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**The Carbonisation and Decarbonisation of the Atmosphere: Systematically Linking Sustainable Development, Decarbonisation, and Adaptation Programs Using Qualitative Comparative Means.**

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## Abstract

*It can be said that the original impacts of human beings on the environment were barely noticeable when they lived as nomadic societies. As they evolved from nomadic to sedentary societies; from subsistence societies to modern industrial and mixed economies, their impacts on the environment grew each time more and more. There seems to be now a general agreement that economic development without social and environmental concerns led to the carbonisation of the atmosphere and to calls to change course in the name of the environment and for the sake of current and future generations. Then the idea of sustainable development came along formally in the late 1980s to minimize current green house emissions as well as later programs such as the United Nations Framework Convention on Climate Change and the Kyoto Protocol and associated mitigation and adaptation programs, which are aimed at decarbonising the atmosphere in a sustainable manner.*

*There is no doubt that sustainable development issues and global warming issues are complex issues which are very often studied as separate issues, yet there seems to be an understanding that they are linked. When looking at them as separate issues, structural interactions that may be relevant in sustainability terms may be missed. Therefore, there seems to be a need to find ways to present and link these issues systematically and in simple terms to point out relevant structural interactions and sustainability issues; and this paper attempts to do that using qualitative comparative means.*

## Introduction

### *a) Natural sustainability*

At the beginning of civilisation, when men had a nomadic way of life, it appears that there was a natural balance in the atmosphere. During this period, the social impact/human impact was at a minimum as human coexisted with the natural environment without the establishment of permanent communities; and no form of economic incentives to increase the use of resources existed. Therefore, the contribution of nomadic lifestyles to concentration of greenhouse gases in the atmosphere, and to climate change can be considered non-existent or extremely minimal. The pure natural greenhouse effect was the dominant

process underlying the cooling or warming of the atmosphere, as the greenhouse effect is a natural event(Sanderson 1996).

Greenhouse gases can be classified into two groups, carbon dioxide(CO<sub>2</sub> gas) and non-carbon dioxide(non-CO<sub>2</sub> gases) since CO<sub>2</sub> is the most important greenhouse gas. Among non-CO<sub>2</sub> gases we have methane(CH<sub>4</sub>), nitrous oxide(N<sub>2</sub>O), nitrate oxides(NO<sub>x</sub>), carbon oxide(CO), haloflouorocarbon(HFC<sub>s</sub>), cloroflouorocarbon(CFC<sub>s</sub>), and sulfurhexaflouride(SF<sub>6</sub>)( OECD 1998a). They are responsible for the greenhouse effect, a heat-trapping mechanism or process that warms the earth(De Jongh and Captain 1999).

### ***b) Moving away from natural sustainability***

As social and economic systems evolved, societies started to settle into permanent communities and established subsistence economic systems. These two aspects can be considered as the ones that initiated the carbonisation process of the atmosphere as both societies and economies started to release increasingly more and more greenhouse gases through their consumption, production, and waste producing activities. In other words, subsistence systems initiated the socio-economic pushing effect on greenhouse gas processes and placed the carbonisation issue in motion. As societies and economies release gases into the atmosphere, they enhance or make more severe the greenhouse effect(Collier and Lofstedt 1997) or they lead to significant changes in the composition of the atmosphere(Michaelowa 2000). Overall, socio-economic contributions to warming processes are expected to be negative on balance(Bartsch and Muller 2000).

As subsistence societies and economies evolved toward industrial socio-economic systems, their contributions to greenhouse gases increased still more due to improved technology than that attributed to subsistence systems. Hence, industrial societies and economies were responsible for speeding up the socio-economic pushing effect on greenhouse processes; and therefore, in making the carbonisation issue more relevant. Then, technology transfers from industrial societies and economies to subsistence socio-economic systems, and increasing interdependency led to the formation of mixed economies, economies where the competition between industrial and subsistence economies has produced higher releases of greenhouse gases into the atmosphere than those attributed to industrial systems or subsistence systems.

