MAPPING SUSTAINABILITY

N. Choucri, Mapping Sustainability, last revised January 14, 2004 © 2003

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1. INTRODUCTION

"If Knowledge is Power
We must Harness the Power of Knowledge".

"If Knowledge has Value,
We must Capture the Value of Knowledge".

Compelling as these observations might be, the fact remains: it is easier said than done.

1.1 Mapping Sustainability

According to *Webster's Collegiate Dictionary* to "map" is "to represent" … "to delineate" … "to assign to every element of a …set an element of the same or another set''; and "to be located near the corresponding structural [element]." In those terms, *Mapping Sustainability* presents a way of representing knowledge content in the domain of "sustainable development", with the full expectation that such knowledge changes over time, and that its representations must also change over time. For mapping purposes, the focus here is on the content-architecture -- the levels, linkages and complexities -- that characterizes the domain of 'sustainability' This initiative represents the knowledge architecture implemented in the Global System for Sustainable Development (GSSD) as a distributed global knowledge network operating on the Internet, see http://gssd.mit.edu/.

1.2 What is Sustainability?

In this context, 'sustainability' refers to 'sustainable development'. The view of sustainable development at the core of GSSD centers on human activities, and places human beings in social systems at its core, while taking into account and respecting the imperatives of nature and natural systems.

We define sustainable development as the process of meeting the needs of current and future generations without undermining the resilience of the life-supporting properties or the integrity and cohesion of social systems. Extending this definition further, we differentiate among four dimensions of sustainability as follows:

- Ecological configuration
- Economic activity & output
- Governance & political activity
- Institutional capacity & performance

To become sustainable, a social system must meet four "conditions" - the quotes are to remind us that we are dealing with processes, not discrete outcomes. These consist of:

(a) Ecological systems exhibiting balance and resilience;
(b) Economic production & consumption that does not undermine ecological systems;
(c) Governance modes reflecting participation and responsiveness; and
(d) Institutional performance which demonstrates adaptation and feedback.

This view posits that *if*, and *only if*, these conditions hold will a system dispose toward sustainability.

1.3 What is the Mapping Challenge?

Access to and effective use of knowledge are critical elements in shaping and managing social change and in transitions and trajectories toward sustainable development – in all contexts and at all levels, in industrial as well as industrializing countries. Despite advances in information and communication technologies, major political, strategic, economic and institutional barriers continue to impede the use of knowledge for decision-making.

In the sustainability domain, the making of decisions and the formation of policy seldom draw on the full range of relevant knowledge, or utilize critical resources and overall social capabilities. Moreover, complexity of sustainability as a notion, coupled with ambiguities in its meanings and understandings, further reinforce the difficulties of bringing existing knowledge into the policy debates.

Given that The quest for sustainable development has become a global challenge, affecting industrial as well as developing societies, we need to converge on even a rough shared understanding of existing knowledge requires a multidisciplinary perspective, spanning local to global levels as well as a range of very diverse forms and types of knowledge.

At issue is not the lack of knowledge, data, information, published materials, raw observations and so on, but rather the absence of intellectual coherence and some internally consistent logic to help make 'best uses' of existing materials. The dearth of integrative approaches (or frameworks) may well be among the most significant barriers preventing effective uses of large bodies of knowledge that bear upon the domain of "sustainable development".

These challenges are compounded in situations where there are often serious uncertainties in theory and in practice, coupled with powerful contentions in policy and strategy. Different stakeholders in different parts of the world have different views and priorities about what is "real", what is "important" and what can or should be done as a result. This is true in general; and it is especially true in the domain of sustainable development where a wide range of knowledge and knowledge systems are emerging.

1.4 What is a Knowledge System?

According to Webster's dictionary, to "know" is to "hold something in one's mind as true or as being what it purport to be"…[this] "implies a sound logical or factual basis" [and it also means] "to be convinced of…." By extension, *knowledge* refers to the "fact or condition of knowing something with familiarity gained through experience or association; acquaintance with our understanding of a science, art, technique, condition, context, etc" [including]... the range of one's information and understanding to the best of abilities in place [as well as]… "the fact or condition of being aware of something…" Accordingly, what is 'known' is that which is 'generally recognized…'?

