Citation:

Muñoz, Lucio, 2003. Linking Sustainable Development Indicators by Means of Present/Absent Sustainability Theory and Indices: The Case of Agenda 21, GDS, IIG, Spain.

Linking Sustainable Development Indicators by Means of Present/Absent Sustainability Theory and Indices: The Case of Agenda 21

By

Lucio Munoz*

*** Independent Qualitative Comparative Researcher / Consultant, Vancouver, BC, Canada Email: munoz@interchange.ubc.ca**

Abstract

The Agenda 21 Framework of Indicators of Sustainable Development has many advantages related to its simple and standard structure. However, it has many limitations such as: it is not clear how the different categories/ systems in the framework(social, economic, environmental, and institutional) are linked; it is not clear how the different sets of indicators within each system(driving forces, state indicators, and response indicators) are connected; it is not clear how a holistic assessment of systems or indicator sets can be carried out; the formulation and use of specific indices is not encouraged making the assessment of progress a little more difficult; and the framework is practically a listing of sustainable development concerns. INCA(1997) highlights the following disadvantages with respect to the Agenda 21 framework: it does not provide a measure of progress because there is no attempt to aggregation and there are too many indicators in the list; it does not provide a measure of linkages among issues; it lacks a holistic perspective; and it has a disproportionate focus of environmental/biophysical indicators. All the above limitations seem to be based on the fact that the Agenda 21 Framework is not based on sustainability theory. The goals of this paper are two: to present the theoretical basis of a sustainability framework that can be used to place the Agenda 21 Framework within the domain of sustainability theory and indices; and to show how the full set of sustainable development indicators in the Agenda 21 framework could be handled within this sustainability framework.

1.0 Introduction

1.1 The isolated role of indicators

Indicators can be defined as the guiding lights toward understanding static and non-static conditions with respect to an aspect of interest. For example, they can provide an insight into the actual state of a selected variable or into the pattern of change of this particular variable through time, place, or scale. Maclaren(1996) points out two important aspects of indicators: they can be used as complexity simplifiers; and they can communicate a condition or problem. These characteristics of indicators are important for policy planning and making as simplified or summarised actual and historical information is easier to convey to information users. UN(1996) states that indicators can provide useful means to trace progress made toward sustainable development. Indicators can be of social, economic, or environmental nature, and their quality if usually associated with their ability to connect practical conditions to policy options. For example, in the case of environmental indicators, WB(1997) points out that good indicators are those that link environmental measurements to practical policy options. Hence, the acceptability of indicators as efficient means of signalling leading roles, conditions, and required actions is well recognised regardless of any theoretical/methodological gap that may exist in their formulation or structure. We need indicators to measure sustainable development and its progress(WB 1997).

Traditionally, indicators have been conceived, used, or formulated within a compartmentalised framework in which they describe the actual and changing state of particular systems under the assumption of minimal or no interaction with other indicators or systems. For example, the traditional economic development model uses indicators totally uncoupled in theory and in practice from social and environmental indicators: GNP measures do not reflect social and environmental links and concerns. Jaffee(1998) points out concerns related to the adequacy of GNP as a measure of development as it does not includes all values. Elliottt(1998) indicates that GNP does not measure external costs such as degradation and depletion of resources. Social paradigms, on the other hand, are based on state of mind apparently unattached to economic and environmental concerns: social well-being is the main objective or social goals are dominant. Finally, ecology paradigms are formulated within a well articulated framework in which it is assumed that the environment can be preserved without disrupting economic and social systems: environmental concerns are paramount. Meyer(1998) mentions that this view sees nature as a garden to be restored.

1.2 The need to integrate indicators

The recognition of the binding nature of environmental and social interdependence in traditional sustainable development theory has led to the need to find way to integrate indicators and paradigms. Roome(1998) points out that sustainable development provides a way that can be used to integrate the environmental, social, and economic aspects of human's actions at all levels from local to global. The need to integrate indicators is directly related to a process of interdependence. For example, GOFC(1998) stresses that the importance given to environmental interdependence internationally is on the increase. However, most efforts have been directed at integrating economic and environmental indicators(today's dominant model), which in this paper is labelled the eco-economic development model. One of the implications of this trend it that within this eco-economic development model, social indicators are considered complementary indicators while

economic and environmental indicators are taken as primary indicators. Hence, when measuring progress or looking for win-win situations, social concerns are most likely to be assumed away or to be underestimated.

The need to integrate indicators is closely linked to the need to connect in measurable ways local, regional, and global development conditions. This need suggest another need, the need to have a both ways top-down state of mind as the basis of effective indicator formulation and planning. For example, one of the most accepted principles within the green-economic development model is that of thinking globally and acting locally. However, for this state of mind to be effective, it must work the other way around too: local thinking must be consistent with global actions. This way, global-local interdependence is effectively recognised and put into a context in which global-local challenges can be addressed in a holistic and integrated fashion. INCA(1997) highlights the need to construct indicators that can provide solid bases to decision-making processes consistent with sustainable development principles at all levels, and which can contribute to self-regulating sustainability.

1.3 Sustainable development indicators in Agenda 21

WB(1997) describes three types of indicator sets: individual indicators sets, based on a system of driving, state and response indicators in list form such as the Organisation of Economic Cooperation and Development(OECD) indicator program, and the Commission of Sustainable Development(CSD) indicator program; thematic indicators in which indicators are selected by theme or topic; and systemic indicators, where system structured indicators are used.

One of the most supported framework today is the CSD indicator program or Agenda 21 Framework because it is one of the best examples where the selection and integration of sustainable development indicators has been done with local country flavour and support. It is based on the notion that local action is paramount if we want to achieve traditional sustainable development(sustained development). Hence, local sustainable development goals are the concerns behind the set of sustainable development indicators chosen in order to search for a more environmentally friendly economic future. Therefore, the need to assess local progress toward sustainable development is an essential and accepted goal.

