# Eye on Earth Summit

Working Group 3 – Technical Infrastructure
White Paper 2:

# Environmental Knowledge Networks

Draft
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## Table of Contents

# 1.0 Introduction

## 1.1 Background and Purpose

The Eye On Earth Summit - Abu Dhabi 2011 ("The Summit") is a global intergovernmental and multi-stakeholder event and exhibition to convene the thought and action leaders in the worldwide environmental and societal information networking movement, to converge consensus on key areas of mutual importance, and to collaborate towards strengthening existing initiatives and filling gaps towards more informed policy making and a sustainable future. The Summit is expected to:

a) Identify commonalities in existing environmental information networks in an effort to strengthen, align and synergize these initiatives while collectively filling the gaps through coordinated alignment of common efforts;

b) Strengthen, synergize, and extend global processes for bridging the environmental knowledge gap and provide data, information and tools for decision-making (transformative action);

c) Reinforce multilateral policies and institutional arrangements to leverage investments in environmental data while ensuring the preservation of the investment in this information to improve information infrastructure in countries needed to support more coordinated, effective and sustainable development;

d) Support technical cooperation to accelerate the building of a federated global environmental information infrastructure;

e) Accelerate capacity building and technology support programs around the world to further close the gap between developed and developing nations.

f) Strengthen access to resources to support developing countries

This document presents a set of topical issues that are the initial outcomes of each Working Group based on collaborative research and evaluation by its members. This Thought Paper provides Issue Statements based on an identification of issues, the current situation regarding each issue, major stakeholders engaged in addressing these issues, opportunities and constraints, and the major impacts and outcomes that can be achieved by further addressing the identified issues as part of the Summit. The identified topical issues will be submitted to the Framework Committee for review that will lead to the selection of a subset of topics that the Working Groups will then focus on more intensively. Based on the selected topics, the Working Groups will expand each Issue Statement into a more detailed White Paper. During its second meeting, the Framework Committee will review the White Papers and use them as the basis for the development of the Summit program and special initiatives.

## 1.2 Process and Results

The planning, design and development of the Summit involves a very diverse range of issues and a large number of simultaneously moving parts. The Working Group and Framework Committee efforts, with the feedback from the Executive Advisory Board will in large part define the Summit content and special initiatives that will be the visible output of the Summit preparation process, and that will define the path forward for some years to come. In general, the process for defining the Working Group white papers includes the following:

Identification of Topical Issues. Working Groups will assess previous topical issues submitted by the stakeholder community and identify a set of topical issues they would like to address as part of their initial evaluation.

Develop Thought Papers. For the identified issues, a Thought Paper will be developed that elaborates each issue by illustrating the importance, implications, major stakeholders, potential impact and special initiatives that could be generated.

Framework Committee Review and Approval. The Thought Papers will be reviewed by the FC, which will recommend specific topical issues to be further developed into a more refined White Paper.

White Paper Development. White Paper development will treat each selected subject in more detail and will include the direct participation and buy-in of key affected stakeholders.

Final Nomination and Commitments. The Framework Committee will evaluate the White Papers and use the submitted information to develop the Summit program and to recommend if any White Papers should be featured as Special Initiatives to be announced during the Summit closing.

## 1.3 Working Group Definition and Purpose

Below is the working definition of this Working Group's scope of activity:

**Technical Infrastructure Working Group (WG3)**

This Working Group will focus on the technical components of the environmental information federation frameworks, addressing information and communications technology interoperability, connectivity, data standards, data format and content standards, and other such issues. This includes standards for the capture, description, and structuring of scientific data, and the development and delivery of various products and services.

Themes

The primary initial themes to be addressed by this Working Group include the following:

- Shared, multi-purpose technical infrastructure;
- Current technology gaps and improving availability and access to environmental data and bridging the data gaps to meet today's environmental challenges;
- Recent technological advances in data collection: from satellites to ground sensors networks;
- Technology Support and Capacity Building.
- Data ontologies, semantics and standards;
- Product and service standards;
- Metadata and data discovery;

Intended Outputs

- Recommended framework for better access to good practice standards and case studies for various assessment reporting and indicators systems, and the experts who are most familiar with each;
- Better access to information regarding data gathering technologies and their applications;
- Recommendations for most critical technical infrastructure capacity building requirements;
- Recommendations for broadening and strengthening technical networks to enable more effective access to data content and format standards, applications, models and other resources;
- Recommended standards for data exchange.

