



**GSSD**

**Knowledge Meta-Networking  
For  
Decision & Strategy**

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# Global System for Sustainable Development



## Knowledge Meta-Networking for Decision & Strategy

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**T**he Global System for Sustainable Development (GSSD) is a multi-dimensional knowledge networking system of public and private networks, based on an integrated framework and an evolving quality controlled, cross-referenced knowledge base. Designed in response to the increasing complexity of global realities, it supports knowledge management and meta-networking functions dedicated to improved decision-making and policy in the domain of “sustainable development” – at all levels and in all contexts.

System implementation consists of a strategy for integrating, annotating, and updating knowledge; an adaptive method for representing and organizing knowledge; and a set of flexible functionalities enabling navigation, searching and browsing, and targeted management.

For knowledge sharing globally, mirror sites have been established in several regions of the world. The purpose is



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to facilitate knowledge access and, at the same time, reduce barriers to the provision of knowledge. GSSD is now configured to support multiple languages (notably Arabic, Chinese, French, and soon Japanese). Internationalization of knowledge access, provision and sharing is important for “reducing the gap between knowledge & policy.”

GSSD collaborators - formal and informal, past and present - include governmental institutions, corporations, research foundations, and academic institutions, such as MISTRA (Sweden), AT&T, Xerox Corporation, Lotus - IBM, Sony Environment Center (Europe), Alliance for Global Sustainability (AGS), and others. In addition, the GSSD CyberPartnership, an international network of knowledge providers, contributes new knowledge on domains and dimensions of sustainable development.

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## **United States Patent**

Date of Patent: May 12, 1998

Choucri et al.

### **NETWORKED DATABASE SYSTEM FOR GEOGRAPHICALLY DISPERSED GLOBAL SUSTAINABILITY DATA**

#### **Abstract**

“A system of computers and implemented method for identifying and organizing data relating to a global problem into a plurality of hierarchies of interrelated categories stored on a plurality of computer systems interconnected by a network. Each category of the hierarchies is divided into a topic having at least one concept and datatype. The method includes the steps of defining the connectivities between data among and within the hierarchies of interrelated categories stored on the plurality of computer systems; providing a mapping between the data related to each category and the computer systems storing the data; and providing access for each of the entities to the data within any of the categories stored on any of the computer systems in response to the

mapping.”

## **1. GSSD in Brief**

### **1.1 Global Realities**

Global problems are invariably complex and require a multidisciplinary global approach for analysis, decision-making, and solution. Such imperatives require that governmental, scientific and industrial stakeholders reach a common understanding of the underlying issues and challenges, while having access to relevant knowledge bases, the basic data, and the relevant expertise and perspectives. All of this must take place in what is, in effect, “real time.”

These challenges are compounded in the domain of sustainability where serious uncertainties exist in theory and in practice, as well as 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.

In addition, the communication facilities made possible by the Internet enhances the accessibility of knowledge, data, information, and so forth, to users in all parts of the world – despite the great unevenness in reliability, cost, and extent of connectivity. But, the sheer size of the World Wide Web (WWW), the distribution of content over various Web nodes – and the varying quality of content – may compromise the usability of this facility, unless some forms of coherence, quality control, and tracking methods are applied in a reliable and consistent manner.

### **1.2 What is the Problem?**

Everyone recognizes that knowledge is the key to technological change and sustainable economic 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. These reinforce the difficulties of bringing existing knowledge into the policy debates. In its 1998 annual Development Report, the World Bank signals the growing dangers of increasing knowledge gaps between rich and poor nations – a problem that is now recognized as one of the most serious impediments to development. Indeed, barriers to knowledge magnify existing developmental challenges.

The complexity of a global problem, by definition, requires the application of some forms of intellectual coherence – a requirement that is especially compelling in the domain of “sustainable development.” In the sustainability domain, however broadly defined, the making of decisions and the formation of policy seldom draw on the full range of

relevant knowledge, critical resources and overall capabilities.