It is during the mixed economic period that concentrations of greenhouse gases in the atmosphere(what the author calls social and economic carbonisation processes of the atmosphere) have reached or are reaching alarming levels. In other words, mixed economies operating outside environmental and social concerns fully enhance the socio-economic pushing effect on greenhouse processes, and therefore, on global warming. For example, there is concern that a high growth scenario could lead to twice more greenhouse gas emissions from 1992 to 2020(OECD 1998b).

### ***c) The climate change problem***

At the peak of the overall carbonisation process(late 1980s), the climate change problem formally appeared; An economy only based development model fueled by extreme competition and exclusion was at play with no social and environmental concerns within it; and formal calls to make societies and economies to treat the environment with respect were made more frequently including by the World Commission on Environment and Development(WCED 1987).

Part of the recent interest in climate change issues is the realisation that human activities are/may be playing an important role in its current dynamics(Burroughs 2001). Climate change results from changes in average climatic conditions between average periods(Parry and Carter 1998). Climate change can seriously affect patterns of development in all countries without discrimination, as it has no geographical restrictions (Rahman 1999); it is expected to have different impacts on development depending on the level of protection of the systems and subsystems that is affecting(Muñoz 2000); and it can have serious

consequences in agricultural/food production worldwide(Burroughs 2001). For example, disasters such as Hurricane Mitch/1998 in Central America and the flooding in Venezuela/1999 show the serious social, economic, and environmental disruptions that can be associated with global warming related events.

The climate change problem is now being taken as a serious challenge that demands concerted action from individuals, NGOs, governments, and industry. For example, in Japan there has been an increase in voluntary action plans undertaken by industry organisations to combat global warming, which indicates that the industrial sector has taken notice of the potential negative consequences of this problem(OECD 1999a).

#### ***d) Dealing with the carbonisation problem affecting the atmosphere***

It can be said that the over all process to address the carbonisation problem took 3 steps that are closely linked, as detailed below:

##### ***i) The sustainable development program***

As the carbonisation process of the atmosphere became worse and worse, concerns on the potential negative consequences of economic development as usual on global warming became more evident. And the need to move towards a more inclusive or balanced type of development or sustainable development, development that is environmentally friendly for the benefit of current and future generations was highlighted(WCED 1987). In other words, sustainable development can be seen as a program that seeks to manage the imbalance of greenhouse gases in the atmosphere coming from new emissions.

The sustainable development program then seeks economic exploitation at minimal environmental costs, including minimal greenhouse gas emissions; and therefore, it seeks green economic development. And this makes sustainable development in essence a win-win environment and economy development process or eco-economic model or a model based on the partnership of the economy and the environment.

In summary, sustainable development proponents prefer the partnership based model as its inclusive nature gives it the potential of being more amenable to be made environmentally friendly. This is because the partnership model is consistent with the sustainable development's notion that the economy and the environment can be developed in compatible ways or win-win situations. In 2000, the United Nations Millennium Summit and Millennium Declaration was based on promoting a partnership based approach to deal with poverty and other issues through the so called Millennium Development Goals(MDGs)(UN 2000). The Report of the World Summit on Sustainable Development meeting in Johannesburg, South Africa, endorsed too in 2002 the idea of inclusive and integrated development(UN 2002). Even the World Bank proposed in the late 1990s a new holistic and inclusive approach to development called “the Comprehensive Development Framework”(WB 2004), still in used today as the need for change was and is still pressing.

##### ***ii) The decarbonisation program through the UNFCCC and the Kyoto Protocol***

Still increasing environmental concerns and a series of dry summers led finally in 1988 to the creation of the Intergovernmental Panel on Climate Change(IPCC)(Jackson et al 2001) with the task of looking scientifically at global warming, its causes, and possible solutions and report on them. And then, the need to link sustainable development policies to climate change mitigation and adaptation programs became clearer. And there is no doubt that the formal recognition of the climate change problem as a problem increasingly driven by anthropocentric causes made the need to decarbonise the atmosphere a more urgent task leading to the wide support that most countries have given to the United Nations Framework Convention on Climate Change(UNFCCC) program since its creation in 1990, a model that brought together scientists and decision makers to set up the general policy structure to address climate

change.

