Knowledge Systems for Sustainability – Advancing Toward Prototypes

November 26-28, 2012
US Dept of Energy Oak Ridge National Lab
Meeting summary

Hosted by the Oak Ridge National Laboratory and the University of Wisconsin-Madison

Note: In advance of this meeting, a special session introduced colleagues from CSIRO to ORNL facilities and colleagues to negotiate a Memorandum of Understanding and Agreement as a foundation for the KSS Partnership. Following this meeting, a session focused on Cereal Systems in South Asia (CSISA) and Vital Signs Africa brought together interested KSS, CGIAR and ORNL colleagues to discuss potential collaborations.

Meeting Synopsis

In its fifth major meeting, a partnership focused on Knowledge Systems for Sustainability (KSS) assembled representatives of major projects and programs that generate, curate, and/or deliver data, information, tools, analytics, and knowledge assets relevant to sustainable landscape management. While social sciences and the social components of social-ecological systems are critical components of KSS, they were not a focus of this meeting. Future efforts will concentrate on these aspects of knowledge systems. This 1.5-day workshop mapped participants' capabilities in relation to each other, reviewed cyberinfrastructure models from leading global efforts, and further mapped partners' capacities into specific place-based natural resource management challenges or "cases," using the U.S. Chesapeake Bay Program as an exemplar.

A major goal of this meeting was to foster targeted interactions among prospective partners with complementary capacity, and to emerge with expressions of interest and concrete agreements that take forward the KSS objectives. Resulting collaborations are anticipated to build defined pieces of knowledge systems, as we have conceived them (i.e., "prototypes") that better support integrative, adaptive management of landscapes that are subject to provisioning demands. Progress was made in advancing specific "cases" that will be nested with the broader context of KSS activities.

Executive Summary: What is KSS?

The Knowledge Systems for Sustainability (KSS) Partnership met at the US Department of Energy's Oak Ridge National Lab on 26-28 November 2012. Approximately 50 senior colleagues convened from governments (Australia, South Africa, United Kingdom, United States), academia, international research organizations and

donors/sponsors to create new partnerships and strategic alliances to better inform landscape management challenges. The KSS Partnership defines itself as an international research community of practice focused on provisioning challenges at the land/water/energy nexus, positioned at the interface between more fundamental 'upstream' science and 'downstream' applied, place-based resource management efforts (Figure 1).

With nodes in the US, UK, Australia and with several projects or "cases" in the US, UK, Australia, Africa and South Asia, the KSS Partnership assembles a community of natural and social scientists, engineers, statisticians, computer scientists, lawyers and others who bring related capacities, assets and commitments across national, disciplinary and technical boundaries. Our goal is to improve delivery of insights and information from science toward decision-making on landscapes related to humanity's provisioning challenges. In community, we have specified and reviewed concepts, principles and protocols for knowledge systems that can better mobilize diverse and disparate data and information assets through models and cyberinfrastructure toward navigation of tradeoffs and tipping points in a knowledge-to-action and action-to-knowledge mode. At ORNL, we focused on the use of geographically defined "cases" anchored in common frameworks, working systematically across scales and geographies to access and link data, information and knowledge assets to decision-making in learning systems.

Our intent is to set up structured dialogs between case study teams and a selected case, providing structured mechanisms to more holistically track human and ecological dimensions through time and space. In these relatively structured interactions, we expect we can more efficiently identify exportable and importable insights across cases. Our goal is to teach ourselves how to specify elements and dynamics within cases such that patterns can be discerned, and underlying approaches can be identified that are most likely to lead to improved outcomes. In our community of practice, we have engaged with large, structured projects and programs, i.e. "cases," to create demand for integrated data, modeling and other services from knowledge systems. Within the KSS Partnership, we have set up trajectories for each knowledge system dimension: (1) data and information; (2) modeling, model intercomparison and improvement and integration; (3) decision sciences; and (4) user interfaces, participatory processes and learning systems. It will be through these multi-directional dialogs among KSS Partners and KSS Cases that we will build our community of practice, interpret data and gain insights about applying systems thinking and tools to particular sustainability challenges. We expect these dialogs will reveal the value of coherent data layers and our ability to work across those layers with analytics that work across scales and dimensions. We have already shown that there is overlap across cases, hence obvious efficiencies to be gained in providing information and tools, e.g., weather data and approaches to interpolation and extrapolation in data-scarce regions.

A fundamental premise of our community of practice is that we can secure improved outcomes in both human and environmental dimensions through federated efforts that systematically enhance coordination and collaboration across traditional boundaries.