The Agenda 21 framework is based on a set of over 130 social, economic, environmental, and institutional indicators organised into three categories: driving force indicators, state indicators, and response indicators. Some of the advantages of this framework are: it groups and uses the most important indicators in each local system facilitating the gathering of relevant information in an organised manner; it provides information about driving forces, state indicators, and responses in a very simple framework; it allows for the modelling of traditional sustainable development concerns; and it is based on a consensus approached to select and define accepted sets of indicators.

1.4 Problems with the Agenda 21 Framework

Some of the disadvantages of the Agenda 21 framework are the following: it is not clear

how the different categories/ systems in the framework(social, economic, environmental, and institutional) are linked; it is not clear how the different sets of indicators within each system(driving forces, state indicators, and response indicators) are linked; it is not clear how a holistic assessment of systems or indicators sets can be carried out; no attempt is made at aggregating indicators into specific indices; and the framework is practically a listing of sustainable development concerns.

The most likely source of the above limitations in the Agenda 21 framework is the fact that the framework is not based on sustainability theory. Hence, it can not provide an indication of over-all system sustainability or system specific sustainability or sub-system specific sustainability. All these issues are imposing strong limitations on the Agenda 21 framework to assess and monitor index/indicator trends in an integrated way so that their relative contribution to sustainability through time can be assessed.

INCA(1997) highlights the following disadvantages with respect to the Agenda 21 framework: it does not provide a measure of progress as no attempt to aggregation is made; it contains too many indicators; it does not provide measures of linkages among issues; it is not based on a holistic perspective; and it is focused disproportionately on environmental/biophysical indicators.

1.5 The Goals of this Paper

The above discussion suggest that the Agenda 21 set of sustainable development indicators reflect traditional sustainable development concerns(sustained development), not sustainability concerns(self-sustained development). This is part of the reason behind the lack of holistic approach and the lack of theory to base the linking of different sets of indicators and/or different levels of analysis. The goals of this paper are two: to present the theoretical basis of a sustainability framework that can be used to place sustainable development indicators within the domain of sustainability theory and indices; and to show how the sustainable development indicators in Agenda 21 framework could be handled within this sustainability framework.

2.0 Presenting the Sustainability Methodology

2.1 Terminology and operational concepts

2.1.1 Terminology

Table 1 below summarises the terminology used to present the ideas contained in this paper:

Table 1 : Terminology used

S = Sustainability

A = Social System

B = Economic System

C = Environmental System

D = Development

*** = Ideal Condition**

A_1 = Social characteristic 1 is present

a_1 = Social characteristic 1 is absent

B_1 = economic characteristic 1 present

b_1 = economic characteristic 1 absent

C_1 = environmental characteristic 1 present

c_1 = environmental characteristic 1 absent

2.1.2 Operational concepts

*** Ideal Development: it refers to optimal development, development that takes place when all its ideal characteristics are present;**

*** Ideal System: it refers to optimal system, a system where all the desired characteristics for the ideal functioning of that system are present;**

*** Desired Characteristics: it refers to the social, economic, and environmental aspects that are required for optimal development to take place.**

2.2 The Sustainability Model

A sustainability(S) model can be stated as follows:

*** * * ***

S = D = ABC

The above expression indicates that sustainability(S) exist when ideal development(D) takes place. It also indicates that a necessary and sufficient conditions for Sustainability(S) or optimal development(D) to take place is the presence of the social system(A), the economic system(B), and the Environmental System(C) in their ideal form at the same time through time. In other words, Sustainability(S) is a function of the ongoing interaction of three ideal systems, the social(A), the economic(B), and the environmental (C) systems.

Figure 1 below summarises the sustainability model stated above:

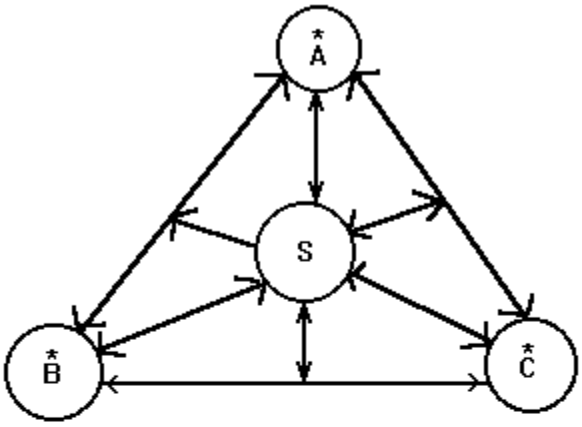

Figure 1 THE SUSTAINABILITY FRAMEWORK
It indicates that sustainability (S) is at the heart of ideal social development (A), ideal economic development (B), and ideal environmental development (C).

The figure indicates that sustainability(S) is at the centre of ideal social(A), economic(B), and environmental(C) development Hence, sustainability(S) captures social, economic, and environmental ideal direct interactions and trade offs. Figure 1 allows us to see the presence of stability within the sustainability triangle resulting from the active interaction of factors within ideal systems and between ideal systems.

The definition of sustainability presented above differs from other existing definitions of sustainability in terms of completeness and detail. For example, Hodge(1996, P. 268) defines sustainability as the persistence over apparently indefinite future of certain necessary and desired characteristics of both the ecosystem and the human subsystem within. Comparing this definition with the model above, we can see the following in Hodge's definition of sustainability: it does not include all desirable characteristics; it does not include the concept of "sufficient conditions"; it does not requires conjunctural desired characteristics; and it apparently lumps both the society and the economy within the human subsystem making their relevance less transparent. Hence, Hodge's definition of

sustainability appears to be incomplete or refers to a very narrow notion of sustainability.

2.3 Measuring Progress Toward Sustainability

Measuring progress toward Sustainability requires a Sustainability vision, and a consistent set of sustainability tools, indicators and indices, to be able to look at progress in a holistic and systematic fashion. The sustainability vision as indicated above is an ideal vision, and must be guided by ideal goals.