With the support of the IPCC, the UNFCCC managed to achieve the adoption of the Kyoto Protocol by 1997, a model that contains the specific policy structures and instruments believe to be needed to properly address the climate change issue and which are legally binding. The relevance of human interactions as drivers of climate change is being day by day better documented(IPCC 2007) and it is expected that by 2009 the implementation of the Bali Road Map approved by the 13<sup>th</sup> Session of the UNFCCC in December 2007 in Indonesia will lead to concrete progress when dealing with climate change through a better Kyoto process and related mechanisms(UNFCCC 2007).

The UNFCCC program seeks in general to free the atmosphere from greenhouse gases and identify ways of encouraging avoiding more human contributions to the problem; and the Kyoto Protocol is an associated program, which contains the binding mechanisms with specific targets to be met by measures at the country level or through market oriented mechanisms such as emissions trading, the clean development mechanism, and joint implementation. It is known that climate change concerns and sustainable development goals can be connected through implementation of emission reduction projects and work on developing analytical tools, especially in the context of developing countries, is underway(Markandya and Halsnaes 2002). However, it can be said that Kyoto markets appear to be designed only as a place for inter country trading of environmental services where developed countries(The better off, richer stakeholders) are the buyers and developing countries(The worse off, poorer stakeholders) are the sellers.

Moreover, it is believed that environmental markets can be used to address the polluting activities of developed countries while transferring resources to developing countries in a way that the world environment benefits(UN 1994). Research in this area is a priority right now, specially in developed countries where emission targets are binding, and where the energy industry is a very important player and it feels threaten. For example, research is being carried out in OECD countries to determine appropriate baselines to measure certified emission reductions or sink enhancement programs(OECD 1999b). On the other hand, representatives of industries most likely to be affected by the decarbonisation process such as the energy industry are searching for ways to achieve a sustainable status(TAI 1998). The importance of the need to integrate climate change action and sustainable development to produce sustainable and climate change friendly development plans is highlighted in the recent Overview of United Nations Activities in Relation to Climate Change presented by the secretary general(UN 2008)

### **iii) The adaptation program associated to the UNFCCC and the Kyoto Protocol**

There seems to be a general agreement that climate change is already at work right now, and the need for adaptation is very real and urgent(UNFCCC 2006). The need to ensure that poor countries(poor people and minority groups) can deal with actual climate change impacts through mitigation, adaptation and prevention programs has led to calls to put forward mechanism of financial and technical support and aide aimed among other things to assess and address the vulnerabilities of those more at risk such as developing countries(UNFCCC 2007).

It is known that the poor and disadvantage are more likely to be affected the most by climate change and therefore, they are the ones who need or will need the resources necessary to survive; and this concern appears to be at the centre of the recent decision of the UNFCCC's 13<sup>th</sup> Session in Bali, Indonesia to enhance action on adaptation to better protect the poorest countries and social groups(UNFCCC 2007) as they get ready for the planned conference in Copenhagen 2009.

We should also keep in mind that the success of the UNFCCC and the Kyoto process will depend partly on how serious decision makers really are in addressing climate change issues; and partly on the reliability of the information and of predictions provided by the IPCC. For example, it has been indicated that most annex 1 countries in the Kyoto Protocol are committed to and actively working at achieving

their CO<sub>2</sub> emission reduction targets except countries like USA, Australia, and Canada who have currently and apparently not intention to be CO<sub>2</sub> emission reduction bound(DSF 2006). And it has been reported that the IPCC has been recently criticised for making too optimistic predictions that lead to underestimating the severity of the climate change's techno-challenges and leaving smaller emission reduction targets to be dealt by policy makers.(CBC 2008).

And finally, it seems that as long as the option to display a development behavior that has a weak landscape-strong emission impact at the same time continues to be the most politically feasible development option in all countries(Muñoz 2004), this type of development should be expected to persist and be at the centre of the current decarbonisation and adaptation process.

#### ***e) Non-natural sustainability***

All programs , the sustainable development program, decarbonisation program, and the adaptation program can be seen as three mechanisms designed to induce a sort of non-natural sustainability scenario where the ultimate goal is to properly manage the over all concentrations of greenhouse gases in the atmosphere through human induced/controlled/imposed processes or human-environment stability. For example, sustainable development is believed to be constrained by an existing unbalanced ratio of population to natural system scale, a world where population levels and the composition of the atmosphere are stabilized is being desired(Firor and Jacobsen 2002).