### **1.3 What is GSSD?**

GSSD is an adaptive knowledge-based networking system for use in conjunction with Internet resources to explore innovative responses to sustainability challenges – at all levels of development, in all parts of the world. Adopting a meta-networking strategy, GSSD provides networking facilities across stakeholder communities to help identify innovative approaches, enabling technologies, as well as new institutional, financial and regulatory mechanisms for meeting sustainability challenges that confront us all, in both rich and poor countries. The system provides evolving, dynamic, interactive, contextual, and distributed meta-networking facilities focused on one issue of major importance for decision makers across the world: dilemmas of sustainability.

### **1.4 What is the GSSD Mission?**

As an a knowledge-based decision-support system, GSSD is designed to:

- (1) Make evolving knowledge about sustainability -- in all its forms -- more accessible to agents of change for public policy, business strategy; and creative ventures by facilitating access to cutting-edge analysis, innovative technologies, and multidisciplinary knowledge;
- (2) Facilitate knowledge sharing through customized search engines, quality-controlled knowledge-mining tools, multilingual capacities; and decision-tools to identify options available in technologies, policies, and strategies,
- (3) Provide leadership and vision in the use of advanced information and communication technologies by strengthening capacities for knowledge access and informed decision-making and providing tools

### **1.5 What are Core Features?**

Operationally, GSSD consists of a coherent:

- (a) Strategy for integrating and organizing knowledge related to the domain of sustainable development, in multi-dimensional, multi-sectoral, and international terms;
- (b) Method to represent this knowledge by a plurality of interrelated concepts, and interrelationships that are organized in hierarchical form;
- (c) Set of functionalities consisting of navigation and search mechanisms to operate over the system's quality-controlled knowledge base;

- (d) Set of multi-lingual functions enabling non-English speaking users access to the

same functionalities as English-speaking users. Current applications seek to support Chinese, Arabic, French and Spanish. German and Japanese are to follow shortly; and

(e) Modality of wide-area knowledge management, sharing and networking, across cultures, languages and disciplines

(f) Mirror sites of GSSD located in different regions and/or countries worldwide supported by a set of partnerships.

## 1.6 What Follows?

What follows are a summary of the GSSD architecture, the conceptualization of 'sustainable development' for implementing the architecture, the strategy for knowledge management, and a review of key functionalities.

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# 2. GSSD Architecture

## 2.1 Design Principles

Formally, GSSD can be characterized as a computer implementation method for facilitation identification and storage of data and the communication of information among a plurality of geographically separated entities working to solve problems related to global sustainability. The basic architecture of GSSD is applicable to a wide range of issues and problems characterized by *uncertainty*, *complexity*, and *contextual diversity*.

The current operational system is an application of the generic GSSD architecture to the domain of "sustainable development." This application is undertaken by specifying a set of interconnected, multi-dimensional relationships among actors, levels, and units.

These relationships are defined in terms of: (a) *activities* at different levels and units; (b) *problems* generated by human impacts on social and natural systems; coupled with knowledge about (c) *technical solutions* as well as (d) *economic and regulatory strategies*; and (e) modes of international coordination supporting joint *responses*.

## 2.2 Knowledge Strategy

The GSSD knowledge strategy consists of:

(1) Organizing knowledge and data related to global sustainability problems into several hierarchies of interrelated sub-concepts stored on several computer systems interconnected by a number of communication links;

(2) Each sub-concept of hierarchies belongs to a category and has at least one attribute and one sub-attribute;

(2a) Defining the connectivities between data among and within hierarchies of interrelated sub-concepts stored on a plurality of computer systems that are already storing data;

(2b) Providing a mapping between the data related to each of the sub-concepts and computer systems of storing data;

(3) Providing access of plurality of entities, to data within any of sub-concepts stored in pluralities of remote locations in response to mapping specifications; and

(4) Providing access to data and information of hierarchies of interrelated sub-concepts on any computer systems from any sub-concepts according to defined connectivities and in to mapping provided by system functions.

(5) Providing multilingual capabilities to serve functions enabling globalization, internationalization, and localization.

(6) Facilitating knowledge networking and knowledge provision worldwide through regional and national mirror-siting in conjunction with multilingualism.