NOTE: Although it will be possible to refine the WG definition following the WG's deliberations, the WGs are not expected to focus on definitional issues.

## 1.4 References

This report includes provisions that are more fully described in other documents and that are included by reference, including:

***Eye on Earth Summit Program Design.*** Original Program Design dated 1 May, 2010. This document is being updated as part of the Summit detailed planning stage. Its provisions will have influence on the detailed activities of the GPC Team.

***Executive Advisory Board, Framework Committee and Working Groups Charter.*** This document provides the Charter for each of these Groups describing their purposes, processes, intended outputs and interdependencies.

***EoE Special Initiatives***. A critical objective of the Eye on Earth Summit is to ensure that there are compelling, specific, achievable outcomes that translate the principles of the Summit to "on the ground" commitments and actions. A target of 4-6 EoE Special Initiatives has been set, each of which is to be defined through the Summit preparation process, and announced during the Closing Plenary.

***WG Thought Papers.*** As an initial input, the Working Groups each developed a Thought Paper that identified and articulated the initial set of issues and special initiatives each WG considered to be the important issues for which content should be developed around for presentation at the Summit and/or Exhibition. The Thought Papers become the starting point for the White Papers by further articulating and expanding on the notions originally presented such that the White Paper can be used to guide and develop the Summit Program.

***FC Feedback on WG Thought Papers***. This report synthesizes the Framework Committee's feedback to the Working Groups on the submitted Thought Papers. This synthesis is based on the a review of the Thought Papers and Special Initiatives as part of the Framework Committee meeting that was held in Geneva, Switzerland on 27-18 July 2011.

# 2.0 Environmental Knowledge Networks

An environmental knowledge network is an instantiation of a knowledge network applied to environmental data, environmental issues, environmental challenges, and other environmental resources. It is typically a network of systems that makes available the results of human and computer processing of information related to a particular community of interest, and delivers those results in a number of ways to increase learning and expertise in the community, and to foster collaboration. The results delivered to the community include, but are not limited to, graphics, reports, best practices, and online learning modules.

This paper will present issues, raised by the Technical Infrastructure Working Group of Eye on Earth, related to environmental knowledge networks. It will expand on these issues, and the associated challenges and opportunities, to facilitate a more in depth understanding of environmental knowledge networks as they exist today and how they could exist in the future.

## 2.1 Executive Summary

The themes of the Technical Infrastructure Working Group that directly address the issues being discussed in this paper are 1) shared, multi-purpose technical infrastructure, and 2) technology support and capacity building. These themes contain, in principle, the main issue areas of this paper; the establishment, maintenance, and operation of a global environmental knowledge network in support of, and supported by, shared environmental data and information systems; and the educational outreach, including online educational material, and best practices for Earth observation and environmental network lineage.

Knowledge networks, in general, are infrastructures that facilitate the harvesting and dissemination of knowledge about the network and what the network supports. They are usually associated with communities of interest. For example, the Teaching-Learning community has a knowledge network[1] in the education space, and the Food and Agriculture Organization of the United Nations (FAO) supports a set of theme-based knowledge networks[2] which support virtual communities formed around the interests of sustainable agriculture and food security.

This paper will address the scalability issue associated with global, cross-community environmental knowledge networks, where environmental knowledge networks, for the purposes of this paper, will be considered knowledge networks focused on environmental data and challenges. There are many opportunities associated with these networks. Some opportunities addressed in this paper include:

the integration of social media networks and frameworks;

[1] http://knowledgenetworks.net

[2] http://www.fao.org/tknet/index_en.htm

the use of semantics and a semantic framework to more easily bring together knowledge from diverse communities in the network;

the use of one or more educational portals to provide certified online training courses to grow and maintain the set of individuals qualified to build, maintain, and manage environmental networks;

## 2.2 Setting the Foundation

An environmental knowledge network, as discussed in this paper, is centered around the key aspects related to intracommunity and intercommunity sharing of knowledge in support of the associated data or information network, and with support for the meaningful use of the data from the associated data or information network. The sharing of knowledge is an administrative and educational endeavor having the goals of improving the expertise of the community and increasing the impact outside the community with respects to the environmental focus of the community.