#### ***f) The need to present and link complex issues in simple terms***

There is no doubt that sustainable development issues and global warming issues are complex issues which are very often studied as separate issues, yet there seems to be an understanding that they are linked. When looking at them as separate issues, structural interactions that may be relevant in sustainability terms may be missed. Therefore, there seems to be a need to find ways to present and link these issues systematically and in simple terms to point out relevant structural interactions and sustainability issues; and this paper attempts to do that using qualitative comparative means.

### **Goals of the paper**

This paper has the following goals: a) To describe, using a qualitative comparative based approach, the evolution of economic models that are responsible for the carbonisation of the atmosphere and to highlight some of their main general characteristics; b) To stress that there can be two types of mixed economy systems; c) To state that sustainable development can be expressed in essence as a green mixed economy based on partnership principles; and to use this structure to point out its sustainability implications.; d) To show that the framework aimed at decarbonising the atmosphere can be thought as a process focused on decarbonising sustainable development; and to use this approach to extract its sustainability implications; and e) to indicate how the decarbonisation process would work with or without appropriate adaptation programs and use this to highlight related sustainability issues.

### **Methodology**

First, qualitative comparative means are used to introduced an economic system variability model that it is based on the notion of whether or not the economic system is dominated by subsistence forces or industrial forces or both types of forces at the same time. Second, the four types of economic models possible under such a notion are listed and their main characteristics highlighted. Third, it is pointed out that mixed economies reflect better current development structures; that they can be either exclusive or

inclusive; and that inclusive development models are currently preferred and being encouraged.. Fourth, it is shown how we can link sustainable development to green inclusive mixed economic models; and the sustainability issues arising from such a framework are stressed.. Fifth, it is indicated how we can think of plans to decarbonise the atmosphere as ways of decarbonising sustainable development; and again the sustainability issues immersed in such structure are listed. Sixth, it is stated how the decarbonisation process would behave with or without proper adaptation programs and the sustainability implications of this listed. And finally, some relevant conclusions are provided.

## Terminology

The qualitative comparative terminology used to present the ideas in this paper are listed in Table 1 below:

Table 1

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E = Economic system exist	e = Economic system does not exist
S = Subsistence system active/dominant	s = Subsistence economic system passive/dominated
I = Industrial system active/dominant	i = Industrial economic system passive/dominated
E1 = Non-economic model	E2 = Subsistence dominated economic model
E3 = Industry dominated economic model	E4 = Mixed economic model
E4a = Exclusion based mixed economic model	E4b = Inclusion based mixed economic model
P = Partnership based mixed economic system	p = Non-partnership based mixed economic system
G = Greening the economy	D = Decarbonising the economy
A = Proper adaptation programs exist	a = Improper adaptation programs exist

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## Economic system variability model

Different types of economic systems(E) can be derived by looking at the existence or not of subsistence economic system dominance(S) or industrial economic system dominance(I) or both in dominant form at the same time as stated below:

1)  $E = S + I$

The four system possibilities that can be derived from the above economic variability model(E) are described below:

***i) The non-economic model(E1)***

When there are passive subsistence economic structures(s) and passive industrial structures(i) at the same time, no economy exists. Neither a primitive market exists under these conditions nor an environmental impact can be clearly established. This non-economic model is presented below:

2)  $E1 = si$

Under the non-economy model E1, humanity interacts with nature in an almost imperceptible ways, which appears to reflect actual conditions when the evolution of humanity started and permanent social communities did not exist. This period can be thought as a period where natural sustainability dominated the landscape and the natural balance of gases in the atmosphere.

***ii) The subsistence economic model(E2)***

When only active subsistence economic structures(S) exist, we have a subsistence economic model, which is stated below:

3)  $E2 = Si$

This is a system where subsistence values underline the exchange of goods and services, and their impact on the environment. Hence, under the original subsistence economy model(E2), humanity interacts with nature in ways generally not very noticeable at the regional level with some perceptibility at the local level. The subsistence model E2 appears to reflect the conditions that existed when human beings became sedentary and communities started to live in permanent settings. Due to primitive technology, the original subsistence system(E2) aimed mostly only at fulfilling basic needs or local supply.