Based on this ideal vision and goals, it is possible to determine ideal/desired social, environmental, and economic indicators. Once this is done, then it is possible to link the different indicators to ideal subsystem and system specific indices and to general system indices. With help of these different types of ideal indicators and indices, it is possible to set up an institutional framework to determine and monitor actual subsystem specific, system specific, and general system sustainability conditions in a very simple manner continuously, period after period, to determine appropriate policy action/reaction. Below there is a general description of how the above can be accomplished.

2.3.1 Selection and Definition of the Desired Characteristics

First, a participative process involving social, economic, and environmental agents should be used to determine the ideal characteristics of the social system, the economic system, and the environmental system required for optimal development to take place. Then, each characteristics should be clearly defined to facilitate the selection of suitable indicators. While it is possible to incorporate all ideal characteristics in the modelling process in theory, budgetary, institutional, and other limitations usually call for the determination of priorities. Therefore, the set of social, economic, and environmental characteristics considered critical for the survival of the subsystem or system, and which can be made operational must be selected through this participatory process;

Let's assume for demonstration purposes that the participatory process led to the determination of three essential characteristics for the optimal working of each system, social (A), economic(B), and environmental(C) system as indicated below:

*** * * * * * * * * * * ***

$A = A_1A_2A_3$ $B = B_1B_2B_3$ $C = C_1C_2C_3$

Where;

*** * ***

A_1,A_2,A_3 = characteristics that need to be present in the optimal social system

*** * ***

B_1,B_2,B_3 = characteristics that need to be present in the optimal economic system

*** * ***

C_1,C_2,C_3 = characteristics that need to be present in the optimal environmental system

The three expressions above indicate that for optimal social development(A), optimal economic development(B), and optimal environmental development(C) to take place, their three ideal characteristics must be present at the same time. A desired social characteristic could be social well-being; a desired economic characteristics could be economic well-being, and a desired environmental characteristics could be environmental health. Please, notice that under incomplete information, it is possible that the selection of critical characteristics may not be complete or accurate, but may reflect general conditions.

2.3.2 Selection and Definition of the Appropriate Set of Indicators

The participatory process should also select and define the indicators that best reflect the ideal characteristics considered essential to the working of the sustainability system. Stakeholder dynamics must also decide which of the traditional indicators are going to continue in use unchanged, which traditional indicators should be abandoned or modified, and which other indicators are needed and should be developed. They also must decide which criteria must be used to considered an indicator present or absent. Finally, The indicators chosen can be qualitatively based or quantitatively based.

For presentation purposes, let assume that one indicator was found to be appropriate for each of the desired characteristics mentioned above. Then, the following holds:

*** * * * * * * * * * * ***

$\mathbf{A = I_{A1}I_{A2}I_{A3}}$ $\mathbf{B = I_{B1}I_{B2}I_{B3}}$ $\mathbf{C = I_{C1}I_{C2}I_{C3}}$

Where;

*** * ***

$\mathbf{I_{A1}, I_{A2}, I_{A3}}$ **= indicators that need to be present in the optimal social system**

*** * ***

$\mathbf{I_{B1}, I_{B2}, I_{B3}}$ **= indicators that need to be present in the optimal economic system**

*** * ***

$\mathbf{I_{C1}, I_{C2}, I_{C3}}$ **= indicators that need to be present in the optimal environmental system**

The above optimal social(A) model, optimal economic(B) model, and optimal environmental model(C) are based on the assumption that the selected ideal indicators when present reflect optimal conditions/characteristics. Figure 2 below placed this directly into context:

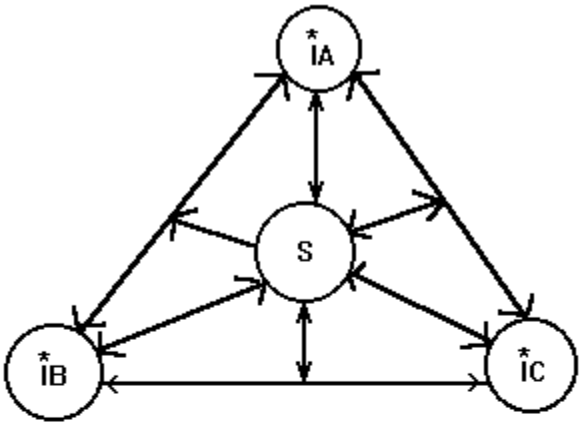

Figure 2 THE SUSTAINABILITY INDICATOR FRAMEWORK
It indicates that sustainability (S) is present when all ideal social indicators (IA), economic indicators (IB), and environmental indicators (IC) are present at the same time. This framework allow us to assess and monitor sustainability conditions by looking at the presence or absence of those ideal indicators in practice.

Notice that figure 2 indicates that for sustainability to take place and be measured we need to determine and select the ideal social, economic, and environmental indicators that need to be present for sustainability to take place.

Please, notice that under incomplete information, knowledge and technological gaps, the indicators selected may not be totally accurate, but could be a good aid to identifying the direction of dominant patterns and conditions.

2.3.3 Preparation of System and Subsystem Specific Indices

Once, the number and nature of the indicators to be used is fixed, then system specific indices can be developed to link the set of indicators within the social system, within the economic system, and within the environmental system. This will provide information relevant to understanding the internal dynamics of each system; and to comparing system-system dynamics.

The system specific sustainability index can be found based on the following formula:

$$SSI_{T1} = P_{T1} / N_{T1}$$

Where;

P_{T1} = No. of desired characteristics present in system $_{T1}$.

N_{T1} = Total No. of desired characteristics in system $_{T1}$.

SSI_{T1} = Sustainability index for system $_{T1}$.