These principles are then used to conceptualize the domain of sustainable development.

### **3. Conceptualizing the Sustainability Domain**

The domain of the knowledge base (sustainable development) is structured in terms of nested relationships. The mechanisms for applying the above knowledge base definitions – consisting of specific concepts representing facets of the sustainability domain covered by GSSD -- involves the creation of added data base dimensions generated by specific combinations of concepts, differentiated along a consistent hierarchy from the most aggregate Core Concepts (also known as “slices”) to the most detailed Sub-Concepts.

#### **3.1 Core Concepts**

Dedicated to the domain of "sustainable development," the GSSD knowledge base is organized around 14 Core Concepts (or topics), shown as “slices” in the figure below, each representing domains of *activities and conditions*. Jointly these core notions represent the various topics, issues, and subject matter that are generally subsumed under the broad rubric of socio-economic and political actions. Each Core Concept is further differentiated in terms of content-specificity and embedded in an integrated structure for knowledge representation. See [Mapping Sustainability](#) for related details.

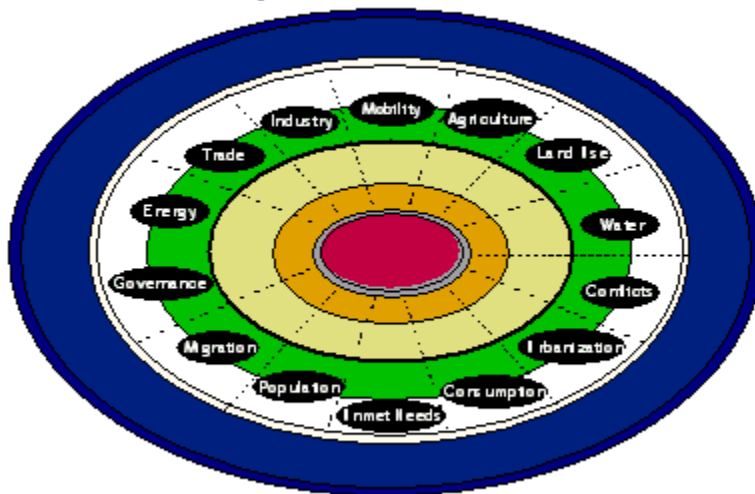
The Core Concepts are as follows:

- Energy use & sources
- Trade & finance

- Industry & manufacturing
- Mobility & transport
- Agriculture
- Land uses & forests
- Water uses & sources
- Conflicts & wars
- Urbanization
- Consumption
- Unmet basic needs
- Population
- Migration & dislocation
- Governance & institutions

The system view of knowledge content is thus

### Conceptual Framework - Slices

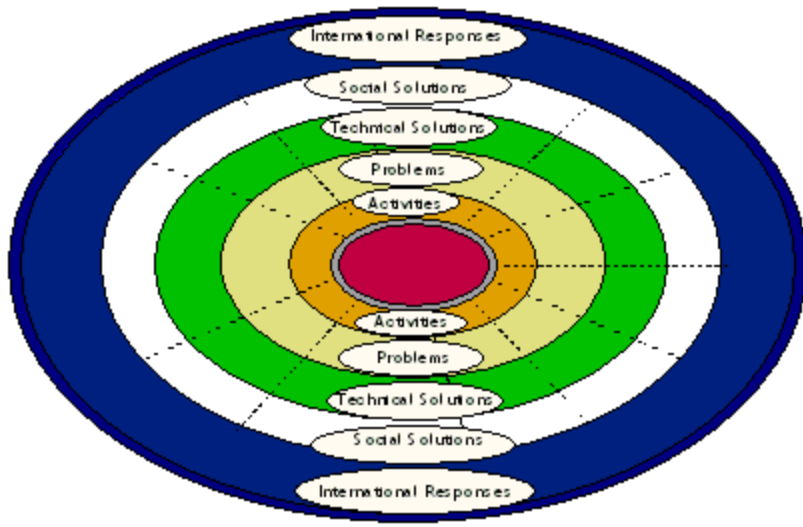


### 3.2 Concept Hierarchy

Given this substantive coverage, the overall knowledge representation strategy can now be conveyed in terms of domain representation and the hierarchical organization. The set of Core Concepts, listed above, are further differentiated in terms of Rings which represent a set of Issue Foci. The Rings in conjunction with the Slices provide the basic architecture for the entire system. The Rings are shown below:



## Conceptual Framework - Rings



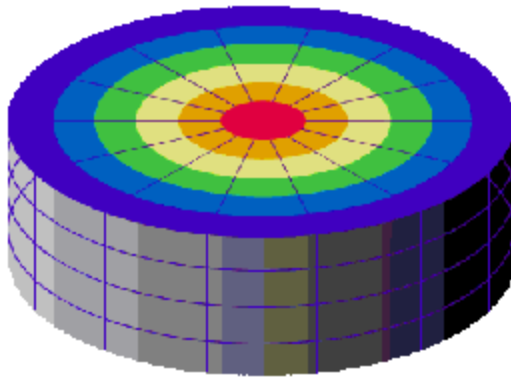
Within the system, each concept is extended in hierarchical terms, as explained further on, as well as the logic for *connectivity* within and across rings and slices.

By combining Slices and Rings (with their respect contents) we generate the GSSD integrated sustainability framework. That framework is, at this point in our discussion, used entirely for intellectual and conceptual purpose- to provide coherence in the subject matter itself. Later on we will how the framework is used to guide search and access functions of GSSD operating over the Internet.

### 3.3 Integrated Sustainability Framework

## Conceptual Framework

- S lice
- R ing
- C ell
- C oncept
- S ub C oncept



Combining concepts and the hierarchical design yields the integrated framework, the nested elements of which we define further below.

### 3.4 Nested System

The nested system, thus, consists of a set of interconnected components. The same conceptual specification holds across all 14 substantive issues (Core Concepts or topics) in the domain of sustainability and provides an internally consistent subject-driven knowledge-management strategy. Linkages across subjects are facilitated by a cross-referencing system.

#### **Slice – Core Concept or Domain**

Refers to the hierarchy of elements which jointly constitute the customized content details of each of the Core Concepts. In each case the Core Concept is 'profiled' to indicate the Core type of (1) *action and conditions* (2) sustainability problems generated, (3) nature of *technical* solutions, and (4) the type of socio-economic or regulatory solution.

#### **Ring – Issue Focus or Dimension**

Refers to key sustainability issues, namely (1) the specific *domain* implied by the core concept, namely the *activities and conditions*, (2) the *types of problems* or dysfunctions generated by human activities and conditions, (3) the *technical & scientific solutions*, namely structured response type to problems and (4) the *socio-economic and regulatory solutions* in response to action, problems across all concepts, as well as (5) the types of *coordinated international actions*. For reasons noted below, the last Ring is not connected to any particular Slice.

## Cell

Represents distinctive knowledge items at specific intersection of Slice and Ring (except for Ring 5).

### Concept

Refers to a specific issue within the Cell topic.

### Sub-concept

Refers to a specific element within the Concept level.

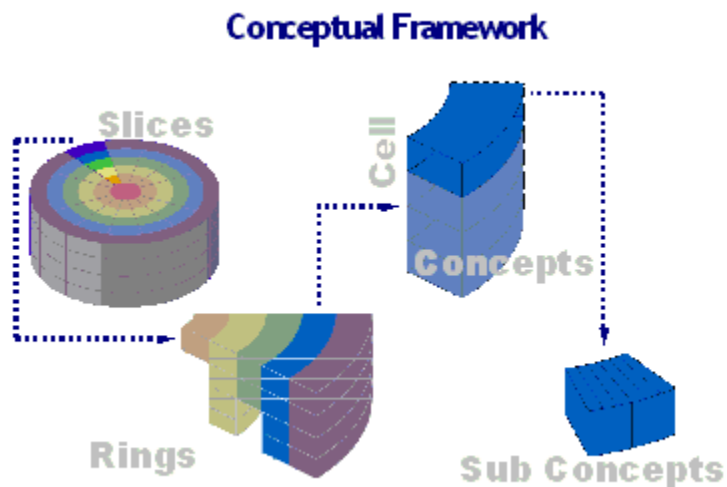
### Connectivity

Connectivity refers to the - content-based indexing system providing linkages among elements of the hierarchical system. This framework serves as a platform for a multidimensional cross-referencing system enabling users more engagement in increasingly refined and targeted search strategies over the GSSD knowledge base as well as more refined ways of providing knowledge into the system.