Primitive technology also explains the lower levels of efficiency, the smaller impacts on poverty levels, and the smaller impacts on greenhouse gas emissions and on global warming that the subsistence economy had as compared to those of the industrial economies that followed. The implication of the above is that, the original subsistence economic model E2 enjoyed more egalitarian economic and social conditions and high environmental quality. Finally, subsistence economic systems can be thought as the ones starting the carbonisation process of the atmosphere.

***iii) The industrial economic model(E3)***

When industrial structures(I) are in dominant form, we have an industrial economic model, as indicated below:

4)  $E3 = sI$

This is a system where industrial values control the exchange of goods and services and their impact on the environment. Under the industrial model E3, humanity interacts with nature in totally perceptible way even at the regional level. This industrial economic model E3 appears to reflect conditions of full sedentary lifestyles and expanding trends in industrial urban communities during the industrial revolution. Due to advances in technology, industrial economic systems aimed mostly at fulfilling regional needs or regional markets.

This explains their higher levels of efficiency, their more visible economic inequities, their higher impact on poverty levels, their higher impacts on low environmental quality, and their higher impact on

green house gas emissions and on global warming as compared to subsistence economies. The implication of the above is that, the industrial economic model has the potential for leading to less egalitarian economic and social conditions and to lower environmental quality if compared with the subsistence system. Finally, industrial economic systems can be thought as the ones that speed up the carbonisation process of the atmosphere.

***iv) The mixed economic model(E4)***

When there are subsistence structures(S) and industrial structures(I) interacting in active form at the same time, we have a mixed economic model as expressed below:

5)  $E4 = SI$

Under this mixed system E4, the interaction of subsistence and industrial values fuels the exchange of goods and services and their impact on the environment. This mixed economic model E4 appears to reflect the variability of economic structures displayed by most countries today.

Notice that under the mixed economic model E4, humanity interacts with nature in fully perceptible ways too, but both subsistence and industrial systems are thought to be responsible for any negative social and environmental impact created. However, all types of negative industrial impacts are likely to be higher than negative impacts coming from subsistence systems.

Due to the sharing of advanced technology and to the global nature that development issues have taken today, mixed economic systems aim mostly at fulfilling global needs or reaching global markets, and they should therefore be expected to have mixed or combined impacts on global efficiency, on global poverty levels, on global economic equity, on low global environmental quality, and on global green house gas emissions and on global warming.

**Types of mixed economic systems**

Depending on whether or not the interactions of the subsistent(S) and industrial(I) components of the mixed economic system(E4) are based on exclusion/pure competition principles or inclusion/partnership principles(P), there can be two types of mixed systems as indicated below:

***a) The exclusion based mixed economic system(E4a)***

In an environment where global monopolies are promoted, an exclusive subsistence-industrial model would prevail(E4a), which can be stated as follows:.

6)  $E4a = SI$

Hence, mixed economies based on exclusion(E4a) can be thought as the ones that have the potential to maximise the imbalance of greenhouse gases in the atmosphere through their extreme competing dynamics. Notice that in this model, individual self-interest rules.

***b) The inclusion based mixed economic system(E4b)***

In an environment where efficient global partnerships are encouraged, an inclusive subsistence-industrial model would persist(E4b)., which can be expressed as follows:



7)  $E4b = SI$

And these mixed economies based on inclusion(E4b) can be thought as the ones that have the potential to minimise the imbalance of greenhouse gases in the atmosphere by means of effective cooperation. See that in this model, common or group self-interest rules.

**c) *Evolution of mixed economic systems(E4)***

Notice that through time, mixed development structures have moved from exclusive(E4a) to inclusive(E4b) systems in response to changing society values, as it is indicated below.