Implications from the system specific sustainability index(SSI_{T1}) are the following:

- if $P_{T1} = N_{T1}$, then $SSI_{T1} = 1$. Therefore, full sustainability exist;

- if $P_{T1} = 0$, then $SSI_{T1} = 0$. Therefore, full unsustainability exist;

- the range of the system specific sustainability index(SSI_{T1}) is from zero to one since

$0 \leq SSI_{T1} \leq 1$

Notice that the system specific sustainability index(SSI_{T1}) can also be broken into sub-system specific sustainability indices. For example if we have the following:

$$SSI_{T1} = P_{T1} / N_{T1}$$

$$SSI_{T1L} = P_{T1L} / N_{T1L} \; ; \; SSI_{T1Q} = P_{T1Q} / N_{T1Q}$$

Then, the system specific sustainability index(SSI_{T1}) can be expressed in two more different forms as follows:

- as the result of dividing the total number of desired characteristics present in the two subsystems by the total number of desired characteristics within both subsystems:

$$SSI_{T1} = P_{T1L} + P_{T1Q} / N_{T1L} + N_{T1Q}$$

- as the result of averaging the two sub-system specific sustainability indices:

$$SSI_{T1} = SSI_{T1L} + SSI_{T1Q} / 2$$

Notice also that the system specific sustainability index(SSI) for the ideal social, economic, and environmental system equals one since all the three desired characteristics must be present for the ideal systems to exist. For example, the sustainability index for the ideal social system(SSI_A) can be expressed as follows:

*****

$SSI_A = P_A / N_A$; since $P_A = N_A = 3$

Therefore;

*

$SSI_A = 3 / 3 = 1$

2.3.4 Preparation of A General System Sustainability Index

Once the set of subsystem and system sustainability indices has been developed, then they can be linked directly by the means of a general system sustainability index(GSSI), which can be found by at least four different means:

- direct calculation

$$GSSI_{T1T2T3} = P_{T1T2T3} / N_{T1T2T3}$$

- by means of dividing the total number of desired characteristics present in the three systems by the total number of desired characteristics attached to all these systems:

$$GSSI_{T1T2T3} = P_{T1} + P_{T2} + P_{T3} / N_{T1} + N_{T2} + N_{T3}$$

- by means of averaging the three system specific sustainability indices:

$$GSSI_{T1T2T3} = SSI_{T1} + SSI_{T2} + SSI_{T3} / 3$$

- by means of averaging all the all the subsystem specific sustainability indices(assuming that each of the three systems has two subsystems):

$$GSSI_{T1T2T3} = SSI_{T1L} + SSI_{T2L} + SSI_{T3L} + SSI_{T1Q} + SSI_{T2Q} + SSI_{T3Q} / 6$$

For example, the general system sustainability index for the ideal model can be found as follows:

*

$$GSSI_{ABC} = P_A + P_B + P_C / N_A + N_B + N_C$$

$$= 3 + 3 + 3 / 3 + 3 + 3 = 1$$

2.3.5 Determination of Sustainability Conditions on the Ground

Once the set of indicators, and the subsystem, system, and general system sustainability indices are in place, then we can proceed to test whether or not the indicators are present in practice. This testing is done based on the criteria developed during the participatory process. Let's assume that the following situation was found on the ground:

_ * * * _ * * * _ * * *

$A_1 = a_1A_2A_3$ $B_1 = B_1b_2B_3$ $C_1 = c_1c_2c_3$

Where;

– – –

A_1, B_1, C_1 indicate the actual social, economic, and environmental conditions on the ground. Given these findings, then the following information can be generated:

–

$SSIA_1 = 2/3 = 0.67$

–

$SSIB_1 = 2/3 = 0.67$

–

$SSIC_1 = 0/3 = 0$

___

$GSSIABC_1 = 2 + 2 + 0 / 3 + 3 + 3 = 4 / 9 = 0.44$

The above information indicates the level of sustainability of each system and the over all system.

2.3.6 Determining System Specific and General System Sustainability Gaps

Once the above information is generated, then actual-ideal system specific and general sustainability index gaps can be found as follows:

– *

$SG_{A1} = SSIA_1 - SSIA = 0.67 - 1 = -0.33$

– *

$SG_{B1} = SSIB_1 - SSIB = 0.67 - 1 = -0.33$

– *

$SG_C1 = SSIC_1 - SSIC = 0.00 - 1 = -1.00$

___ * * *

$GSG_{ABC1} = GSSIABC_1 - GSSIABC = 0.44 - 1 = - 0.56$

The above sustainability gaps indicate how far are actual social, economic, environmental, and general system conditions are from ideal ones. In this example, the environmental system is fully unsustainable.

Please, notice that the sustainability gap between actual and ideal indices worsen as it tends to -1 and improves as it tends to zero. Also notice, that the general system sustainability gap(GSG) is affected the most by the environmental system sustainability gap(ESG).

2.3.7 Monitoring progress toward full sustainability

Once the framework described above is in place, monitoring tasks become very simple. In the following year or period, we just need to determine again whether or not the desired characteristics of the systems involved are present or absent.

Then, this information can be compared to previous information to determine the degree of change, which in this framework can be positive or negative depending on whether we are gaining or losing ideal characteristics through time.

For example, if the new conditions are the following:

$\bar{A}_2 = a_1A_2A_3 \quad \bar{B}_2 = B_1b_2B_3 \quad \bar{C}_2 = C_1C_2c_3$

Based on this new information, the following information can be generated:

$SSI\bar{A}_2 = 2/3 = 0.67$

$SSI\bar{B}_2 = 2/3 = 0.67$

$SSI\bar{C}_2 = 2/3 = 0.67$

$GSSIABC = 6 / 9 = 0.67$

By comparing the above information with information from the previous period, we can see the following:

$SSI\bar{A}_2 - SSIA_1 = 0.67 - 0.67 = 0.00$

$SSI\bar{B}_2 - SSIB_1 = 0.67 - 0.67 = 0.00$

$SSI\bar{C}_2 - SSIC_1 = 0.67 - 0.00 = +0.67$

$GSSIABC_2 - GSSIABC_1 = 0.67 - 0.56 = +0.11$

Therefore, the situation on the ground for the social system(A) and the economic system(B) did not change as they have an index change of zero. The environmental

sustainability shows a positive index change signalling an improvement, which led to an improvement in the general system sustainability index too.