It is important to note that this conceptual characterization is designed to ensure consistency in the representation of *content*. This representation, in turn, allows for the *indexing system* used for organizing and accessing Internet resources.

### Connectivity Structure

The diagram below shows the nested linkages (and the connectivity implications). The diagram is followed by two specific illustrations of the framework – for agriculture and industry – in order to show the contents connections of slice, ring, cell, concept, and sub-concept. The arrows in the diagram below show the attendant logic for the hierarchy.



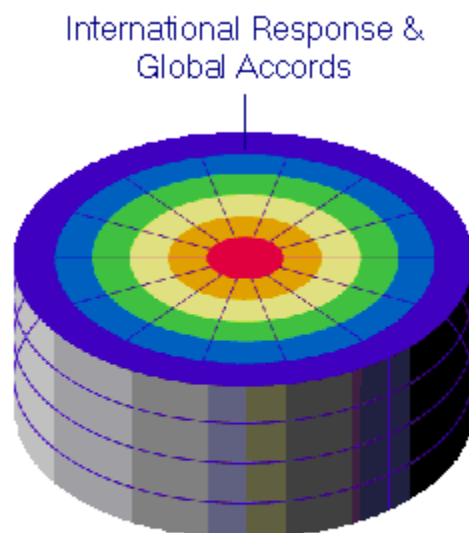
[Slide Illustrations: Agriculture](#)

[Slide Illustrations: Industry](#)

### 3.5 The Fifth Ring

We now turn to the matter of the “Outer Ring” – or ring (5) in the Concept Ring listing above – representing types of coordinated international actions. This Ring (dimension) does not conform to Domain-Dimension 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.

GSSD supports 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).



## GLOBAL SUSTAINABILITY STRATEGIES



### 3.6 Coordinated International Actions

As noted, the logic for the “Outer Ring” is driven not by concept-content, but by the *content of different types of coordinated international strategies*. These topics serve as entry points to the Internet knowledge-based resources on:

#### 1. Agenda 21

#### 2. Conventions & Global Conferences

- FCCC
- CBD
- Other

#### 3. New Development & Investment Mechanisms

- Cleaner Development Mechanism
- Joint Implementation
- Activities Implemented Jointly
- Innovative Investment Systems

#### 4. Technology Agreements

#### 5. Monitoring Performance

- Limits on Hazardous Activities
- Benchmarking Systems
- Compliance Records
- Other

## **6. Codes of Conduct & Voluntary Agreements**

- Environmental Conduct
- Voluntary Agreements
- Human Rights Issues
- Other

## **7. Financial & Investment Codes**

## **8. Conflict Management & Peace Strategies**

- Dispute Resolution
- Peace-Keeping
- Conflict Prevention
- Other

## **9. Population Management**

- Population Policies
- International Migration Strategies
- Resettlement Initiatives
- Other

## **10. Economic Adjustments & Agreements**

## **11. Trade Regimes & Agreements**

## **12. Environment Agreements**

## **13. Private-Public Partnerships**

## **14. Strategies of International Institutions**

# **4. Knowledge Base & Data Type**

The contents of the knowledge base consist of a body of selected (quality controlled) WWW-based resources – tagged per the above – and each item is accompanied by an abstract. The tags deposited in the GSSD database are used for retrieval of original Internet resources – per user specification. The system as a whole constitutes a knowledge meta-network. And the original sources remain of course, in their original ‘location’ which we point to via link to the attendant ‘url’ as relevant

### **4.1 Knowledge Source**

This meta-network of networks consists of knowledge representation supported by some formal institutional framework or entity backing the integrity of its knowledge base.