These aspects of an environmental knowledge network have existed for a long time, but have been engaged, in large part, within smaller, non-global communities. These communities are not just associated with environmental data and concerns, but include areas such as the financial industry, the insurance industry, education, etc. There do exist some communities that operate on a global basis, examples being GOOS[3], GEO Communities of Practice (CoPs)[4], and WMO[5] to name a few. Notwithstanding the successes of some communities and their associated knowledge networks, there remain challenges. The difference today is that there is beginning to be a more widespread understanding that the world is flatter, more decentralized, and more interdependent than ever before. With this realization comes the understanding that problems cannot be solved on a global basis unless the global community is engaged.

There has been much work done on a technical level to date by various communities, national agencies, and organizations to deploy and operate regional and global data and information networks, however the administration and education aspects of a globally distributed environmental knowledge network have not advanced as much. There are opportunities to integrate newer technologies and to evolve the services and knowledge that are offered through a knowledge network.

Environmental knowledge networks can be deployed and operated on many different levels. Traditionally, they are community specific and tend to make available rather static knowledge, where static in this context is to mean that the knowledge is created manually, so that if the associated data or information network were to change significantly, the knowledge would reflect that change until people modified the knowledge. However, deployments can also be based upon

[3] GOOS – Global Ocean Observing System (http://www.ioc-goos.org/)

[4] GEO CoP - the intergovernmental Group on Earth Observations Communities of Practice ((http://www.earthobservations.org/cop.shtml)

[5] WMO – World Meteorological Organization (http://www.wmo.int)

the amount of coverage the associated data or information network receives, the sophistication of the knowledge represented by the knowledge network, and the amount of automation involved in delivering the knowledge.

The issues discussed in this paper give rise to challenges, and those challenges carry with them opportunities. The goal for the scope of this paper is to address the challenges and opportunities of a global interoperable infrastructure that scales easily to address the administrative and educational aspects of global environmental knowledge networks.

## 2.3 Issues, Challenges and Opportunities

Communication capabilities, access to knowledge resources, and support of education are among the assets that a well-designed global environmental knowledge network could provide and are among the most important priorities in advancing environmental understanding. In addition to this, there remains a strong need to cultivate and evolve an infrastructure for connectivity and interoperability between environmental knowledge networks and other Earth observation-based networks that address societal benefit areas. This paper will address the issues related to the technology concerns regarding knowledge sharing and accessibility.

The primary issues from the Technical Infrastructure Working Group that environmental knowledge networks address include scaling to the global level; integrating cross-community, multi-disciplinary knowledge; and providing education outlets for the knowledge via online courses. These issues will be discussed from the point of view of the challenges and opportunities they expose.

As technology evolves, knowledge networks are confronted with new challenges that result in new opportunities to consider that enhance what is made available to an environmental knowledge network user. The global community has also evolved, and has become more motivated and engaged in sharing data and knowledge. This motivation and engagement makes the opportunities more likely to be realized.

### 2.3.1 Evidence-based decision making as a driver for requirements

Communities of interest date back to before the advent of the Internet and the World Wide Web. In these scenarios, communities tended to be local or regional in scope, thus so were any associated knowledge networks. With the web, communities and the knowledge networks expanded to be available globally, meaning anyone with web access could, conceivably, access the knowledge. This was, however, an outreach by-product of the web. It was not met immediately by an improvement of resources, access to resources, or access to knowledge.

When the desire to evolve the community scenario, and the associated knowledge network, into a global setting is considered, it is met by certain challenges. First, and foremost, is the challenge of whether to adjust the architecture of the network to support global access in a satisfactory manner, or to leave the architecture “as is” and simply improve the hardware used to host the knowledge

network so that performance and storage access can handle the demand from a global network. Without a viable infrastructure, users will be met with less than expected access and capabilities.

Boosting hardware performance and storage access might be enough to handle the foreseen global environmental knowledge network user base. However, as the network grows and the user base grows, the exercise of boosting performance will need to be revisited again and again. The opportunity of cloud computing can be considered a means of addressing the issue of scaling to a global environmental knowledge network, both in the growth of the network resources available and in the size of the user base.