We extend this standard view of knowledge to take into account a cluster of understandings that we refer to as a knowledge system. Thus, we define a *knowledge system* as:

> An organized structure and dynamic process (a) generating and representing content, components, classes, or types of knowledge, that is (b) domain specific or characterized by domain-relevant features as defined by the user or consumer, (c) reinforced by a set of logical relationships that connect the content of knowledge to its value (utility), (d) enhanced by a set of iterative processes that enable the evolution, revision, adaptation, and advances, and (e) subject to criteria of relevance, reliability, and quality.

Among the most fundamental attributes of knowledge is that its acquisition and utilization follows a law of *increasing returns.* This means literally that, the more knowledge is obtained and used, the greater is likely to be its value and its 'utility' to the individual (or group) user. This is a critical feature of this asset and a distinctive input into social and economic output. Our purpose here is only to highlight this feature

upon which much of the trends toward knowledge intensity worldwide is based.

The presumption is that a knowledge system has value, in one form or another, and that capturing this value is essential for enhancing knowledge intensity in economic activities. Further along we specify – based on the above -- the constituent elements of a knowledge market in modular terms.

Conventionally, 'value' is defined as 'fair return or equivalent in goods, services, or money for something exchanged' (Webster's *Collegiate*). It also means worth of some kind, as well as being of some importance. But the terms of conditions of that 'value' and its units or measure are not implied in the core concept. The value of knowledge has different meanings in private and in public settings. In private contexts it is connected to economic gain and market prices and conditions; in public settings it is viewed in terms of facilitating the provision of services for meeting social needs and implementing policies to improve social and public well being.

1.5 Why Mapping Sustainability?

There are four answers to this question:

Conceptually**,** while everyone recognizes that sustainable development is conceived as a holistic and integrative concept, there are considerable ambiguities and interconnections among various facets of human activities, about the constituent elements of sustainability, and about the proverbial matter of 'inter-linkages'. More importantly, there is as yet no overall view of the ways in which major forms of human activities generate problems, nor a coherent understanding of various solutions, social as well as technical.

Disagreements persist regarding the 'solutions' to sustainability 'problems', and the conditions under which one alternative might be better than another. *Mapping sustainability* is a step in the direction of intellectual order and coherence as a means of unbundling the knowledge content of issues central to matters of 'sustainable development'.

Strategically, mapping the knowledge domain for sustainable development is intended to help organize evolving knowledge about sustainability, in all its forms, and to make it more accessible to agents of change for public policy, business strategy and creative ventures. To also facilitate access to cutting-edge analysis, innovative technologies, and multidisciplinary knowledge. So, too, we seek to facilitate opportunities for knowledge provision and sharing through experimenting with some form of 'division of labor' based on expertise and interests, so as to enable and/or encompass 'voices' from diverse perspectives worldwide.

Operationally, mapping sustainability provides a way of organizing knowledge about sustainability that is operational as well as replicable. It is a means of reducing barriers to the access of knowledge about sustainability, as well as a means of alerting us to situations in which the 'solution' of one problem is the source of another - exporting problems can seldom be the foundation for solutions.

Functionally, to the extent that the mapping 'works', then it provides the foundations for the design of web-based systems for knowledge management, networking and sharing, devoted to 'sustainable development'.

2. THE MAPPING DESIGN

2.1 What Process for Mapping?

Mapping sustainability is about generating an ontology of 'sustainable development' according to some select principles. When completed, the ontology consists of key features of 'sustainable development' that are integrated into a coherent knowledge system. Our approach to the mapping process consists of:

(a) Organizing the content of types of human activities and framing these in terms of different types or *domains* human behavior – from the most general level of aggregation to the most specific granularity for individual components or components manifestations thereof;
(b) Defining the *dimensions* of human behavior, characterizing the problems generated by human activities, on the one hand and the range of solutions available to date, on the other;

(c) Determining the *interconnections* (or intersections) among and between domains and dimensions. The full-ontology is a multidimensional representation of sustainable development – by domain, dimension, and intersections of human activities.

