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Envisioning Sustainability Three-Dimensionally

Rodrigo Lozano

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The Centre started work in October 2001 under the leadership of Professor Ken Peattie of the Business School, Professor Terry Marsden of the Department of City and Regional Planning and Professor Bob Lee of the Law School. The funding of the Centre covers an initial five-year period, but this should just mark the beginning of BRASS' contribution to creating more sustainable and responsible businesses locally, nationally and globally.

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Abstract

Even though Sustainability has arisen as an alternative to the dominant socio-economic paradigm (DSP), it is still a difficult concept to understand by the general public, to whom it is seldom targeted. Visual representations have been used to capture Sustainability's complexity and dynamism. These help to communicate and make more tangible concepts that are otherwise difficult to express clearly and succinctly with words. Two of the most used, and criticised, Sustainability representations are: a Venn diagram, i.e. three circles that interconnect, where the resulting overlap that represents Sustainability can be misleading. The other model is three Concentric circles, the inner circle representing economic aspects, the middle social aspects, and the outer environmental aspects. The problems with this model include its centric focus and its rigid delimitation between the circles. Neither model includes important longitudinal aspects, i.e. the time perspective. This paper presents an innovative attempt to represent sustainability in three dimensions to show the complex and dynamic equilibria between economic, environmental and social aspects, and the short-, long- and longer term perspectives.

Keywords: Sustainable Development, Sustainability, graphical representations, Venn diagram, Concentric circles, interconnectedness

Introduction

The roots of the Sustainable Development (SD) concept used in the Brundtland Report (WCED, 1987) can be traced back to 1974 when the concept of Sustainable Societies, based on equitable distribution, was first used at the World Council of Churches. The main achievement of the Brundtland Report was to bring SD to the mainstream international political agenda, and to create a simple definition that became widely quoted world-wide (Reid, 1995). The WCED's (1987) defines SD as: *"…development that meets the needs of the present without compromising the ability of future generations to meet their own needs."* (WCED, 1987, p. 43) It is common to find the terms Sustainable Development and Sustainability used interchangeably, but they are inherently different. Reid (1995), Lozano-Ros (2003), and Martin (2003) state that the difference lies in SD the journey, path or process to achieving Sustainability, i.e. the "*…capacity for continuance into the long-term future"* (Martin, 2003) or the ideal dynamic state.

Many Sustainability efforts have attempted to address the three pillars of society, i.e. civil society, governments and corporations (Holliday, Schmidheiny, & Watts, 2002, p. 18), however there is still a lack of Sustainability, and its principles, awareness throughout the world. Two examples where sustainability is still largely unknown include universities (Lozano-Ros, 2003) and corporations (Holliday, Schmidheiny, & Watts, 2002, p. 18). To increase the world-wide understanding and diffusion rate of a complex concept, such as Sustainability (Atkinson, 2000), certain aspects and challenges need to be addressed. These include: perspectives on short-, long- and longer-term equilibrium, issues of scale, complexity, inter-connectedness, and lack of conceptual coherence, the difficulty of seeing human processes as systems, the challenges to the economic status quo and perceived sacrifices in short-term growth, problems in understanding interactions among economic, environmental and social aspects, lack of appeal to the general population, and issues surrounding academic specialisation and trans-disciplinarity.

Many other authors have sought to define SD, with at least 70 definitions available by 1992 (Kirkby, O'Keefe, & Timberlake, 1995, p. 1). In general, definitions of SD and sustainability converge into two dynamic and simultaneous tiered equilibria: the **first** amongst economic, environmental and social aspects, and the **second** amongst longitudinal aspects, i.e. short-, long- and longer-term perspectives. Many definitions have only focused on environmental sustainability, e.g. (Atkinson, 2000; Costanza, 1991; Currie-Alder, 1997; Dobers & Wolff, 2000; Doppelt, 2003; Fadeeva, 2004; M. Hart, 2000; Miller, 2002; Rees, 2002; Reinhardt, 2000), i.e. the use of natural resources without going beyond their carrying capacities and the production of pollutants without passing the limits of biodegradation. These often come from developed countries and do not consider the importance of social aspects, e.g. human rights, corruption, poverty, illiteracy, and child mortality, and their inter-relations with economic and environmental aspects. In countries or societies where the basic human needs, such as food, shelter and security, have not been fulfilled the environmental sustainability becomes unimportant, at least in the short-term.

To help explain SD, different authors have appealed to the use of images, graphical representations, and models. It is argued that the use of images can improve learning and understanding of new or complex concepts, such as Sustainability, especially when images are carefully selected and constructed to complement written text and not substitute it (Carney & Levin, 2002; Hilligoss & Howard, 2002; Sankey, 2003; Schnotz, 2002; Stokes, 2001). In many

cases, images are easier to remember than non-image data (Carney & Levin, 2002; Schnotz, 2002). Images can also help make the text more compact or concise, concrete, coherent, comprehensible, correspondent and codeable. Thus, visual representations help to communicate concepts that are difficult to express clearly and succinctly with words and to make them more tangible. Nevertheless, even professionally designed images may not be perfect and instead of helping in the learning and understanding processes, they may have the opposite impact (Carney & Levin, 2002).

Schnotz (Schnotz, 2002) suggests that image "*…comprehension is based on a specific interplay between visual perception and higher-order cognitive processing. In picture comprehension, the individual first creates through perceptual processing a visual mental representation of the picture's graphic display. Then, the individual constructs through semantic processing a mental model and a propositional representation of the subject matter shown in the picture.*" (Schnotz, 2002) Images can therefore drive in the way individuals make assumptions and generalizations on how they understand the world, or a concept such as sustainability.