More information can be generated by looking at the sustainability gaps in this new situation:

*****

$$SG_{A2} = SSIA_2 - SSIA = 0.67 - 1 = -0.33$$

*****

$$SG_{B2} = SSIB_2 - SSIB = 0.67 - 1 = -0.33$$

*****

$$SG_{C2} = SSIC_2 - SSIC = 0.67 - 1 = -0.33$$

*** * ***

$$GSG_{ABC2} = GSSIABC_2 - GSSIABC = 0.67 - 1 = -0.33$$

The above implies that the actual-ideal sustainability index gap for the social and economic systems did not change, but both the environmental system gap and the general system sustainability gap became smaller.

In conclusion, the sustainability model presented above allow us to do the following: it allows us to directly link the over all sustainability objective with the system and subsystem specific objectives; it indicates the relative contribution of the different elements of the system to over all sustainability; it is able to handle both qualitative and quantitative data; it allows us to see indicator and indices trends which can help to determine remedial or preventive action; it can be used to assess the distance between actual and ideal sustainability conditions through time; and f) it can be used to monitor changes over time in relevance in comparison to the whole system, other systems or in comparison with other elements of the same system.

3.0 Testing the Methodology

3.1 The Agenda 21 framework of sustainable development indicators

In general terms, the Agenda 21 sustainable indicator framework is consistent with the theory described above: indicators have been selected through a participatory process; all sustainable development indicators are classified in four categories: social, economic, environmental, and institutional. All indicators within each category are subdivided into three groups: driving force indicators, state indicators, and response indicators; the policy relevance and significance of each indicator is provided; methodological issues around each indicator in terms of definition and measurement are covered; and the data availability of each indicators is addressed.

Hence, the general structure of Agenda 21 framework facilitate the reorganisation of indicators in order to make them consistent with the sustainability theory and

sustainability indices. The reorganisation process includes the restatement of the sustainability model in a way consistent with the Agenda 21 framework and the reclassification of data collected on each indicator in qualitative form as it is explained later. This reorganization will make it possible to get insight into the over all system sustainability structure(general sustainability), specific category sustainability structure(system specific sustainability), and specific group sustainability structure(subsystem specific sustainability).

3.2 Redefining the Sustainability Model

To facilitate the presentation and reorganisation of Agenda 21 indicators, the sustainability model can be restated as follows:

*** * * ***

S = ABCI ;

Where;

*****

A = ideal social system

*****

B = ideal economic system

*****

C = ideal environmental system

*****

I = ideal institutional system

Therefore, sustainability(S) results from the active interaction of the four ideal systems. Notice, that the only difference between the above sustainability(S) model and the one presented in section 2.2 is that all the ideal social, economic, and environmental institutional indicators are factor out to make up the ideal institutional system. In this case, we have a four system sustainability model as shown in figure 3 below.

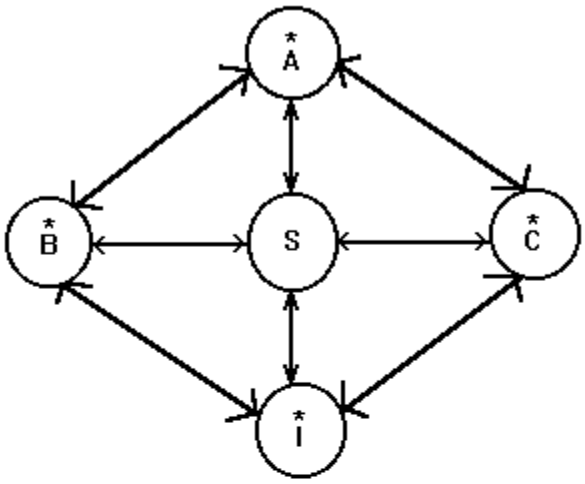

Figure 3 THE FOUR SYSTEM SUSTAINABILITY FRAMEWORK
This is the framework consistent with the four system structure of Agenda 21. Here sustainability(S) is achieved when all the ideal characteristics of the social system(A), the economic system(B), the environmental system(C), and the institutional system(I) are present at the same time.

Figure 3 indicates the interdependence or active interaction of these four systems in the sustainability framework consistent with Agenda 21.

Since each ideal system or category can be divided into three groups, driving forces(DF), state indicators(ST), and response indicators(RP), the sustainability(S) model can again be restated as follows:

*** * * * * * * * * * * ***

$$S = DF_A ST_A RP_A DF_B ST_B RP_B DF_C ST_C RP_C DF_I ST_I RP_I$$

Where;

*** * * ***

$$A = DF_A ST_A RP_A$$

*** * * ***

$B = DF_B ST_B RP_B$

*** * * ***

$C = DF_C ST_C RP_C$

*** * * ***

$I = DF_I ST_I RP_I$

Hence, sustainability(S) comes from the active interaction of ideal driving force indicators(DF), state indicators(ST), and response indicators(RP) within each of the four ideal systems mentioned above.

Please, notice that we can separate the set of indicators as follows:

*** * * * ***

$DF = DF_A DF_B DF_C DF_I$

*** * * * ***

$ST = ST_A ST_B ST_C ST_I$

*** * * * ***

$RP = RP_A RP_B RP_C RP_I$

Hence, the sustainability(S) model can be restated as function of the conjunctural interaction of the three ideal types of indicators as follows:

*** * ***

S = DFSTRP

Figure 4 below describes how driving force indicators(DF), state indicators(ST), and response indicators(RP) are related or linked to sustainability(S).