2.2 What Domains of Human Activity?

Of the many ways to characterize modal types of human activities, we have chosen to focus on (a) demographic domains (b) energy and resource uses (c) technology-centered activities, as well as (d) conflict and violence, on the one hand and (e) modes of governance and institutions, on the other, two of the most ubiquitous forms of human activity. More specifically,

Demographic Domain

· Population dynamics
· Urbanization
· Migration & dislocation
· Consumption patterns
· Unmet basic needs

Energy & Natural Resource Uses

· Energy use & sources
· Forests & land uses
· Water uses & sources
· Agricultural & rural activities
· Migration & dislocation

Technology-Centered Domain

· Trade & finance
· Industry & manufacturing
· Mobility & transport

Decisions & Choices

· Conflict & War
· Governance & institutions

These are the broad categories. A detailed representation requires us to take into account the matter of dimensions.

2.3 What Dimensions of Human Activity?

We highlight five generic dimensions, or issue areas, for each domain of human activity. The process for generating dimensions consists of:

1. Defining Specific Activities & Conditions - for each domain of human behavior;
2. Determining Sustainability Problems - generated by types of activities;

3. Characterizing Modes of Technical & Scientific Solutions - for each domain;

4. Representing Social, Regulatory & Political Solutions - for each domain;

5. Tracking International Responses & Global Accords - formal and informal, private and public, state and non-state

Given the changing nature of actions and reactions, of problems and solutions, and of policies and programs, the topics at hand are 'moving targets'. Our understanding changes as our knowledge develops and as we begin to comprehend the implications.

2.4 What Knowledge Content?

So far, we have focus on matters of knowledge-design and conceptual architecture. We turn to matters of substance. The contents for each of the sustainability domains and dimensions pertains to the substantive features of:

Agreements

Treaties, resolutions, accords, or other binding agreements reached by governments, organizations, and special interest groups on relevant topics of study, including national level legislation.

Bibliographies & Reports

Compilations of books, reports, research papers, links, or other generally informative documents, including reports consisting of technical papers, policy papers, and instructions on implementation of knowledge.

Case Studies

Projects, initiatives, programs, or experiments carried out by one or more organizations, academic institutions, or governments on a global, regional, or local level.

Definitions/Theories

Documents that clarify the meaning of a concept, including its composition or key components, and the relationships among its elements.

Events

Conventions, conferences, workshops, symposiums, or other activities or gatherings designed to address the issues surrounding one or more concepts (of issues, problems, or challenges).

Indicators/Data

Statistics (or metrics) that provide some indication of the condition or direction of a social, economic, environmental, scientific, or other measurable variable.

Models

Smaller-scaled versions of a larger object or plan that are used to study its characteristics or make inferences about its effects. Generate an output in response to user input, or generate output in response to endogenous adjustments.

Organizations

One or more groups of people brought together by a common interest or purpose, in formal or informal arrangements, and with continuity over time.

In terms of *aggregation*, however, the content-types pertain to, or span to include, various levels of analysis, geographical locations, or jurisdictional categories.

2.5 What Gains from Mapping?

Mapping Sustainability is useful, because it helps to:

(a) Provide an ontology, a conceptual architecture, for the domain of 'sustainable development';

(b) Track evolving knowledge (as well as revisions, changes, etc.) which reflects the overall sociology of knowledge for this subject-matter most broadly defined;

(c) Help capture contentions, alternative perspectives, and views from different knowledge sources;

(d) Use the emergent representation or ontology of 'sustainable development' as a multidimensional indexing system for what is one of the most important issues of the 21st century;
(e) Draw on the ontology as a provider of 'topic outlines' for teaching or research purposes;

(f) Extend *Mapping Sustainability* to serve as the foundations for designing a web-based knowledge-sharing system devoted to the overall domain of sustainable development. The elements of the ontology elements are the 'hooks' for the classification of substantive content.