Two of the most widely used sustainability graphical representations are: (1) a **Venn diagram**, , see Figure 1 (Dalal-Clayton & Bass, 2002; Lozano-Ros, 2003; Mebratu, 1998; Mitchell, 2000; Peattie, 1995, p. 41), where the union created by the overlap among the three components of economy, environment and society seeks to represent sustainability; and (2) **Concentric circles**, where the outer circle represents environment, the middle one, society, and the inner, economic aspects, see Figure 3 (Mitchell, 2000). Some authors propose a model with embedded circles but no concentricity, e.g. (M. Hart, 2000; Mebratu, 1998; Peattie, 1995, p. 42), i.e. no common middle point, see Figure 4.

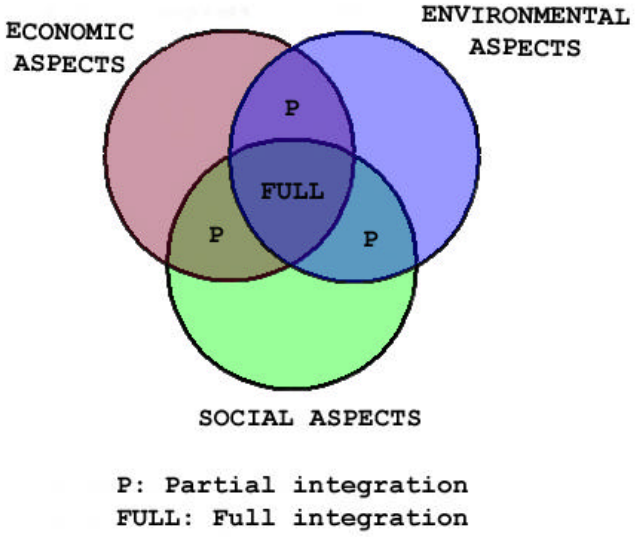

Figure 1 Graphical representation of Sustainability using a Venn diagram
Source: (Dalal-Clayton & Bass, 2002; Lozano-Ros, 2003; Mebratu, 1998; Mitchell, 2000; Peattie, 1995, p. 41)

Dalal-Clayton and Bass (2002) complement the Venn diagram representation by adding local, national, and global perspectives, which encompass four societal influences: politics, peace and security, cultural values, and institutional and administrative arrangements. Lozano-Ros (2003) incorporates technology as an additional societal factor. See Figure 2.

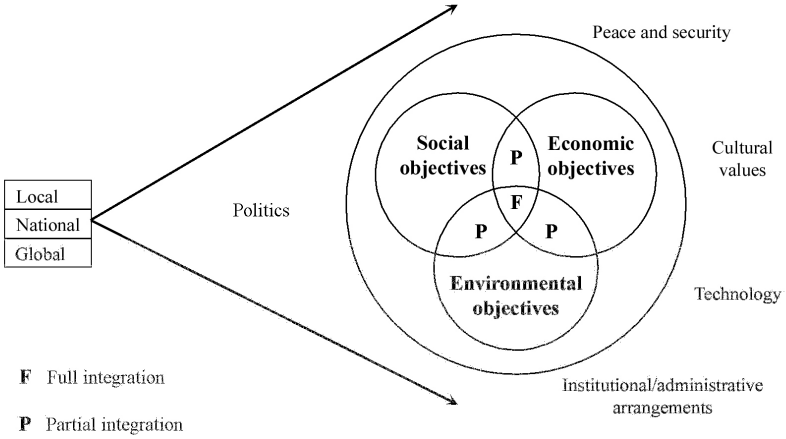

Figure 2 The systems of SD underscoring the relationships among the local, national and global levels and underscoring the need to integrate the social, economic and the environmental in a holistic manner
Source: Adapted from Dalal-Clayton & Bass (2002) and Lozano-Ros (2003)

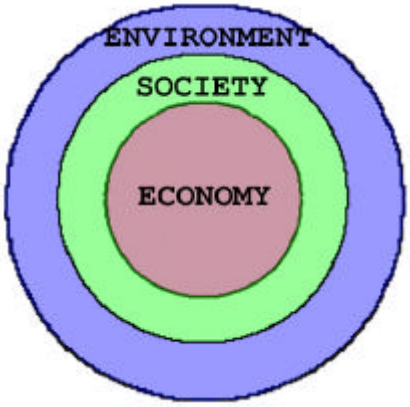

Figure 3 Graphical representation of Sustainability using concentric circles
Source: (Mitchell, 2000)

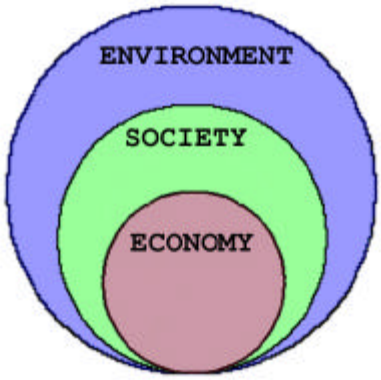

Figure 4 Sustainability representation using non-concentric adjacent circles
Source: (M. Hart, 2000; Mebratu, 1998; Peattie, 1995)

Although these representations are helpful, they do not fully capture all the aspects and interactions of Sustainability and are highly anthropocentric and compartmentalized. They also lack continuity, i.e. the long- and longer-term perspectives, appearing to be snapshots of a moment in time, which lack the ability to fully explain dynamic processes. In the Venn diagram, for example, sustainability is represented by the overlapping area of the three circles, shown as 'full' (F) in Figure 1 . The areas lying outside of this are considered either as partial sustainability (P), i.e. the union of two circles, or not at all related to sustainability. In spite of such drawbacks the Venn model offers a basic approach to understanding sustainability for those who are not familiar with the term and the interaction of the three aspects.