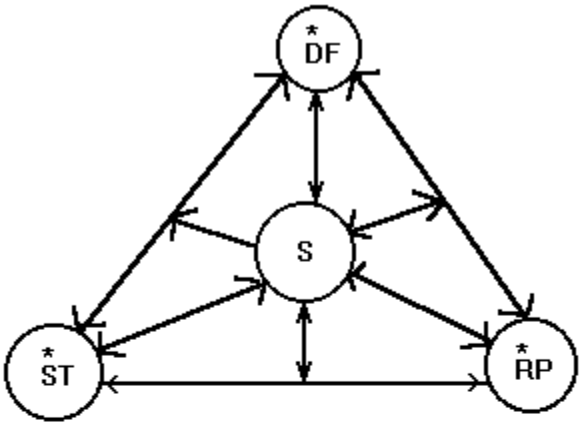

Figure 4 THE INDICATOR BASED SUSTAINABILITY FRAMEWORK
It shows a sustainability model (S) dominated by the interaction of driving force indicators(DF), state indicators(ST), and response indicators(RP) in their ideal form.

The some aspects that can be highlighted from figure 4 are the following: driving forces(DF) affect the level of sustainability; state indicators(ST) affects the policy responses(RP); response indicators(RP) affect the level of sustainability too; state indicators(ST) have an impact on the driving forces(DF) too; and it can be seen that this process is a several ways process in which sustainability is being affected by the constant interactions of these three different sets of indicators.

3.3 Practical application of the new framework for agenda 21 indicators

Appendix 1 to Appendix 4 contains the matrix through which the above 4 system/12 subsystem sustainability model could be implemented. It is intended to simulate the 132 indicators listed in pages ix to xiii in UN(1996). Appendix 1 contains the information relevant to the social system; Appendix 2 contains the information important to the economic system; Appendix 3 summarises the information of the environmental system; and finally, Appendix 4 presents the information relevant to the institutional system. Each matrix has a similar structure: the component column list the type of system/ category, and

the different indicators within each of the three groups/subsystems; and the horizontal line indicates the relevant years/periods for which information about those indicators is collected.

3.4 Collection and classification of information

All information collected is then classified in two types, type 1 or type 0. If the indicator is in a form that is expected to lead to Increasing Sustainability, it is classified as type 1. If an indicator is classified as type 1 it is considered to be present. If the indicator is in a form that is expected to lead to Not Increasing Sustainability, it is coded at type 0. If an indicator is classified as type 0, it is considered to be absent. For example, the information in Appendix 1 representing the interception of year/period P_1 and indicator type A_1 shows that this indicator for this period was present(type 1) in a form leading to sustainability. However, for the same year/period P_1, but indicator A_3, it reveals that the indicator A_3 was absent (type 0) or not present in a form leading to increasing sustainability during period P_1. The sustainability indices that can be formed from the information in those four Appendices is are provided in Appendix 5.

4.0 Measuring Progress Toward Sustainability

There are two ways to measure and monitor progress toward sustainability in this sustainability framework, one is by means of determining sustainability index gaps and the other way is by determining sustainability index changes. Each of these two ways are described below.

4.1 Sustainability Index Gaps

As described in Section 2.3.6, sustainability index gaps indicate how far actual sustainability conditions are from ideal sustainability conditions. Appendix 6 contains the index gaps for all sustainability indices in Appendix 5. The sustainability index gap in each cell in Appendix 6 came out from subtracting each value in each cell in Appendix 5 from 1, since 1 is the value of the ideal index as shown above.

The last column in Appendix 6 indicates that the index gaps can be classified into three different trends: persistently decreasing gaps(PDG), which indicates that sustainability conditions are improving. Example, the environmental system sustainability index; persistently increasing gaps(PIG), which indicates that sustainability conditions are worsening. For example, the social system response indicator sustainability index; and not persistent gaps(NPG), those which shows no persistency either increasing or decreasing. The last column in Appendix 6 shows the specific type of gap trend per index across periods.

4.2 Sustainability Index Changes

As described in section 2.3.7, sustainability index changes can be found by subtracting the sustainability index of the actual period from the previous one, as indicated in Appendix 7. Sustainability index changes between periods provide information on the magnitude and direction of specific index changes. For example, from period P1 to P2, sustainability conditions within the social system worsen while they improved in the economic,

environmental, and institutional systems.

Sustainability index changes can also be classified into three types of trends: persistently increasing index changes(PIC), which indicates that sustainability conditions are improving. For example, the economic system sustainability index; persistently decreasing index changes(PDC), which indicates that sustainability conditions are worsening. For example, the social system response indicator index; and non-persistent index changes(NPC), which indicates that the changes do not show persistency across period changes. The last column in Appendix 7 indicates the specific type of change trend per index across period changes.

5.0 Summary and Conclusions

Five general conclusions can be made based on the above discussion: First, the Agenda 21 framework is not based on sustainability theory, which is the main source of its limitations. Second, the sustainability theory presented in this paper can be used to link sustainable development indicators by means of sustainability indices. Third, the practical application of the sustainability theory to reorganise and classify the Agenda 21 indicator and data structure shows how some of its limitations can be eliminated. Fourth, the different sustainability indices generated provide useful information about present/absence persistent dominance, about persistently/non-persistently increasing indices, about persistent/non-persistent index gaps; and about persistent/non-persistent index changes. And fifth, the making of the Agenda 21 framework consistent with sustainability theory may improve the over all benefit of having a standard methodology that bridges the gap between local and global levels of analysis as well as between qualitative and quantitative data by providing a theoretical and practical way to overcome these difficulties.