While there is an increasing abundance of data in human and ecological dimensions and increasing scientific understanding of the impacts of management choices on landscapes and ecosystems, this knowledge often relatively inaccessible to the people actually making management decisions.

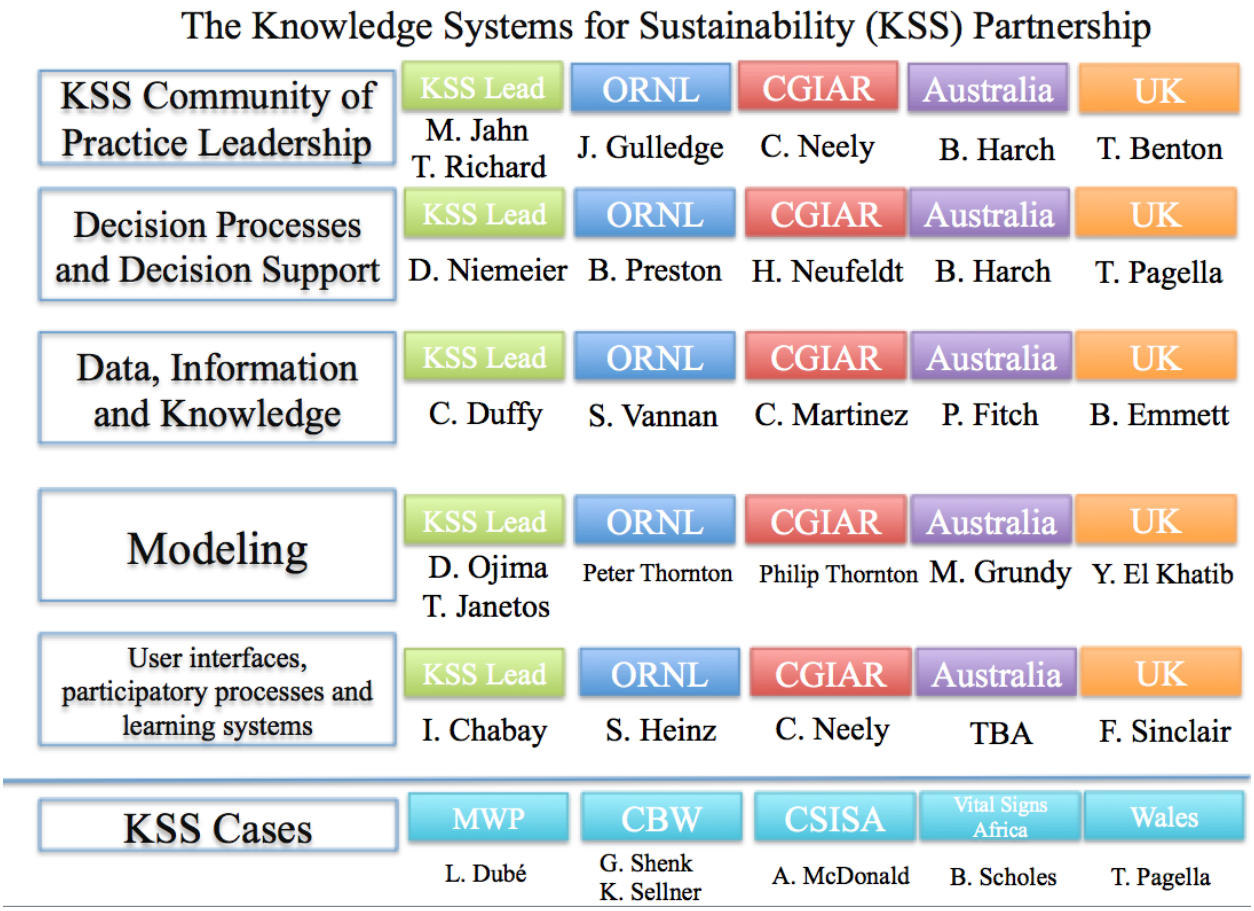


Figure 1: KSS Partnership leadership.

Table of Contents

Summary of stated meeting goals and meeting outcomes

This meeting had 5 major goals:

Goal 1: Confirm scope and plans to generate/finalize foundational KSS documents

Articulate in community the foundation for the KSS effort and place our shared commitments in the context of the many related activities already underway. Concepts distilled from this meeting will inform development of detailed written products planned for early 2013.

Outcomes for Goal 1:

General input was solicited for the vision, structure, content and format of documents needed to describe the purpose, goals and organization of the KSS, specifically the KSS Case Framework, elevator pitch, white paper, policy-oriented paper, white paper on a canonical slow variable (soil carbon), strategic short-term and long-term plan and pathways for impact.