The Concentric circles model, Figure 3, depicts a large system, 'the environment', with a subsystem 'society', which has a further subsystem, 'the economy'. Here, society is a part of nature, and the economy part of society, although the delimiting of the three aspects by the use of circles does not really reflect the complex interconnectedness that actually exists between them. An example of such inter-relatedness is presented by Hart (S. Hart, 1997, p. 69) who argues that a conflict appears when a population starts invading natural reserves to obtain food and other short-term subsistence resources, e.g. fire-wood. In this case, humans are taking resources from the environment, breaking out of the social 'circle'. It might be argued that in a sustainable society there would be no need to take resources outside of natural resources that are "assigned" for the use of the social system, but this implies that there are sufficient resources with no external factors e.g. climate disasters, or political and military conflicts leading to reductions in supply for the subsistence of a society. The model also implies that economy is at the centre of Sustainability, a characteristics perspective of the Western world, which conflicts with the idea of balance between the three components.

Another lesser known graphical model is the Planning Hexagon (Benson, 2002; Benson & Darracq, 2001). The Planning Hexagon shown in Figure 5 models the relationships between economy, environment, the individual, group norms, technical skills and legal and planning systems. The advantage of this model over the previous models is that it makes these components, which are inherently part of social aspects being created by societies, explicit. The Planning Hexagon also does not address the time dimension.

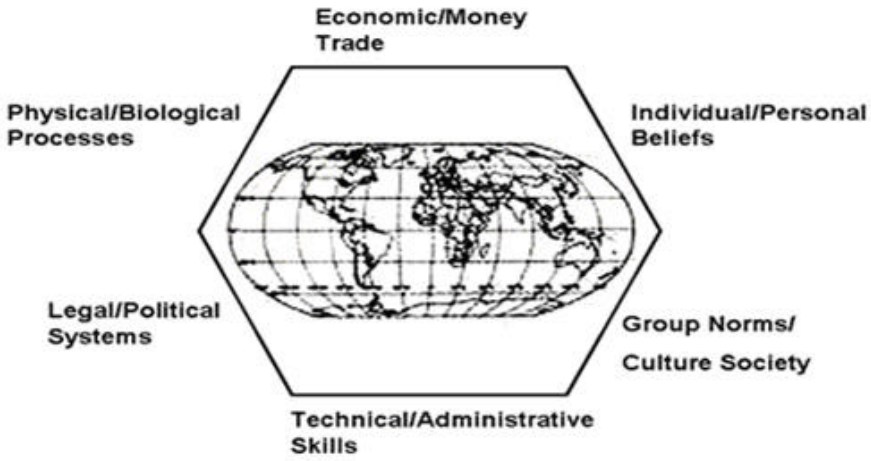

Figure 5 The Planning Hexagon
Source: (Benson, 2002; Benson & Darracq, 2001)

It can be observed that the representations presented attempt to show a complex concept, Sustainability, in a simple manner through graphical representation, a task not easily achievable. Each representation has its strengths, such as ease of understanding and power of depiction, and weaknesses, such as lack of completeness and of continuity. Furthermore, they are incorrect in many ways. Representing the Sustainability concept fully and accurately through graphical means is more difficult than it appears, but it is also clearly an important task to achieve. This paper seeks to develop a new and more useful way of envisioning Sustainability to make the concept even more understandable.

Envisioning Sustainability three-dimensionally

Useful tools for envisaging concepts rarely arrive fully-formed, and usually they are developed though an evolutionary process. The following paragraphs explain the mental process that the author went through to develop a new way of envisioning the vastness and complexity of Sustainability.

Modern societies that follow the dominant socio-economic paradigm (DSP), neo-liberal capitalism, are based on the importance and centrality of economic aspects. Historically other socio-economic paradigms, i.e. socialism and communism, disregarded the impacts of industrialisation on the environment, as the Aral Sea's shrinking dimensions and increasing salinity bear witness (Micklin, 1994; Waltham & Sholji, 2001). In both cases, central importance has been given to economic aspects, under the names of development[1] and industrialisation, while impacting or disregarding environmental and social ones. This is depicted in Figure 6, which could be considered as a precursor of the Venn diagram and Concentric circles models.

The first step (**1**) in the quest for SD and Sustainability would be to help equalize the importance and integrate the three aspects, i.e. the "relative" importance and impact of the economic aspects

[1] It should be noted that in many occasions the term development is used to indicate economic growth, even though they are inherently different. The former being improvements in well-beings, quality of life and the environment, the latter being an increase in GNP/GDP.

should be equalled to that of the environmental and social ones. Two different trajectories are proposed. To avoid further confusion, the morphology of the circles is used with the following note of caution[2]: Most of the literature does not state what the circles represent; usually they are referred to as aspects, dimension or pillars. Do they represent economic, environmental and social capitals? Or do they represent the impacts that each has upon the other two? This author is inclined to believe that they represent a difference between the capitals and the impacts that the other circles have upon a particular circle. For example the economic circle should be the sum of all the different economic aspects, e.g. sales, profits, and revenues, among others, minus the impact that environmental and social circles could have upon it, e.g. the impact of strikes, natural disasters, poverty, and epidemics amongst many others. In such way the circles become interdependent, and depending on the model used, Venn or Concentric circles the following trajectories can be developed.