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SOCIAL SYSTEM

COMPONENTS	APPENDIX 1	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	TREND
SOCIAL SYSTEM												
	DRIVING FORCES											
	A1	1	1	1								PPD
	A2	1	1	1								PPD
	A3	0	1	1								NPD
	A4	0	0	0								APD
	A5	1	0	1								NPD
	A6	1	0	1								NPD
	A7	1	1	1								PPD
	A8	0	1	0								NPD
	A9	0	1	0								NPD
	A10	0	0	1								NPD
	A11	1	1	1								PPD

	STATE INDICATORS											
	A12	1	1	1								PPD
	A13	1	1	1								PPD
	A14	1	1	1								PPD
	A15	1	0	1								NPD
	A16	0	0	1								NPD
	A17	0	0	1								NPD
	A18	0	0	1								NPD
	A19	0	0	1								NPD
	A20	1	1	0								NPD
	A21	1	1	0								NPD
	A22	0	1	1								NPD
	A23	1	1	1								PPD
	A24	0	0	1								NPD
	A25	1	1	0								NPD
	A26	0	0	1								NPD
	A27	0	1	0								NPD
	A28	0	1	1								NPD
	A29	0	0	1								NPD
	A30	1	0	1								NPD
	A31	1	0	1								NPD
	A32	1	1	1								PPD
	RESPONSE INDICATORS											
	A33	1	1	0								NPD
	A34	0	0	0								APD

	A35	1	0	0								NPD
	A36	1	1	0								NPD
	A37	1	0	1								NPD
	A38	1	1	0								NPD
	A39	1	1	1								PPD
	PPD = PRESENT PERSISTENT DOMINANCE											
	NPD = NON PERSISTENT DOMINANCE											
	APD = ABSENT PERSISTENT DOMINANCE											

ECONOMIC SYSTEM

COMPONENTS	APPENDIX 2	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	TREND
ECONOMIC SYSTEM												
	DRIVING FORCES											
	B40	1	1	1								PPD
	B41	1	1	1								NPD
	B42	0	1	1								NPD
	B43	0	1	1								NPD
	B44	0	0	1								NPD
	B45	0	0	1								NPD
	B46	1	0	0								NPD
	B47	1	0	0								NPD

	B48	1	1	1								PPD
	STATE INDICATORS											
	B49	1	1	1								PPD
	B50	1	0	1								NPD
	B51	0	1	1								NPD
	B52	1	1	1								PPD
	B53	1	1	1								PPD
	B54	0	1	0								NPD
	B55	0	1	0								NPD
	B56	0	0	0								APD
	B57	1	0	1								NPD
	B58	1	0	1								NPD
	B59	1	0	1								NPD
	RESPONSE INDICATORS											
	B60	0	1	1								NPD
	B61	1	1	1								PPD
	B62	0	1	0								NPD
	PPD = PRESENT PERSISTENT DOMINANCE											
	NPD = NON PERSISTENT DOMINANCE											
	APD = ABSENT PERSISTENT DOMINANCE											

ENVIRONMENTAL SYSTEM

COMPONENTS	APPENDIX 3	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	TREND
ENVIRONMENTAL SYSTEM												
	DRIVING FORCES											
	C63	1	1	1								PPD
	C64	1	0	1								NPD
	C65	0	0	1								NPD
	C66	0	1	1								NPD
	C67	0	1	0								NPD
	C68	1	1	0								NPD
	C69	1	0	0								NPD
	C70	1	0	0								NPD
	C71	0	1	1								NPD
	C72	0	1	1								NPD
	C73	0	0	1								NPD
	C74	0	0	0								APD
	C75	0	1	1								NPD
	C76	0	1	1								NPD
	C77	0	0	1								NPD
	C78	0	1	1								NPD
	C79	0	1	0								NPD
	C80	1	0	1								NPD
	C81	1	1	1								PPD
	C82	1	1	1								PPD
	C83	1	0	1								NPD

	C84	1	1	1								PPD
	STATE INDICATORS											
	C85	0	1	1								NPD
	C86	0	1	1								NPD
	C87	0	0	1								NPD
	C88	0	1	1								NPD
	C89	0	1	1								NPD
	C90	0	0	1								NPD
	C91	1	1	0								NPD
	C92	1	1	0								NPD
	C93	0	0	1								NPD
	C94	1	1	1								PPD
	C96	0	1	1								NPD
	C97	1	0	0								NPD
	C98	1	1	1								PPD
	C99	0	1	1								NPD
	C100	0	1	1								NPD
	C101	1	0	1								NPD
	C102	1	1	1								PPD
	RESPONSE INDICATORS											
	C103	0	1	1								NPD
	C104	1	0	1								NPD

	C105	1	1	1								PPD
	C106	0	1	1								NPD
	C107	0	0	1								NPD
	C108	1	0	1								NPD
	C109	1	1	0								NPD
	C110	1	1	0								NPD
	C111	0	0	0								APD
	C112	0	0	0								APD
	C113	0	0	1								NPD
	C114	0	0	1								NPD
	C115	0	1	1								NPD
	C116	0	1	1								NPD
	C117	0	1	1								NPD
	PPD = PRESENT PERSISTENT DOMINANCE											
	NPD = NON PERSISTENT DOMINANCE											
	APD = ABSENT PERSISTENT DOMINANCE											

INSTITUTIONAL SYSTEM

COMPONENTS	APPENDIX 4	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	TREND
INSTITUTIONAL SYSTEM												
	DRIVING FORCES											

	STATE INDICATORS											
	D118	**1**	**1**	**1**								**PPD**
	D119	**0**	**0**	**1**								**NPD**
	D120	**0**	**0**	**0**								**APD**
	RESPONSE INDICATORS											
	D121	**1**	**1**	**1**								**PPD**
	D122	**1**	**1**	**1**								**PPD**
	D123	**1**	**1**	**1**								**PPD**
	D124	**0**	**1**	**1**								**NPD**
	D125	**0**	**1**	**1**								**NPD**
	D126	**0**	**1**	**1**								**NPD**
	D127	**0**	**0**	**1**								**NPD**
	D128	**1**	**0**	**1**								**NPD**
	D129	**1**	**0**	**0**								**NPD**
	D130	**0**	**0**	**0**								**APD**
	D131	**1**	**1**	**1**								**PPD**
	D132	**0**	**1**	**1**								**NPD**
	PPD = PRESENT PERSISTENT DOMINANCE											
	NPD = NON PERSISTENT DOMINANCE											