**The economy only based development model**

The characteristics of the economy only matter type of development working at the pick of the carbonisation process in the late 1980s was based on maximization principles, exclusion, and no social and environmental concerns as indicated in the introduction; and therefore, it has a similar structure as that of an exclusion based mixed model(E4a) mentioned above. In other words, the economy only based development model is an exclusion based mixed model(p), which can be stated as:

8)  $p = SI = E4a$

If the interaction between the subsistence system and the industrial system is exclusive(p), then the negative pressures on society and the environment can be maximised due to extreme competition. In other words, under antagonistic relationships we should expect deeper negative externalities or crises.

**The coming of the eco-economy based development**

The move from the pure economy only based model to the eco-economy based model in response to the environmental crisis can be expressed in several steps as seen below:

**a) *The supremacy of the inclusion based mixed economic model***

As stressed in the introduction, as the negative consequences of development exclusion became more evident, the need implement partnership based development models became urgent and local and international organizations started to promote development approaches that are more inclusive and able to exploit win-win economy-environment situations.

And this led to the abandonment of the exclusion based mixed economic model(p) and to the supremacy of the partnership(P) based mixed economy, which for presentation purposes is stated as below:

9)  $P = SI = E4b$

The formula above simply says that there is a need to balance subsistence(S) and industrial(I) development concerns for the partnership based development(P) to work.

**b) *The need to green the inclusion based mixed economic model***

As environmental concerns became more and more pressing, the need to green(G) the partnership based model(P) became more critical so that economic activities can take place with no or minimum environmental impact, which can be represented as follows:

$$10) \quad G[(P)] = G[(SI)]$$

The formula above simply states that the greening process(G) must be consistent with subsistence(S) and industrial(I) development interactions for the greening of the partnership based development{G[(P)]} to work. Greening process(G) here means making the partnership environmentally friendly.

***c) Linking sustainable development(SD) and the green inclusion based mixed economic model***

As described in the introduction, sustainable development(SD) is about inclusive green economic development; Hence, the greening of the partnership based mixed economic model{G[(P)]} is consistent with the structure and goals of sustainable development(SD) as indicated below:

$$11) \quad G[(P)] = G[(SI)] = SD$$

The above formula indicates that the greening of the inclusion based mixed economic model G[(P)] requires the greening of both partners the subsistence economic system and the industrial economic system at the same time[G(SI)]; which is the essence of full sustainable economic development(SD). In other words, sustainable development(SD) requires the greening of the subsistence-industrial system in order to minimise environmental externalities. And this means that in essence sustainable development(SD) is a green inclusion based mixed economic model{G[(P)]}.

***d) Sustainable development and sustainability issues***

Notice that if only the subsistence systems(S) are required to become green[G(P) = G(S).I] or if only the industrial systems(I) were required to become green[G(P) = S.G(I)], sustainable economic development would be on a very unstable ground in environmental terms.

Moreover, notice that since sustainable development(SD) aims at maximising compatible economic growth in ways that are the least damaging environmentally, it is still possible that it can lead to an unfair allocation of cost and benefits between subsistence and industrial economies, specially on their social sides, which would be a persistent source of social unsustainability.

To succeed then, sustainable development(SD) must find the way to green the inclusion based mixed economic system in ways that are fair to both partners and which are socially friendly at the same time.. In other words, under unfair treatment of partners and social unfriendliness sustainable development(SD) would be a very unstable process.

**Lining sustainable development to the decarbonisation programs**

***a) The decarbonisation of sustainable development***

As highlighted in the introduction, the goal of the decarbonisation program(D) of the United Nations Framework Convention on Climate Change(UNFCCC) is the elimination, if possible, of actual sources of greenhouse gas emissions and the reduction of past greenhouse gas emissions, which is called here the decarbonisation process(D).

Based on formula 11, the global decarbonisation process(D) of the economy being pursued by the UNFCCC framework mentioned above can be stated as follows:

$$12) D[G(P)] = D[G(SI)] = D(SD)$$

The above formula indicates that the decarbonisation of the green partnership based mixed economic model  $\{D[G(P)]\}$  requires the decarbonisation of the green subsistence and industrial system at the same time  $\{D[G(SI)]\}$ ; which is the essence is the decarbonisation of full sustainable economic development  $\{D(SD)\}$ . Therefore, the decarbonisation of sustainable development  $\{D(SD)\}$  can be seen as an attempt by the UNFCCC framework to create a situation where a non-natural balance of greenhouse gases in the atmosphere can be created and sustained. And achieving and maintaining this requires, as formula 12 shows, a balanced policy framework that accommodates both subsistence and industrial interactions at the same time; and therefore, we need a system approach to the issue.