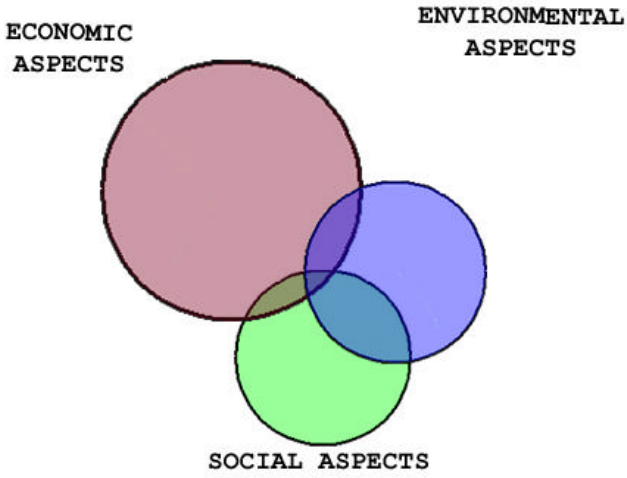

Figure 6 Socio-economic paradigms' focus on economic aspects, disregarding environmental and social ones

The first step of the first trajectory (**1Vd**) is the integration of the aspects resulting in the Venn diagram. It must be noted that for this to occur the power and influence of economic aspects must be reduced, be equalled by increasing the environmental and social ones, or a combination or both (Figure 7). In the graphical representation this is achieved by circles having the same area. Further, the aspects must be united, giving rise to the Sustainability as the union of the three, as in the Venn diagram (Figure 1). The following step (**2Vd)** is to further unite the three aspects, see Figure 8, to make the economic, environmental and social aspects interrelate. Once this has been achieved, the circles need to continuously rotate so that the different parts of each aspect are in touch with the parts of the other two aspects. Note the further fusing of the circles until the

[2] I would like to thank Prof. Peattie for making me reflect upon this particular topic. The reflections have helped clarify many of my deep thoughts about the circles and helped me to arrive at an interesting way of 'seeing' their interactions.

First tier Sustainability equilibrium (**FTSE),** similarly to a **nebulous fuzzy cloud,** is created, see Figure 9.

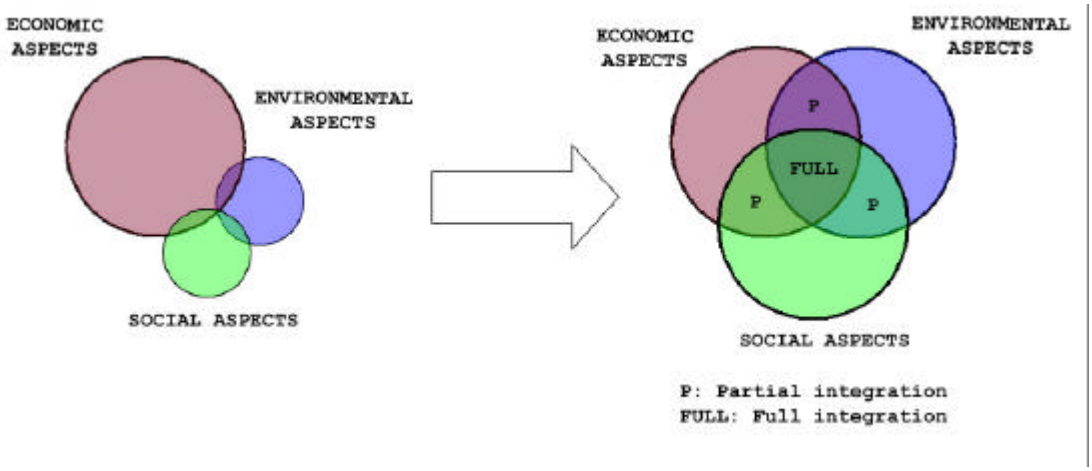

Figure 7 Equalizing and merging economic, environmental, and social aspects. (1VD)

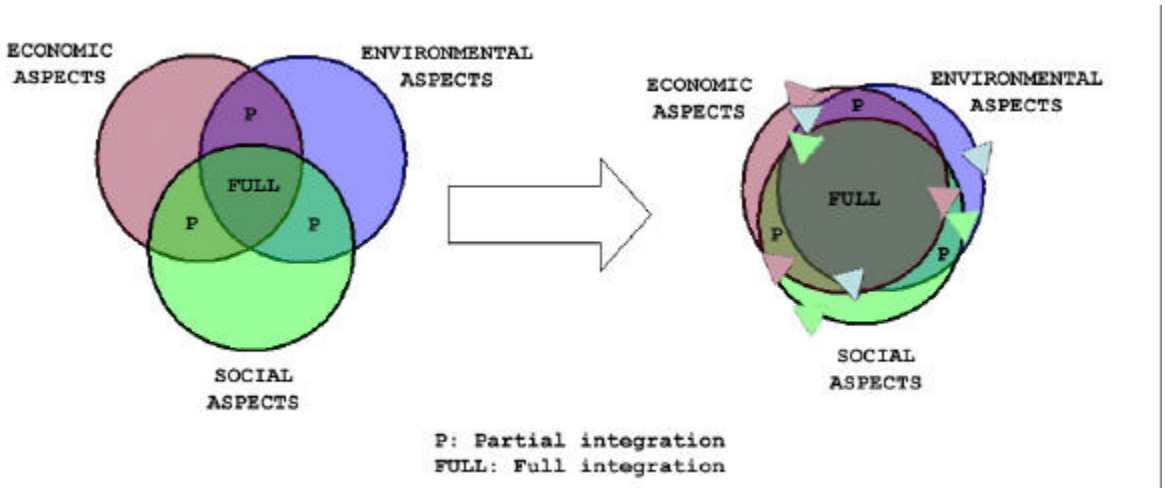

Figure 8 Approaching the economic, environmental, and social aspects to achieve full interrelatedness. (2Vd)

