and-world-bank-facts

Figure 11. Two Main Approaches



assignment, for instance determining how much GHG emission can be allowed in a certain low-developed area. One of the strategies of coping with climate change is to reduce carbondioxide rapidly to the level below the current 390 ppm. Fitzroy & Papyrakis proposes 350 ppm (Stern gave an estimate of 450 – 500 ppm). Also important in this matter is increasing the recognition of the uncertainty (and risks) aspect in economics – climate processes. Human (economic) activities often disregard or dismiss the uncertainty and risks embedded in, say, the patterns of ocean currents and other natural processes. It is necessary for economies to be more risk-averse in planning and designing their growth path and the related economics as well.

At a more technical perspective, any policy option should have the purpose of maximizing its net benefit upon the economy or society, in other words they need to take into account the entire set of costs as well as benefit justifications. Included in here are the costs of mitigation as well as adaptation initiatives (Morgenstern, Pizer & Shih,1998). The result will then indicate whether or not the mitigation (or adaptation) has already been implemented optimally, or whether they are insufficient (or even excessive).

As described above, mitigation to climate change deals with attempts, planning, policies, initiatives and actions to reduce environmental impact brought by economic activity. By limiting those impact (for instance, waste dumping and GHG emissions), the carrying capacity of the environment and the climate is prolonged as the global warming and/or climate change impacts on economic activity itself is reduced, and thereby improving the dynamic efficiency and better ensuring sustainability. The United Nations Environment Programme (UNEP) describes the nature of mitigation as being multi-dimensional, as follows[7]:

> *"Mitigation can mean using new technologies and renewable energies, making older equipment more energy efficient, or changing management practices or consumer behavior. It can be as complex as a plan for a new city, or as a simple as improvements to a cook stove design. Efforts underway around the world range from high-tech subway systems to bicycling paths and walkways. Protecting natural carbon sinks like forests and oceans, or creating new sinks through silviculture or green agriculture are also elements of mitigation. UNEP takes a multifaceted approach towards climate change mitigation in its efforts to help countries move towards a low-carbon society*".

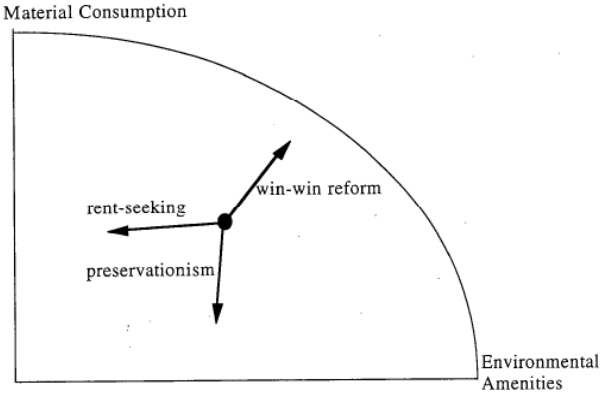
On the same side, the World Bank implements a mitigation support program that addresses the issues of technology adoption in various fields such as forestry, waste management, energy, and transport, including data provision for research purposes[8]. Moreover, the Bank established a climate initiative called Strategic Framework on Climate Change and Development (SFCCD) with the objectives to "how to integrate climate change and development

[7] http://www.unep.org/climatechange/mitigation/
[8] http://climatechange.worldbank.org/overview/climate-change-mitigation

challenges, without compromising growth and poverty reduction efforts through its country operations, including policy dialogue, lending, and analytical work in client countries, and through its regional and global operations". (Mani, Markandya & Ipe, 2008). Mani et.al. also proposes important policy and institutional reforms that are necessary for achieving optimal mitigation mechanisms, with emphasis on sectoral policies that improves energy efficiency and promoting greater use of renewable energy, especially in the industrial sector and transportation. Climate or carbon financing should be included in the reform package as a supporting scheme. Metz et. Al. (2007) suggests that mitigation ideally starts as sectoral policy options, which are then integrated cross-sectors.