In sum: the challenge of mapping the *domain* and the *dimensions* of sustainability is also one of helping organize the contents of available *knowledge* about sustainability.

3. IMPLEMENTATION

The conceptual architecture we have designed is structured as a set of nested and hierarchical relationships, or individual parts and coherent wholes. We begin with definition of *domains* (i.e. topics or facets of human activities) and then turn to attendant *dimensions* (i.e. problem created and types of solutions proposed to date).

3.1 Domains of Human Activity & Sustainability Problems

The first step for mapping sustainability is to select the core concepts (or topics) of interest. The goal is to be indicative and inclusive, not exhaustive or definitive. Shown in the figure below, each concept represents distinct sets of human *activities and conditions*. Figuratively, each topic constitutes a 'slice' of the overall concerns. Each of these Core Concepts is further differentiated in terms of content-specificity and embedded in an integrated structure for knowledge representation (defined later on).
The second step is to specify (or identify) the major types of relationships between activities and conditions, on one hand, and sustainability problems, on the other. In other words, we need to specify what are the problems, if any, created by human activities, and to delineate as specifically as possible the nature of these problems. So, the set of Core Concepts shown above is further disaggregated into a set of dimensions or critical issues customized to the realities of each core concept. These dimensions are represented as a set of concentric circles, consistent with the embedded aspects of *Mapping.* See Activities & Conditions and Sustainability Problems.

3.2 Dimensions of Human Activity & Types of Solutions

This means that first we must understand the nature of any 'problem' before venturing to articulate potential 'solutions'. Given that the domains of sustainability have been defined above, and the problems identified, we now turn to the classes of known 'solutions'. Recall, of course, that both problems and solutions are dynamic in nature and that, at time, the solution to one problem becomes a problem in its own right.

The specific challenge is to develop the detailed contents for two broad classes of 'solutions', namely, Scientific & Technical and Social, Economic, Political & Regulatory – and to do so for each of the 14 domains of human activities.

3.3 Intersections of Domains & Dimensions

Given the substantive domains coverage, the overall knowledge representation strategy can now be described in terms of domain representation and the hierarchical organization. Combining concepts in a hierarchical design yields the integrated framework (which will be described in more detail later on). In other words, each Core Concept (dimension or topic) is extended in hierarchical terms, shown further on, as we present the logic for *connectivity* within and across domains and dimensions). The figure below shows the combined perspectives. The details of the nested elements will be described later on.

At this point, we have completed the symmetrical features of the GSSD architecture. The next step is to define the set of coordinated international actions that are undertaken in order to reduce the potential problems generated by human activities.

3.4 Coordinated International Actions

This final segment of the knowledge-architecture involves articulating the contents of coordinated international actions, and introduces a new element in the strategic design. Namely a ‘fifth ring’. However, it does not conform to the Core Concept-Slice structure of the nested system as a whole. The reason is that individual forms and types of international agreements may cover a range of topics (core concepts) or a range of elements across the nested system of relationships.

In terms of content, the knowledge base represents 14 generic forms of coordinated international responses designed to facilitate consensus towards sustainability, e.g. “Agenda 21”, “Conventions” and “New Development Mechanisms” (which includes joint implementation, activities implemented jointly, clean development mechanism, among others).

We now turn to the more detailed archetectural features of *Mapping Sustainability.* The following section focuses on the internal logic for organizing domains (topics) and dimensions (issues).

4. KNOWLEDGE ARCHITECTURE & CONNECTIVITY

This knowledge strategy for *Mapping Sustainability* is designed to ensure consistency in the representation of content. Designed in terms of a hierarchical nested system, the nesting logic introduced below proceeds according to specific principles defining the interconnected components of the 'parts' as well as the integration into a 'whole'.

The same conceptual specification holds across all 14 substantive domains (Core Concepts or topics) pertaining to sustainability, and provides an internally consistent subject-driven knowledge-management strategy. Linkages across subjects are facilitated by a cross-referencing system.

4.1 Definitions

The elements of the Conceptual Framework (above) are as follows:

Slice – Domain of Core Concept

Refers to the hierarchy of elements that jointly constitute the customized details for each of the individual Core Concepts or domains.