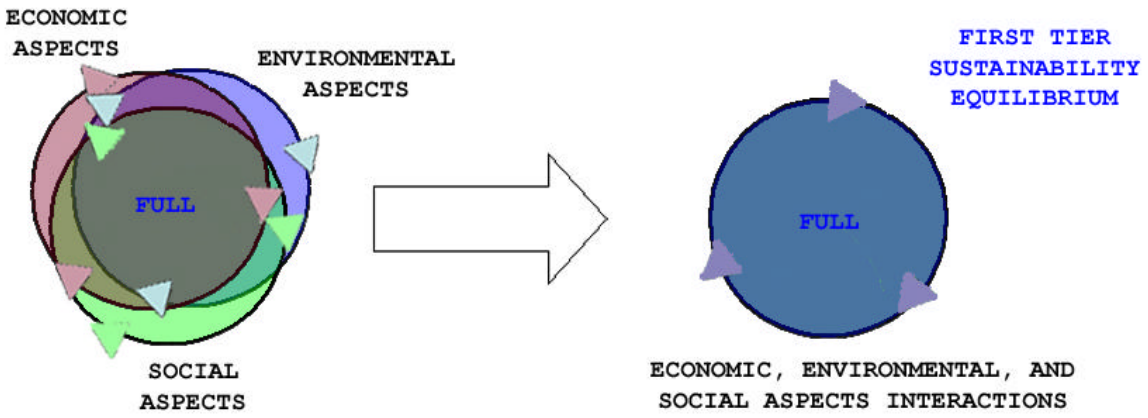

Figure 9 Transformation towards the First tier Sustainability equilibrium. Interactions among economic, environmental, and social aspects from the Venn diagram. (FTSE)

The other trajectory results the Concentric circles model. It should be noted that Hart (2000) proposed progressing from the Venn diagram to the three concentric circles, but this shows little interaction among the aspects and no longitudinal perspective. Hart's representation indicates retrogression to a time in history where economic activities had little impact on society and the environment, one that would not fully represent the status of modern societies. It also does not differentiate about economic activities that improve the environment or society and those which reduce them. In this trajectory the economic aspects expand and inter-connect with the social subsystem, i.e. economic factors are related to social ones (**1CC**) and go beyond economic theories that disregard the effect of social aspects upon economic ones. In the graphical representation this is equivalent to enlarging the economic circle and spinning it continuously so that each of its parts is in contact with each of the social aspects (Figure 10). An example of this is profits, which are not directly linked to personnel. Typically, in calculating profits, the different costs are subtracted from revenues. One of the costs is that of labour; a problem with this is that labour is just another part of the equation and disregards motivation, culture and human needs amongst others. In many cases employees are considered to be liabilities instead of assets (Drucker, 2002).

Similarly, the social aspects, including the economic ones, expand and rotate inter-connecting with the environmental aspects. As a result each and every part of each aspect is interrelated to each and every part of the other two aspects. In the representation this could be viewed as only one circle, which is composed in reality of three spinning and mixing with the others, creating the **First tier Sustainability equilibrium (FTSE)**, see Figure 11.

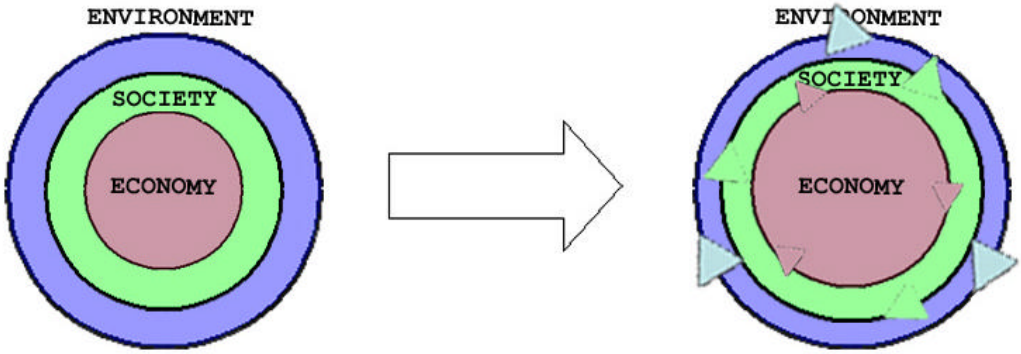

Figure 10 Continuous interrelatedness among economic, environmental, and social aspects through concentric circles (1CC)