***b) The decarbonisation of sustainable development and sustainability issues***

See that if only the green subsistence systems  $[G(S)]$  are required to be decarbonised  $\{D[G(S)].G(I)\}$  or if only green industrial systems  $[G(I)]$  were required to become decarbonised  $\{G(S).D[G(I)]\}$ , decarbonised sustainable economic development (subsistence or industrial) would be on a very unstable ground. .

Moreover, notice that since decarbonisation of sustainable development  $\{D(SD)\}$  aims at maximising compatible economic growth in ways that are if possible, environmentally enhancing or at least neutral, it is still possible that it can lead to an unfair allocation of cost and benefits between subsistence and industrial economies, especially on their social sides, which again would be a source of social unsustainability. Hence, decarbonisation approaches of sustainable development that reflect again only green concerns may not be a sustainable processes as they reflect non-optimal solutions in social terms.

To succeed then, decarbonisation programs of sustainable development  $[D(SD)]$  must find the way to decarbonise the green inclusion based mixed economic system in ways that are fair to both partners and which are socially friendly at the same time.. Otherwise, under unfair treatment of partners and social unfriendliness the decarbonisation(D) mechanism of sustainable development(SD) would be a very unstable process. In other words, for decarbonisation programs such as the UNFCCC and the Kyoto Protocol to work, economic policies, environmental policies, regulations, and tax policies must be made in a way that are partner and socially friendly at the same time.

**Linking decarbonisation programs to adaptation programs**

Hence, there is a need to implement decarbonisation programs in a way that they benefit or protect even the more vulnerable ones in society, and the effectiveness of these programs depends on the existence or provision of proper adaptation programs(A) or improper adaptation programs(a), as explained below: Notice that for presentation purposes here proper or improper adaptation programs also includes the existence or not of the resources needed for effective mitigation and prevention too.

***a) Decarbonisation without proper adaptation programs(a)***

If the decarbonisation program expressed in formula 12 is implemented without a proper adaptation programs(a), it would not work as it would be socially unsustainable, which it can be presented as follows:

$$13) a\{D[G(P)]\} = a\{D[G(SI)]\} = a\{D(SD)\}$$

See that a decarbonisation program without a proper adaptation package  $\{a[/D(SD)]\}$  even when it is partner friendly would not be sustainable as it would be socially unfriendly. And this situation would be

more severe in the poorest countries or poorest segments of society where vulnerability is worse; and this concern may be behind the adaptation packages just recently added to the UNFCCC and Kyoto protocol.

**b) Decarbonisation with proper adaptation programs(A)**

If the decarbonisation program expressed in formula 12 is implemented with proper adaptation programs(A), other things being equal, it would be sustainable, which can be stated as follows:

$$14) A\{D[G(P)]\} = A\{D[G(SI)]\} = A[D(SD)]$$

Notice that a decarbonisation program implemented with proper adaptation package{A[/D(SD)]} would be sustainable, except when there is no partnership fairness.

**c) Adaptation programs and sustainability issues**

Without proper adaptation programs(a), decarbonisation processes would be unsustainable even when there is partner fairness. With proper adaptation programs(A) and partnership fairness, decarbonisation processes would meet the sustainability requirements. In other words, with appropriate adaptation programs(A), the UNFCCC and Kyoto protocol as decarbonisation programs, other things being equal, could meet the full sustainability structure.

**Conclusions**

It was shown using qualitative comparative means how we can link sustainable development, decarbonisation programs and adaptation programs systematically. It was stressed that sustainable development is in essence an inclusive green mixed economic model. It was pointed out that the decarbonisation process represented by the UNFCCC and the Kyoto Protocol can be stated as a process aimed at decarbonising sustainable development. And finally, it was indicated that without the provision of proper adaptation packages, especially to the poorest segments of society and other things being equal, the process of decarbonising sustainable development should be expected to be very socially unsustainable process.

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