Ring – Dimension of Problem and Solution

Refers to the *dimensions* of issues and consequences, namely, (1) *types of problems* or dysfunctions generated by human activities and conditions, (2) the *technical & scientific solutions* proposed to date, (3) the *socio-economic and regulatory solutions* in response to action, problems across all concepts. Below we refer to an additional Ring in the system as a whole, namely that of *coordinated international actions* that transcend or cut across all of the domains of human activity.

Cell

Represents distinctive knowledge-content or items at specific intersection of Slice and Ring (i.e. domain and dimension) with the exception of Ring 5 as discussed later on.

Concept

Refers to a specific item or issue within the Cell topic.

Sub-concept

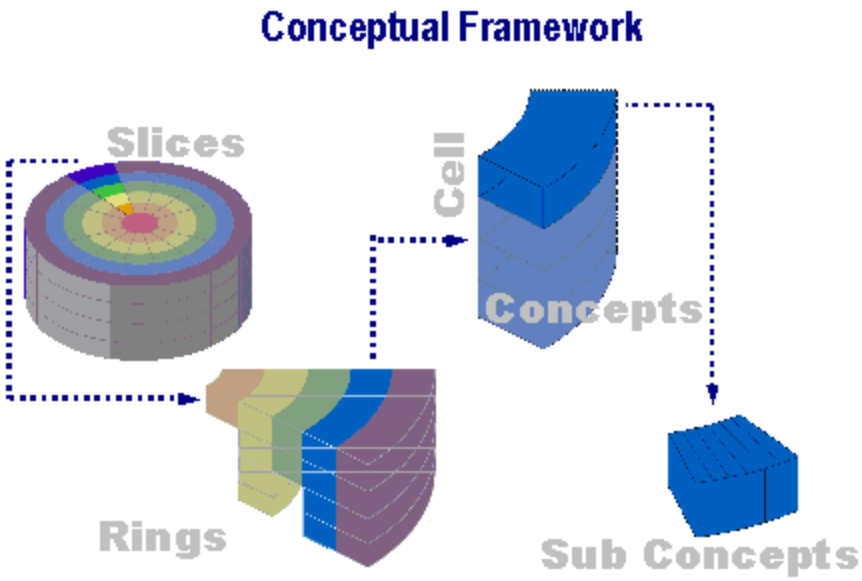
Refers to a specific element within the Concept level.

Connectivity

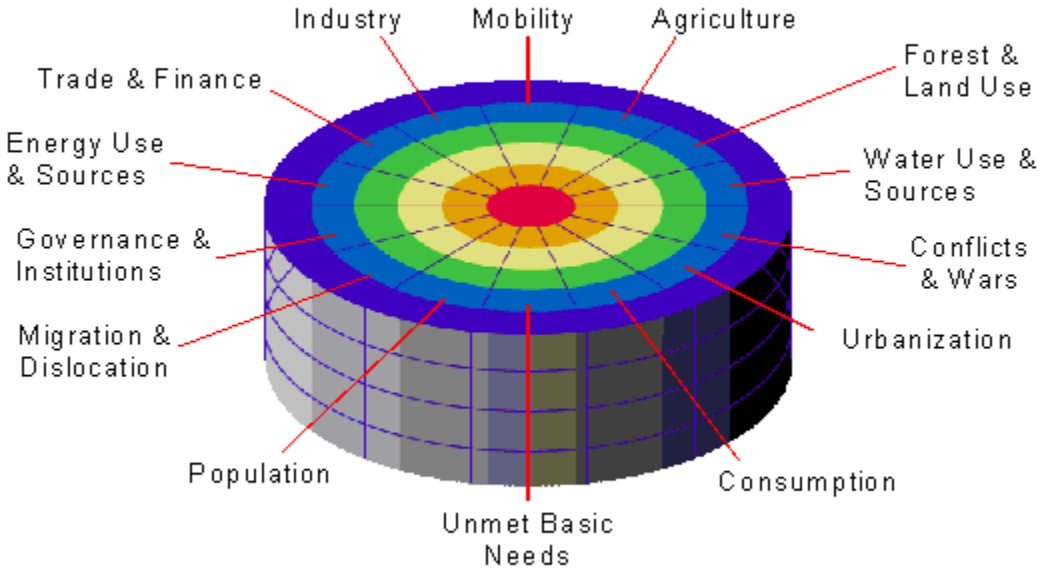
Refers to the content-based system architecture, which links elements of the hierarchical system.