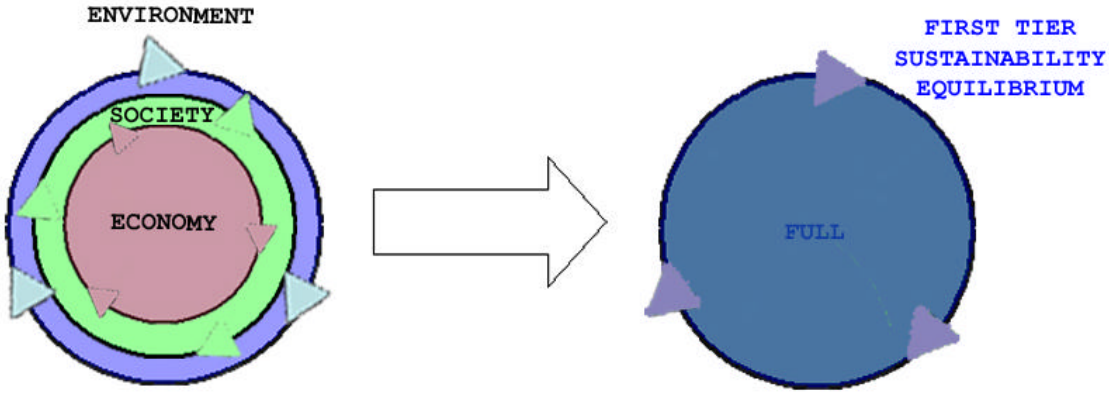

Figure 11 Transformation towards the First tier Sustainability equilibrium. Interactions among economic, environmental, and social aspects from concentric circles. (FTSE)

Both the Venn and Hart representations lack the ability to show the longitudinal perspective. They appear only as snapshots, thus being flawed in representing Sustainability. The next step in the process is to include the time perspective, i.e. the intergenerational aspect (WCED, 1987), into the three spinning circles. Figure 12 shows an example of a prior attempt to show this perspective. However, this is flawed because it does not show the interrelatedness of each aspect with the others. It also reflects the focus of the Venn diagram, where Sustainability is only the union of the three circles.

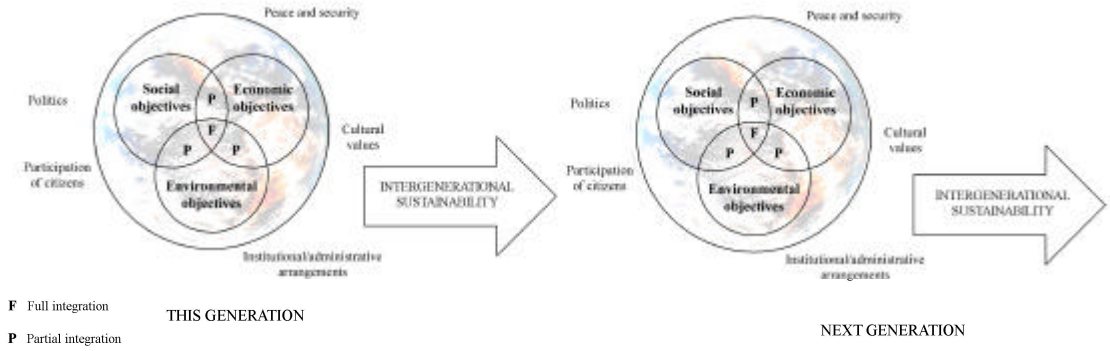

Figure 12 Intergenerational sustainability, designed to safeguard the rights and abilities of future generations to also meet their needs
Source: (Lozano-Ros, 2003)

A better way to graphically incorporate the time perspective is by making the FTSE 'explode' into the third dimension (**3D-Sust**), in the form of a cylinder (Figure 13). Here, Sustainability is not only condensed and focused on today, the short-term, but on the continuum of tomorrow, the long- and longer-terms. As there are two simultaneous equilibria in sustainability, it is presupposed that the spinning circles are projected with no deviation through time, i.e. they form a perfect cylinder

If there is no longitudinal equilibrium, i.e. if too much emphasis is put on the future limited the capacity to satisfy today's needs, then instead of a cylinder the shape takes the form of a cone with its wider side in the future (Figure 14). On the other hand, if too much emphasis is put on the present, e.g. using discounting methods, and little or no attention is given to the needs of tomorrow, then the cone would have its wider base in the present (Figure 15).

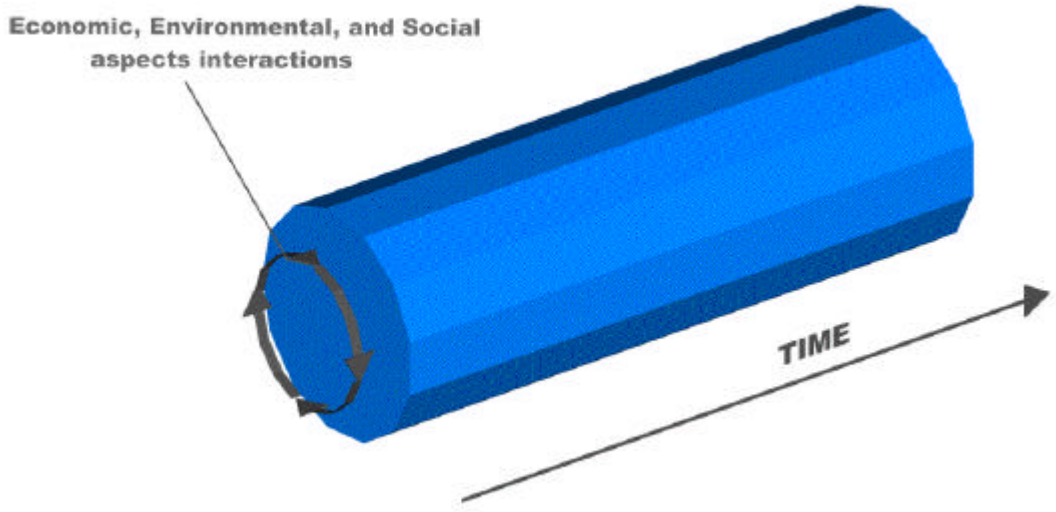

Figure 13 Integrating the time dimension into the first tier equilibrium. (3D-Sust)