With cloud computing, the community does not need to invest large amounts of resources in hardware, maintenance, and normal considerations such as security and backups. There also exists the possibility of deploying the knowledge network, depending on its design, as a cloud-based architecture in the form of a Software as a Service (SaaS) or Platform as a Service (PaaS) offering. Cloud computing allows the dynamic scalability required to support a growing global user base and a growing set of knowledge resources and capabilities.

Global environmental knowledge networks also face a challenge from constraints on participation in the network from a perspective in-between the developed world and the developing world. These constraints include:

- financial matters, which limit the depth of implementation and project size;
- the quality of resources to produce knowledge, which are thinly spread and overcommitted; and
- collaborations, which are not easy to identify or pursue due to an overly complex funding and opportunities landscape.

These constraints can be addressed by individuals or organizations that act as brokers for the global environmental knowledge network. Brokers can work to seek partners, providers, and recipients for the knowledge network.

Governance and operational matters of a global environmental knowledge network carry large challenges, simply due to the nature of the parties involved. It isn't that the challenge can't be overcome. It is, rather, the slow nature of doing so. With the speed at which technology evolves and the opportunities of knowledge sharing increase, the governance structure adopted by the participating parties of a global environmental knowledge network must be careful to nurture the network and not hinder it from its development and evolution. This cannot take place by edict. It must take place by the participating parties acknowledging that global interests are sometimes more important than national, regional, or individual interests.

Traditionally, environmental knowledge networks have been limited to the specific community of interest they represent. It is well known that communities of individuals with a common purpose or interest find mechanisms for sharing the knowledge that the common purpose or interest cultivates. The motivation for this, to a large extent, depends on the desires of the interested parties to reach a common, subconsciously understood yet sometimes unspoken, set of goals. This motivation, in turn, leads to the identification of resources to achieve these goals. This

scenario certainly exists in the many diverse communities that exist, and continue to form, around Earth observation and environmental concerns. In order to include cross-community and multi-disciplinary resources and capabilities in a global environmental knowledge network, it may be necessary to adopt a semantic aspect to the network. The semantics used could allow for the expression of relationships between knowledge resources in a manner that deals with different vocabularies, different languages, and links to associated data and information. Introducing semantics into the knowledge network is both a challenge and an opportunity. Semantics is difficult to implement properly, yet it promises very nice solutions with respect to expressing and utilizing relationships between resources.

### 2.3.2 Education and Outreach

A primary goal of any knowledge network is to reach out to providers of knowledge in order to populate the network, and to take the contributed knowledge resources and make them available to a community in order to educate users of the network. For the purposes of this discussion, we will consider the environmental knowledge network to be global, cross-community, and multi-disciplinary in nature, although the discussion can be easily applied to an environmental knowledge network less ambitious in scope.

In terms of outreach to providers of knowledge resources, there are challenges in sparking interest to contribute. A global environmental knowledge network must provide a home where government agencies, private and non-profit organizations, and individuals can:

- self-identify as having core environmental interests;
- describe those interests;
- register or make available their environmental knowledge resources, such as publications, services, best practices, maps, and other resources; and
- be supported in finding, communicating and cooperating with other entities or individuals with similar goals and interests from across the globe and across communities of interest.

A global environmental knowledge network that provides the above capabilities will improve its chances of success. The amount of knowledge resources contributed, and the manner in which they are delivered and made available to the user base will help define the success of the network.

The current limited knowledge networks in the environmental community tend to be focused primarily at a national interest level[6] or be very limited in the sector participation they allow or in the services and capabilities they provide.[7] Other knowledge networks related to the environment often

[6] Examples include the U.S. *Environmental Information Exchange Network* at http://www.exchangenetwork.net/, U.S. *Envirolink* at http://www.envirolink.org/, or the U.K. *Environmental Sustainability Knowledge Transfer Network* at https://ktn.innovateuk.org/web/sustainabilityktn

[7] Globally focused examples include the nonprofit *Conservation Commons* at

focus on a specific component such as leading users to knowledge within a domain[8] and/or a geographic region.[9] By contrast, over 40,000 development professionals from across the globe and their affiliated organizations are linked through a world-wide knowledge exchange.[10] Yet even this example of an extensive knowledge network does not provide the breadth of access to valuable resources that a comprehensive global environmental knowledge network could provide.