Roumasset (2009) suggested a win-win approach to climate policy, in which the respective policy can improve efficiency as well as equity measures simultaneously- There are possibilities that mitigation (or adaptation) policies can cause efficiency degradation albeit at the same time generate welfare improvements.

Figure 11. Win-win Approach



Source: Roumasset & Endress (1996)

The diagram depicts the possible paths that a policy or reform can bring about. Increased economic growth or material consumption and environmental improvement or abatement can only be achieved simultaneously when the policy in question is able to facilitate participation among players while at the same time be technologically efficient. In turn, participation in climate mitigation involves various aspects, namely who will pay, related leakages and coalitions, complete and incomplete participation, and the Green Paradox (Roumasset, 2009). For instance, Lutsey & Sperling (2008) collected information about policy actions taken from the local up to national level in the United States. Their survey indicates increased commitment of the people in engaging in mitigation actions. Such behavior is what is necessary in shaping a win-win policy solution that Roumasset described, above.

From another perspective, Burniaux *et al.* (2009) documented a wide range of mitigation policies spreading across countries as well as across levels of governance. They show that among all policies, the most effective remains market-based mitigation policies, such as emission trading and credit schemes. However, effectiveness of those polices can enhanced when complemented by non-market mechanisms such as regulatory schemes and international transfers[9].

[9] Burniaux *et al.*'s scenario is one that puts the development of a single, global carbon price as its primary goal.

7. CONCLUSIVE SUMMARY

From the short discussion on various approaches in looking at the climate change issue, we come toward the following points:

- Climate conditions and changes affect the economy, and vice versa, thereby pinpointing a symbiotic relationship between the two sides. This seem to be a common understanding but yet remains necessary to be emphasized.
- Economic efficiency approach argues that the environment is considered to be a resource necessary for economic consumption and production: The more resource can be utilized at a fairly standard cost, the more efficient the state of the economy.
- Dynamic efficiency states that efficient utilization of resources can only be achieved when current consumption of resources does not diminish future consumption of the resource, giving way for environmentalism and concerns for climate changes. Dynamic efficiency is also considered to be a necessary condition for environmental sustainability. In other words, one needs to be cautious when applying the "efficiency" terminology into the discussion.
- According to the property rights approach, efficient (and fair) allocation of resources needs proper prior assignment of property rights. This assignment of rights is acknowledged to be very difficult, which further implies that fair and efficient resource allocation may not be possible. This implies serious intervention by the (respective) government to enforce such rights. Further implication is that the government itself needs to be "in good standing"; or, in other words, a good government regime is a necessary condition for the property rights approach.
- However, climate change coping mechanisms, whether mitigation or adaptation, requires the combination or complementarity of both dynamic efficiency and well-defined property rights. This implies that any climate policy needs to also work on both sides of that requirement.
- Various studies have indicated that market-based mitigation approaches are the most effective, particularly those that embed price consequences and technological changes (whether in consumption as well as in production). Furthermore, all of those need to be implemented in such a manner that will enhance economic development (or material consumption) and maintain environmental quality and amenities; which is labeled as "win-win approach" in climate change mitigation policy.

REFERENCES

Bretschger & Valente (2011). Climate change and uneven development. *Scandinavian Journal of Economics, 113*(4): 825-845.

Bromley & Paavola (eds.) (2002). *Economics, ethics and environmental policy*. Great Britain: Blackwell Publishing.

Burniaux, J. et al. (2009). The economics of climate change mitigation: how to build the necessary global action in a cost-effective manner. *OECD Economics Department Working Papers*, No. 701, OECD Publishing. Retrieved September 2011 from http://dx.doi.org/10.1787/224074334782

Cato, M.S. (2009). *Green economics: an introduction to theory, policy, and practice*. London: Easthscan.