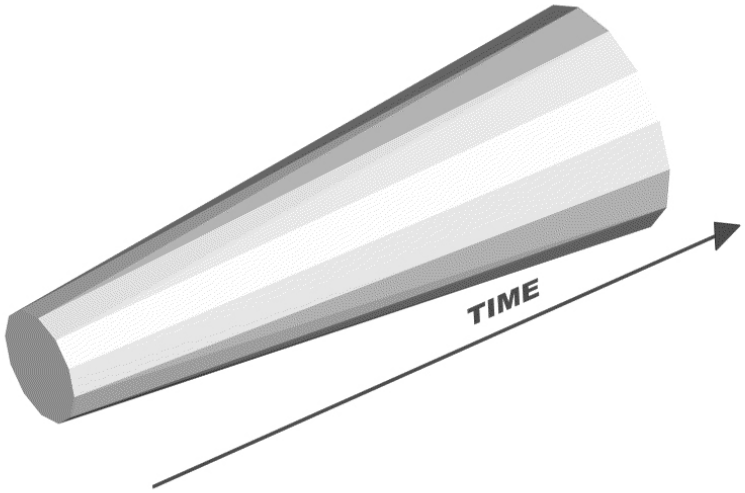

Figure 14 Disequilibrium in the time dimension. Lack of short-term perspective

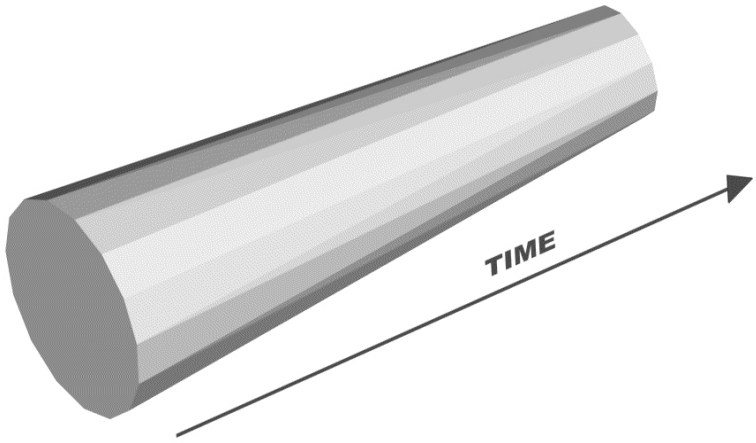

Figure 15 Disequilibrium in the time dimension. Lack of long-term perspective

The last step involves the interactions of both equilibria into a Two Tiered Sustainability Equilibria (**TTSE**). The FTSE, spinning circles, is to a great extent independent of time, while the 3D-Sust model presupposes that the three aspects are in equilibrium. The interest increases when economic aspects of today are inter-related with social aspects of tomorrow, environmental of today with the ones of tomorrow, and so on. The cylinder undergoes yet another transformation, as it implodes upon itself, to create a doughnut shape (Figure 16). In a practical sense it would mean that the economic aspects of today are inter-linked and inter-related to the economic aspects of the long- and the longer-term, but also with the environmental aspects of the present, the near and the far future, and with the social aspects of the present, the near and the far future. These patterns occur with all the other aspects of today, the near and the far future.

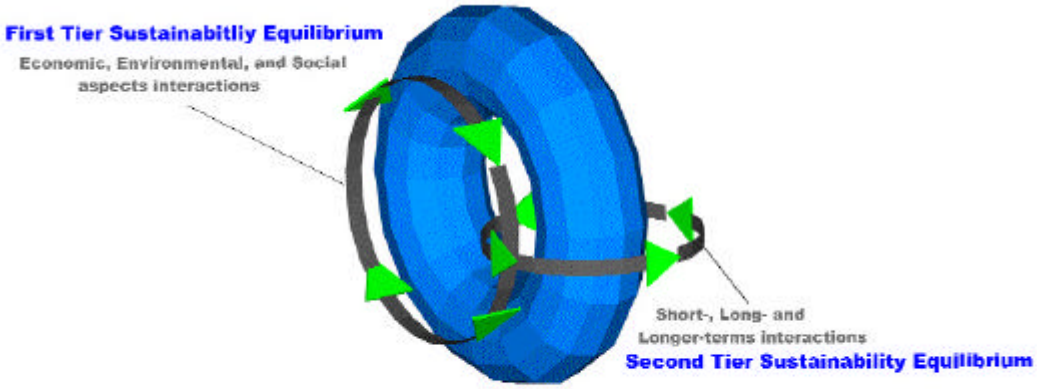

Figure 16 Two Tiered Sustainability Equilibria (TTSE). Interactions between the First Tier Sustainability Equilibrium, i.e. among economic, environmental, and social aspects; and the Second Tier Sustainability Equilibrium, i.e. the short-, long- and longer-terms.

An illustrative example of envisioning Sustainability three-dimensionally

Population change can be used as an example to help understand and visualise the three-dimensionality of the two tiered sustainability equilibria. During the last decades two factors have been recognised to drive environmental degradation: population (Cropper & Griffiths, 1994; Kirkby, O'Keefe, & Timberlake, 1995; WCED, 1987) and poverty (Duraiappah, 1998; WCED, 1987).