The sharing of knowledge about the global environment is an aspect to the global network concept that is largely decoupled from the highly technical aspect of data sharing itself. In this regard, there exist many platforms that are currently used by the general public, and many professional communities, to support this goal. Social media solutions can be integrated and leveraged in a global environmental knowledge network to facilitate communication, collaboration, and education. Whether existing platforms, such as Facebook, LinkedIn, Google+, WordPress, or other content managers and blogs are used directly or not, the ideas behind them are often compelling. These are the mechanisms that are being employed throughout the world now to share knowledge on a global scale.

An important, yet overlooked, aspect to a knowledge network is the knowledge that is contained in the lineage of the associated data or information network. The historic documentation of the steps taken to establish the data or information network (outlining the challenges and opportunities faced) should be made available to the public and looked at as part of best or common practice for facilitating knowledge transfer. This initiative would provide detailed reporting of best practices in environmental information systems implementations and provide resources such as guideline manuals to other interested parties or communities wishing to establish similar networks.

An educational portal providing free and/or sponsored certified online training courses might contribute towards solving the challenge of having qualified people to maintain the associated data or information network. This portal could base its courses on open source technologies and open access materials and present them as a viable cost-effective alternative to commercial options. Providing an online resource that compiles such course and degree offerings would be valuable,

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http://www.conservationcommons.net/ and the commercial *Ecology Global Network* at http://ecology.com/about/

[8] The *Global Earth Observation System of Systems Common Infrastructure* (http://www.earthobservations.org/gci_gci.shtml) is focused on registering primarily components and services and therefore is complemented by the emerging *Geographic Information Knowledge Network* (http://giknet.org) that allows also the detailed reporting of organization profiles, individual profiles, spatial data infrastructure implementation experiences, best practices and supports communication forums.

[9] Examples include the U.S. National Biological Information Infrastructure, http://www.nbii.gov/, and the U.K. National Biological Information Marine Life Information Infrastructure, http://www.marlin.ac.uk/speciesfullreview.php?speciesID=3183

[10] *Zunia Knowledge Exchange* at http://zunia.org/ and the affiliated *Development Gateway* at http://www.developmentgateway.org/programs/zunia/

particularly in the context of an environmental knowledge network. However, new course materials are also very much needed. The provision of such courses and workshops will help towards bridging existing technology gaps. They could also provide remote access to experts to clarify issues of continuing development. The technology behind online learning has made great leaps in the last few years, and could be leveraged greatly in providing more accessible educational opportunities to the public and the educational community, as well as the professional community.

## 2.4 Direction and Way Forward

In establishing a global environmental knowledge network, it is fairly clear that the infrastructure for the knowledge sharing need not be the same infrastructure as for the data sharing. Whereas the data sharing requires a highly sophisticated architecture and design in order to deal with interoperability issues related to the discovery and access of data, the knowledge sharing side has existing technical solutions and infrastructures to leverage, such as cloud computing, social media solutions, and online learning.

Regarding educational outreach, existing infrastructures such as IEEE Xplore[11] can possibly be partnered with to achieve the goals of this issue. IEEE Xplore is a globally available portal for educational purposes, and provides all kinds of educational content. Key goals for educational outreach, which IEEE Xplore has built into its operational infrastructure, include the ability to perform outreach for, and target, different levels of education, and to always improve upon existing content while adding new content as more is learned or developed.

From the main discussions of this paper, and based upon real experiences, it is suggested that the knowledge sharing and educational outreach should lead the way for global data sharing, allowing a “global” community to organically form around the global environmental issues. It is, in many ways, easier to draw a crowd around the knowledge about, and of, the environment than it is to draw a crowd around the technical aspects of supporting an architecture and infrastructure that facilitates the sharing of data globally by methods of interoperability and standards usage. The success of knowledge sharing as a first step, will naturally lead to the common motivation and desire to share data globally.

[11] IEEE Xplore - http://ieeexplore.ieee.org/Xplore/guesthome.jsp