The listing in **GSSD Institutional Holdings** provides a partial record of institutions whose materials are entered in the knowledge base. Over 250 institutions are covered, and the current knowledge base consists of over 2500 abstract-and-cross-indexed sites.

## 4.2 Knowledge Type

Individual items in the knowledge base are cross-referenced and cross-indexed to facilitate understanding the linkages among issues and problems, as well as strategies and solutions – and enhance integration of alternative views of and perspectives on sustainability.

Each item in the GSSD knowledge base is classified by according to eight data-types. These are labeled and defined as follows:

### **Agreements**

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

### **4.3 Level of Aggregation**

The matter of 'level' refers to the distributional attributes of the data and the extent of its aggregation by geographic, jurisdictional, location or other criteria. This allows the user to access or provide knowledge signaled (or tagged) in those terms as well.

## **5. GSSD Functionality**

We highlight here two sets of functionalities: those related to knowledge management (including representation and input into the knowledge base) and those used for selective retrieval through navigation options and search mechanisms.

### **5.1 Knowledge Management**

The knowledge base of GSSD consists of abstracts of selective materials on the WWW provided by a range of institutions, national and international, both private and public. Each abstract is subjected to a cross-referencing process. The content of each entry in the knowledge base is represented by:

- (i) Title
- (ii) Abstract
- (iii) Descriptors
- (iv) Pointers to facilitate intelligent retrieval.

### **5.2 Submit Site**

Management of the knowledge base in terms of update and input facilities is done via the 'Submit Site' function. Submit Site manages entry and update of individual entries in the knowledge base. Instructions for submission are on the GSSD site. Users interested in providing submissions are encouraged to use the abstract function.



### 5.3 Navigation & Search Mechanisms

Navigation and search mechanisms operate over the GSSD knowledge base. The knowledge base itself is initially generated through prior (screened) selection of quality-controlled materials.

**Navigation options** consist of four mechanisms enabling users to:

- **Select by core concept**
- **Select by slice** focusing on subject, topic, or issue (e.g., energy, population, etc.)
- **Select by ring** focusing on problem type, or solution type (i.e., specific socio-economic problems, such as distorting effects of energy subsidies, specific technical intervention, etc.)
- **Select by cell** focusing on a specific target item in slice or ring (e.g., solar panels, etc.)

**Search options** consist of two mechanisms:

- **Simple search** – user-defined key word search (e.g., China, energy, population)
- **Advanced search** – user-specified selection of criteria from a complex menu of choices (such as China, solar energy, imports from Japan, concessional rates, supported by ODA, for rural use in Northeast China)

Navigation & Search functionalities are supported by icon-based facilities operating over the GSSD knowledge base to provide direct link to the original sources on the WWW.

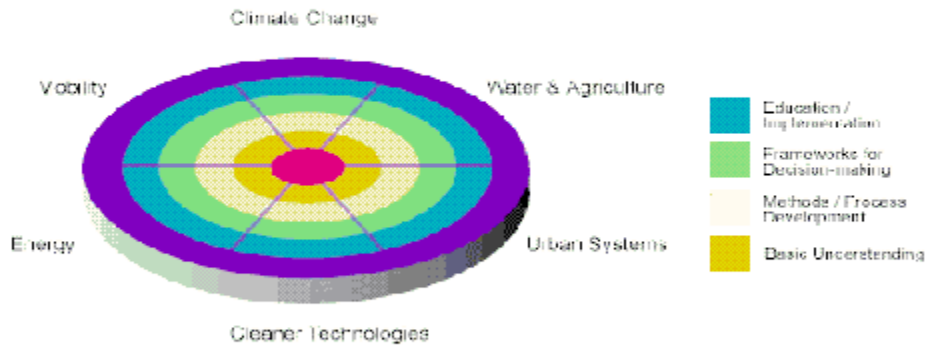
# GSSD Search Types



# Standard Interface



# AGS Interface



## 6. Multilingual Capacity

GSSD offers a platform in which the knowledge-holdings in any supported language can be cross-indexed and then made available to users without a heavy translation cost. New expansion of GSSD functionality includes a multiple language interface and workflow, which currently includes Arabic and Chinese, and shortly, French, Spanish, Italian and Japanese.