Since Malthus, the relations between population and environmental degradation have been known. During the last 50 years world population has increased at rates not previously seen, from 2.78 billion in 1955 to 6.46 billions in 2005 (Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat, 2005). Population is usually considered to be one of social aspects of Sustainability. Here, it is directly related to health, education, and governmental policy. The relation between population growth and health is positive in nature, e.g. improvements in health helped raise life expectancy in the World from 49.9 years in 1950 to 64.6 in 1985, while reducing infant mortality from 117 deaths per 1,000 live births in 1960 to 81 in 1985 (WCED, 1987, p. 103), while education, especially that of women, and governmental policy, by helping to reduce or control it, can have a negative relation to population growth (WCED, 1987, p. 103). The relations presented lie within the social aspects category. However, improvements in health and education require governmental infrastructure expenditure on hospitals, schools, and training and education of labour, which are usually considered to be economic aspects. Long-term impacts are also involved; constructing a hospital, and training qualified employees can take several years, yet the benefits in health improvements may last for many years, even decades. Other long-term issues relate to governmental planning, policy and implementation. For the sake of simplicity, corporate and civil societies' relations and effects are not considered in the example.

Population pressures can also degrade the environment, especially through deforestation, i.e. transforming forests into arable land (Cropper & Griffiths, 1994; Kirkby, O'Keefe, & Timberlake, 1995). Some examples include Brazilian peasants who have been forced to settle in Amazonia by rich landowners, causing irreparable damage to the rain forest (Kirkby, O'Keefe, & Timberlake, 1995, p. 107), and the Han, Chinese, that cleared north lands to make them suitable for agriculture until overuse and erosion would no longer give the necessary yield (Landes, 1999).

Another impact of population increases to the environment is the increasing demand for fish. Inland and marine fishing has increased from 118.2 million tonnes in 1998 to 132.2 in 2003, while global population grew from 5.9 to 6.3 billions (FAO, 2004). Increases in fish production can be achieved by farming fish, which requires supplemental fish food to be produced, or by tapping into the "commons", the seas outside of national boundaries. Either would not present a problem if the food for fish could be done without the use of chemicals or without deforesting, and if the "commons" could be used without depletion to crisis levels.

Another example comes from increments in agricultural output which are usually made by increasing the area where the crop is planted, in many cases through deforestation; and by increasing the output per hectare with the help of machinery and the use of chemicals, such as fertilisers, herbicides, and pesticides among others. Increases in the use of chemicals have proven to be detrimental to human health, e.g. approximately 10,000 people died and 400,000 were acutely poisoned by continuous exposure to chemical used in agriculture (WCED, 1987, p. 126), and biodiversity, as Carson (2000) notes in her book "Silent Spring".

Poverty, the second factor driving environmental degradation, is commonly categorised as part of the economic aspects. According to the predominant school of thought reducing poverty can reduce environmental degradation (WCED, 1987). Duraiappah (1998) argues that the views of the relation between poverty and environmental degradation are too simplistic, and other factors should be considered. Another problem with the predominant school of thought is that it considers the relationship between poverty and environmental degradation to be causal. The myriad inter-relations among issues directly and indirectly linked issues to poverty and environmental degradation are not well understood, and are therefore not considered. Duraiappah's (1998) arguments are closer to the ones raised in this paper, as they suggest that reducing environmental degradation needs to be done by addressing several factors and by bearing in mind the synergies and inter-relatedness among them, and not only by addressing population and poverty.

Population and poverty, as driving forces of environmental degradation, affect, and are affected, by other issues in inter-related and synergic relationships. Addressing a single issue in the sustainability spectrum through cause-effect would not reap the full potential of sustainable development. Sustainability issues need to be addressed with considering two, three or more ways direct and indirect inter-relations with a holistic, short-, long- and longer terms vision. The commonly used discounting method of transferring future value into present value attempts to flatten the second-tier sustainability equilibrium with the result of wishing to maximize today's profits at the expense of future profits, and degradation of resources.

Conclusions

Modern ideologies have helped make economic short-term aspects pervasive worldwide. This has been reinforced by scientific traditions that have attempted to express economical, environmental, and social phenomena, through reductionistic simple cause-effect relationships. Such approaches are flawed since they do not consider the complex dynamic inter-relatedness of these phenomena and their evolution over time.

The concepts of Sustainable Development (SD) and Sustainability offer an alternative way to understand, address and reduce current, and potentially future, economic disparities, environmental degradation, and social ailments. However, these concepts are still unfamiliar to, or misunderstood by many individuals and societies worldwide. In order to achieve real change it is necessary to facilitate greater awareness and understanding within and throughout societies' three pillars.

A key barrier to promoting such understanding among the general public is that SD can appear to be an abstract and complex idea as soon as the discussion goes beyond the classic "soundbite" definition made famous by the Brundtland report. Diagrams and images have been developed to help people grasp the different aspects of SD and sustainability. Two of the most well known ones are the Venn model and the three Concentric circles. These models have been helpful but they suffer from pervasive drawbacks, such as the depiction of sustainability as a steady state, a lack of full integration and inter-relatedness amongst the different aspects, and a lack of consideration of the time perspective.

This article proposes a new way of seeing sustainability, the Two Tiered Sustainability Equilibria (TTSE), where the issues in each aspect, economic, environmental and social, interact with each other, but also with those of other aspects, and in a longitudinal way as well. The TTSE shows the complex inter-links and inter-relations among the First and Second Tier Sustainability Equilibria. It is hoped that the TTSE visual model will help people to understand that Sustainability refers to holistic, continuous and inter-related phenomena amongst economic, environmental, and social aspects, and that each and every of our decisions has implications to each of the aspects today and in the future.

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