Coase, Ronald H. (1960). The problem of social cost. *Journal of Law and Economics*, *3*(1): 1–44.

De Villemeur & Leroux (2011). Sharing the cost of global warming. *Scandinavian Journal of Economics, 113*(4): 758-783.

Dinar, Albiac & Sanchez-Soriano (eds.) (2008). *Game theory and policymaking in natural Resources and the Environment*. New York: Routledge.

Fitzroy & Papyrakis (2010). *An introduction to climate change economics and policy*. London: Eartscan.

Furubotn & Pejovich (1972). Property rights and economic theory: A survey of recent literature. *American Economic Review*, *10*(4): 1137-1162.

Gibbs, D. (2002). *Local economic development and the environment*. London: Routledge Research Global Environmental Change.

Goulder & Pizer (2006). *The economics of climate change*. Resources for the Future: Discussion Paper.

Helm, D. (ed.) (2005). *Climate change policy*. Oxford: Oxford University Press.

Leggett, J.A. (2011). *Climate change: Conceptual Approaches and Policy Tools*. Washington, DC: Congressional Research Service.

Lohmann, L (2011). Capital and climate change. *Development and Change, 42*(2): 649-668.

Lutsey & Sperling (2008). Americа's bottom-up climate change mitigation policy. *Energy Policy,* 36: 673-685.

Mani, Markandya & Ipe (2008). *Policy and institutional reforms to support climate change adaptation and mitigation in development programs*. Washington DC: The World Bank.

Meinzen-Dick & Knox (1999). *Collective action, property rights and devolution of natural resource management: a conceptual framework.* Working Paper.

Mellette Forestry Group, LLC. http://www.melletteforestry.com/ accessed September 2013.

Mendelsohn, Robert (2003). Assessing the market damages from climate change. in Griffin, J. (ed). *Global Climate Change: The Science, Economics and Politics*. Northampton, MA, USA: Edward Elgar Publishing.

Metz, Davidson, Bosch, Dave & Meyer (eds.) (2007). *Climate change 2007: mitigation to climate change*. Cambridge: Intergovernmental Panel on Climate Change.

Morgenstern, Pizer & Shih (1998). *The cost of environmental protection*. Resourced for the Future: Working Paper 98-36.

National Aeronautics and Space Administration, Goddard Institute for Space Studies (2011). http://data.giss.nasa.gov/gistemp/2011/ accessed September 2013.

OECD (2009). *Integrating Climate Change Adaptation into Development Cooperation*: *Policy Guidance*.

Peters, Fudge & Jackson (eds.) (2010). *Low carbon communities: imaginative approaches to combating climate change locally*. Northampton, MA, USA: Edward Elgar Publishing.

Ravindranath & Sathaye (2003). *Climate change and developing countries*. New York: Kluwer Academic Publishers.

Rezai, A. (2011). The opportunity cost of climate policy: a question of reference. *Scandinavian Journal of Economics, 113*(4): 885-903.

Roumasset, J. (2009). *Climate change policies: implications and challenges for Asia*. Working Paper.

Roumasset & Endress (1996). The yin and the yang of sustainable development: a case for win-win environmentalism. *Journal of the Asia Pacific Economy, 1*(2): 185-194.

Sanderson & Islam (2007). *Climate change and economic development*: *SEA regional modelling and analysis*. Great Britain: Palgrave Macmillan.

Soltau, F. (2006). Climate change and sustainable development: understanding the linkages. *Natural Resources Forum, 30,*253-255.

Tanner & Allouche (2011). Towards a new political economy of climate change and development. *Institute of Development Studies Bulletin*, *42*(3).

Turner (ed.) (1993). *Sustainable environment economics and management: principles and practice.* London: Belhaven.

Uzawa, H. (2003). *Economic theory and global warming.* New York: Cambridge University Press.

Woerdman. E. (2004). *The Institutional Economics of Market-based Climate Policy*. Amsterdam: Elsevier.