	APD = ABSENT PERSISTENT DOMINANCE											

SUSTAINABILITY INDICES

SUSTAINABILITY		P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	TREND
INDICES												
	APPENDIX 5											
SOCIAL SYSTEM INDEX		0.64	0.58	0.61								NPI
	DRIVING FORCES	0.55	0.64	0.73								PII
	STATE INDICATORS	0.52	0.52	0.81								NPI
	RESPONSE INDICATORS	0.86	0.57	0.29								PDI
ECONOMIC SYSTEM INDEX		0.51	0.70	0.72								PII
	DRIVING FORCES	0.56	0.56	0.78								NPI
	STATE INDICATORS	0.64	0.55	0.73								NPI
	RESPONSE INDICATORS	0.33	1.00	0.67								NPI
ENVIRONMENTAL SYSTEM INDEX		0.39	0.60	0.75								PII
	DRIVING FORCES	0.45	0.59	0.73								PII
	STATE INDICATORS	0.39	0.67	0.78								PII
	RESPONSE INDICATORS	0.33	0.53	0.73								PII
INSTITUTIONAL SYSTEM INDEX		0.42	0.50	0.75								PII
	DRIVING FORCES											

	STATE INDICATORS	0.33	0.33	0.67								NPI
	RESPONSE INDICATORS	0.50	0.67	0.83								PII
GENERAL SYSTEM INDEX		0.49	0.60	0.71								PII
GENERAL DRIVING FORCE INDEX		0.52	0.52	0.75								NPI
GENERAL STATE INDEX		0.47	0.52	0.75								PII
GENERAL RESPONSE INDEX		0.51	0.69	0.63								NPI
GENERAL SYSTEM INDEX		0.50	0.58	0.71								PII
	PII = PERSISTENTLY INCREASING INDEX											
	NPI = NOT PERSISTENTLY INCREASING INDEX											
	PDI = PERSISTENTLY DECREASING INDEX											

SUSTAINABILITY INDEX GAPS

SUSTAINABILITY		P1	P2	P3	P4	P5	P6	P7
INDEX GAPS								
	APPENDIX 6							
SOCIAL SYSTEM INDEX		-0.36	-0.42	-0.39				
	DRIVING FORCES	-0.45	-0.36	-0.27				
	STATE INDICATORS	-0.48	-0.48	-0.19				
	RESPONSE INDICATORS	-0.14	-0.43	-0.71				
ECONOMIC SYSTEM INDEX		-0.49	-0.30	-0.28				

	DRIVING FORCES	-0.44	-0.44	-0.22				
	STATE INDICATORS	-0.36	-0.45	-0.27				
	RESPONSE INDICATORS	-0.67	0.00	-0.33				
ENVIRONMENTAL SYSTEM INDEX		-0.61	-0.40	-0.25				
	DRIVING FORCES	-0.55	-0.41	-0.27				
	STATE INDICATORS	-0.61	-0.33	-0.22				
	RESPONSE INDICATORS	-0.67	-0.47	-0.27				
INSTITUTIONAL SYSTEM INDEX		-0.58	-0.50	-0.25				
	DRIVING FORCES							
	STATE INDICATORS	-0.67	-0.67	-0.33				
	RESPONSE INDICATORS	-0.50	-0.33	-0.17				
GENERAL SYSTEM INDEX		-0.51	-0.41	-0.29				
GENERAL DRIVING FORCE INDEX		-0.48	-0.48	-0.25				
GENERAL STATE INDEX		-0.53	-0.48	-0.25				
GENERAL RESPONSE INDEX		-0.49	-0.31	-0.37				
GENERAL SYSTEM INDEX		-0.50	-0.42	-0.29				
	PDG = PERSISTENTLY DECREASING GAP							
	NPG = NOT PERSISTENT GAP							
	PIG = PERSISTENTLY INCREASING GAP							

SUSTAINABILITY CHANGE

SUSTAINABILITY		P2-P1	P3-P2	P4-P3	P5-P4	P6-P5	P7-P6	P8-P7	P9-P
CHANGE									
	APPENDIX 7								
SOCIAL SYSTEM INDEX		-0.06	0.03						
	DRIVING FORCES	0.09	0.09						
	STATE INDICATORS	0.00	0.29						
	RESPONSE INDICATORS	-0.29	-0.29						
ECONOMIC SYSTEM INDEX		0.19	0.02						
	DRIVING FORCES	0.00	0.22						
	STATE INDICATORS	-0.09	0.18						
	RESPONSE INDICATORS	0.67	-0.33						
ENVIRONMENTAL SYSTEM INDEX		0.20	0.15						
	DRIVING FORCES	0.14	0.14						
	STATE INDICATORS	0.28	0.11						
	RESPONSE INDICATORS	0.20	0.20						
INSTITUTIONAL SYSTEM INDEX		0.08	0.25						
	DRIVING FORCES								
	STATE INDICATORS	0.00	0.33						
	RESPONSE INDICATORS	0.17	0.17						
GENERAL SYSTEM INDEX		0.10	0.11						

GENERAL DRIVING FORCE INDEX		0.00	0.23						
GENERAL STATE INDEX		0.05	0.23						
GENERAL RESPONSE INDEX		0.19	-0.06						
GENERAL SYSTEM INDEX		0.08	0.13						
	PIC = PERSISTENTLY INCREASING CHANGE								
	NPC = NOT PERSISTENT CHANGE								
	PDC = PERSISTENTLY DECREASING CHANGE								

Citation:

Muñoz, Lucio, 2003. Linking Sustainable Development Indicators by Means of Present/Absent Sustainability Theory and Indices: The Case of Agenda 21, GDS, IIG, Spain.