Such functionality enables:

**(1) Improved access to information**, reducing difficulties facing non-English speakers by allowing them to find specific information on the Internet through our use of abstracts. Each site included in the GSSD knowledge base is abstracted, and that abstract is, in turn, translated into each of GSSD's supported languages. These are then available for e-searches through the system's five search modes.

**(2) Strategic use of resources**, given that GSSD's abstracts allow the user to know in advance of translation where the most fruitful information is housed thus improving access significantly.

**(3) Expansion of knowledge base**, since the absence of a platform for non-English content has hurt the ability of many groups to make their own data available widely and reduced the amount of local knowledge found on the Internet



## 7. GSSD Meta-Network & Strategic Partnerships

Given the multiple uses of GSSD, it is no surprise that users are also diverse. They represent different constituencies, communities, and functional roles.

### 7.1 User Types include:

- public sector, at national, international, inter-governmental levels,
- private sector, for commercial and non-commercial uses,
- national and international professional groups,
- decision-makers, at diverse levels, contexts, and institutions,
- policy leaders, for agenda setting, consensus-building,
- Knowledge providers, who seek to use the system to diffuse their knowledge base, data, etc.,
- System developers who use the intellectual architecture of GSSD as a standard and platform for their own products, which may be distributed subsequently through GSSD.

This diverse user-base represents different purposes, extents, form, etc., thus representing different stakeholders in the global system, at different levels of development. In essence the “client” is not homogenous; it is as diverse as the configuration of the international community.

## **7.2 GSSD CyberPartnership**

The CyberPartnership for Sustainability is a sub set of the GSSD meta-network. It consists of national and international knowledge providers and knowledge brokers, seeking to:

- (i) exchange information, data and knowledge,
- (ii) explore common problems encountered in internet-based information management,
- (iii) anticipate evolving directions in technology and applications, and
- (iv) explore ways of expanding users and use.

The CyberPartnership was formed in 1996 and held its second formal meeting at MIT two years later. Its goal is to address innovative responses to sustainability challenges – at all levels of development, in all parts of the world. It seeks to provide multiple forms of networking facilities across stakeholder communities to help identify innovative approaches, enabling technologies, as well as new institutional, financial and regulatory mechanisms for meeting sustainability challenges that confront us all, in both rich and poor countries.

## **7.3 Consortium on Global Accords for Sustainable Development**

GSSD served as the core of the loosely organized Consortium on Global Accords for Sustainable Development committed to “reducing the gap between knowledge & policy.” Consisting of governmental institutions, corporations, research foundations, and academic institutions, its founders and core contributors include the Global Environment Facility, MISTRA-Sweden, AT&T, Xerox, Sony Environment Center (Europe), among others. See “Consortium” on the GSSD WWW-site: <http://gssd.mit.edu>. At this point the Consortium serves as a loose set of collaboration, based on priorities, research issues, and immediacy in policy relevance.

# **8. Mirror Sites**

## **8.1 Mirror Locations**

Mirror sites of GSSD are located in several parts of the world, with others in the planning stage. Mirror sites facilitate localization and enable GSSD partners to participate in the knowledge base development more effectively. More important is the enabling role that local mirrors play in the provision of local knowledge, in knowledge development, and in the articulation of situation specific perspectives.



The location operational mirror locations are, currently, in US (MIT) and China (Ministry of Science and Technology, ACCA21 Administrative Office), Tokyo University, Japan, in restricted access due to the development status, in France (Ecole des Mines, St. Etienne).

## 8.2 Mirror Sites & Multilingualism

The following two frames show the GSSD page for Arabic and for Chinese. In principle, all languages (including French and others shortly on line) appear on all sites, and the knowledge base would also appear on all sites. In practice, there are some time lags in the synchronization process.



### 8.3 Initial Perspective



There is no simple way of representing the structure and content of any web site or knowledge system. Nonetheless, below is a screen shot of the main GSSD page. This serves as a device for illustrating how the various pieces fit together.



## 9. The GSSD Team

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