4.2 Connectivity Structure

What holds the entire knowledge architecture together is its connectivity logic through which different 'pieces' of the framework are connected to each other and to the 'whole'. This logic also guides the content-based indexing system designed to provide linkages among elements of the hierarchical system. The diagram below shows the nested linkages and the connectivity logic that holds for every single domain (i.e. topic, concept, or activity). This logic for full-system connectivity serves as an important reminder of the multi-dimensionality of the hierarchical structure.



A view of the integrated framework can be generated by combining knowledge about the topics (i.e. concepts, domains of human activity), on the one hand, with its grouping according to classes of 'problems' and 'solutions'. This is done for each of the 14 topics or domains.



5. INTEGRATED KNOWLEDGE CONTENT

This section presents several ways of viewing the contents of *Mapping Sustainability* since different readers have different needs.

5.1 Display of Knowledge Domains & Dimensions

When the content-representation of each Core Concept (i.e. topic) is unbundled, i.e. disaggregated in hierarchical terms as we combine Slices (domains) and Rings (dimensions) -- each customized with their respect contents -- we can then generate the GSSD Integrated Sustainability Framework.

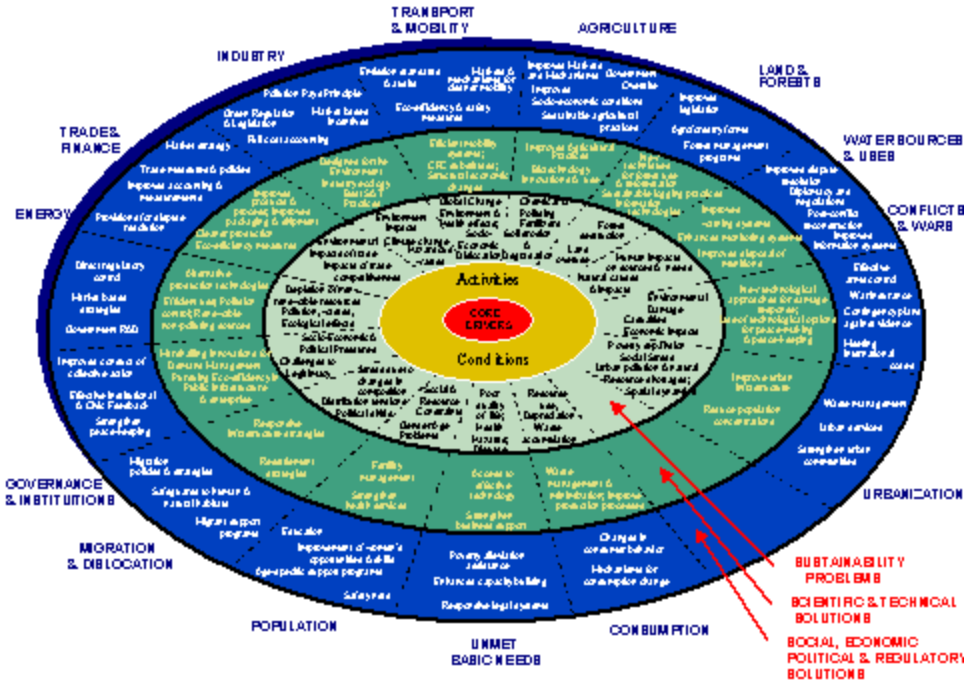
This display of domains and dimensions is organized by topic, thus yielding 14 separate displays. Each can be seen as representing the topic ontology -- its basic skeletal content structure, the multiple manifestations and meanings. This knowledge display, integrated within topics, is shown here largely for intellectual and conceptual purpose - this integration fully shows the structural breakdowns which are then populated with knowledge content. It is to be read, initially, from left to right, and subsequently in any order selected by the reader.

5.2 Display of Hierarchical Knowledge Content

The same materials – dissaggregated knowledge content by topic -- are shown here in the form of a traditional or conventional table of contents. This format is so well known that it is a useful way of conveying the 'unbundling' results. One could consider each as a 'table of content' for the individual topic at hand.

5.3 Display of Integrated Perspective

At this point, we present an integrated view of all domains and dimensions at the same time. It is essential to enlarge this figure due to its density. Visually daunting, this integration serves as an orienting device, to show the knowledge content of the 'whole'. Remember that each entry refers to one specific knowledge item of domains and dimension Coordinated International Actions (the fifth ring) are not represented in this view., but given the complexity of content, it does not provide the same level of granularity as the above two display methods. This integrated view is the only holistic perspective of Mapping Sustainability. It is the content-enriched version of the Figures in section 3 above. (Click to enlarge).



5.4 Knowledge Content of Coordinated International Actions

Consistent with the earlier sequence, we now turn to the differentiated contents of Coordinated International Actions. This segment of *Mapping* is at a relatively high level of aggregation, and further differentiation is currently being undertaken. Nontehelss, it does provide a view of the entire range of known forms of international collaboration directly relevant to sustainability. These are listed as individual types of Coordinated International Actions.

6. GAINS FROM MAPPING SUSTAINABILITY

Mapping Sustainability is distinctive in several useful but interrelated ways.

One - It is a 'baseline' of internally consistent ideas about the nature of 'sustainability' as a knowledge subject (i.e. topic). The 'science' of sustainability is at an early stage of development; therefore this 'baseline' captures current understandings of dimensions and domains at this point in time.

Two - The ontology (in essence a multidimensional typology) remains an important reminder of the complex nature of the issues and their various interconnections and interrelationships. It is an insurance against undue simplification.

Three - Conceived and written in English, the terms used throughout *Mapping Sustainability* are commonly understood by English speakers and the definitions of concepts is intended to interject a degree of precision in understanding, even when the subject itself can be interpreted differently by different communities of knowledge, policy, or practice.

Four - When *Mapping Sustainability* is rendered in another language, we generally assume that the various concepts are portable and that each language does in fact have a corresponding term or an equivalent in other languages. This assumption is simply wrong. In Arabic and in Chinese, for example, the 'sustainable development' glossary is not as fully developed as in English. This has forced us to help formulate the correspondence for the terms in question. The result is as reliable a multilingual rendering of ideas as currently possible.

Five - The ontology generated by *Mapping Sustainability* (and the companion glossary of explanations and definitions) serves as an indexing system to categorize Internet-materials of relevance to domains and dimensions at various levels of granularity or detail and to generate a knowledge base consisting of information about the Internet-materials characterized. The elements of the ontology are the 'hooks' for the classification of substantive content.

Six - The repository for the knowledge base on sustainable development is an integral part of the *Global System for Sustainable Development* (GSSD - http://gssd.mit.edu), a web-based knowledge-sharing system devoted to the overall domain of sustainable development.

Seven - Further, *Mapping Sustainability* provided key guidelines for the architecture and the operations of the foundations *GSSD*.

Eight - Since the ontology serves as a provider of 'topic outlines' for teaching or research purposes as well as an indexing system for what is emerging as one of the most important issues of the 21st century, it is something of a 'net' (in the most literal sense) to help track evolving knowledge over time.

Nine - The knowledge content of GSSD -- that is organized according to the *Mapping* ontology -- is the framework for knowledge networking among users, providers, and 'brokers' of content on sustainable development.

Ten - *Mapping Sustainability* is also the knowledge platform for the provision of local content, i.e. knowledge generated at the local or national levels around the world, and made available to the international community through GSSD. This knowledge represents 'voices' of communities other than the usual ones, namely the advanced industrial countries, that dominate the Internet.