Goal 2: Collective mapping of shared space

Identify intersections between existing projects, programs and organizations to define areas of shared interest and activity within the KSS community. Collaborative "maps" will be developed to highlight KSS partners' complementary efforts.

Outcomes for Goal 2:

Through an interactive exercise, meeting participants plotted existing initiatives and organizations onto four "map" surfaces:

- The four knowledge system dimensions of KSS[1]
- A KSS Case: the Chesapeake Bay Program
- KSS-relevant cyberinfrastructure components
- A diagram illustrating the concept of "slow" variables: Soil carbon

The visualization of a virtual "shared space" or "commons" provides a foundation upon which shared interest, complementary capacity and opportunities for partnership can be explored. These "maps" will be edited, further refined, posted, and/or published to highlight KSS Partners' collective efforts as well as opportunities to advance the synthesis of improved knowledge management systems anchored in decision-making on landscapes.

[1] (a) Decision Processes and Decision Support; (b) User interfaces, participatory processes and learning systems; (c) Modeling and Scenario Building; and (d) data, information and knowledge assets relevant to sustainable provisioning at the land/water/energy nexus.

Goal 3: KSS Case Framework

Evolve a mechanism that defines a structured dialog to transition geographically bounded projects or programs into mutually informative "KSS Cases" through knowledge-to-action / action-to-knowledge approaches.

Outcomes for Goal 3:

The conceptual foundation to facilitate contributions by the KSS community to a learning system that collects and distributes knowledge within and between KSS Cases was discussed and refined. Specific outcomes included a defined value proposition and pathways for impact for KSS Partnership-KSS Case Interactions and a two-part KSS "Framework" (Principles, Protocols) that governs the dialog between KSS Cases and the KSS Partnership.

Goal 4: Developing KSS Cases and next steps

Explore the opportunities within KSS Cases that have drawn intensive investment to test the assertions of the KSS Partnership and to leverage customized, demand-driven solutions to develop more generalized approaches for managing information and knowledge to sustainability challenges.

Outcomes for Goal 4:

In-depth discussions of opportunities to collaborate and engage with the Chesapeake Bay Program focused on six specific challenges. These discussions resulted in generalized, exportable insights from the Chesapeake Bay Program for KSS in addition to concrete next steps, including: brokering dialogs with new and existing partners, investigating new approaches and viewpoints to address complex challenges, and connecting research across scales and disciplines.

Goal 5: Cyberinfrastructure Scoping

Identify and advance the discussion of how cyberinfrastructure tools, approaches and components would advance the goals of creating a virtual "shared space." This KSS "backbone" will enable the contribution of platforms, components, data, information and knowledge assets, tools and analytics that have potential relevance for adaptive management of provisioning demands from terrestrial ecosystems.

Outcomes for Goal 5:

Through several scoping exercises focused on creating a virtual "shared space", sets of principles, best practices and development strategies were outlined and prioritized for future exploration. These included the near-term refinement and further development of cyberinfrastructure principles that include: reusability, discoverability, accessibility, and interoperability. Maturity models were also proposed as a relevant methodology to assess the quality of data, models, and other tools in relation to KSS goals.

In plenary and breakout sessions, these 5 specific areas of activity were developed.

Near term next steps to build the KSS Partnership

KSS Origins

From its initial roots in US Government research agencies, the KSS partnership has come together over the past two years as leaders across the global research enterprise identified concerns and opportunities that were difficult to navigate across traditional boundaries. KSS originates in the general failure of today's scientific investments to achieve much more than describing problems. Further, we recognize an urgent need to better characterize the full spectrum of risks encountered as a result of current approaches to provisioning humanity at the land/water/energy nexus and to actively support transformative outcomes in the sustainable management of landscapes. KSS is also focused on democratization of knowledge (i.e. getting knowledge in the hands of those who manage resources and make decisions) and adaptive capacity that will lead to better-tailored strategies.

Meeting discussions

In plenary, meeting participants discussed how KSS can (or should) anchor in existing global programs (e.g., GEO, ICSU, Merton Initiative) and other large data and monitoring initiatives. As part of the context for KSS, a number of voluntary efforts (see Figure 2[2]) have made substantial gains in data-sharing, legal frameworks and interoperability, however programmatically they are not very well integrated and the "overhead cost" of interaction needs to be lowered. It was noted that, in general, existing programs do not extend far enough beyond observational capabilities and the KSS Partnership can be a catalyst for turning observations into useful outcomes with real social benefit.

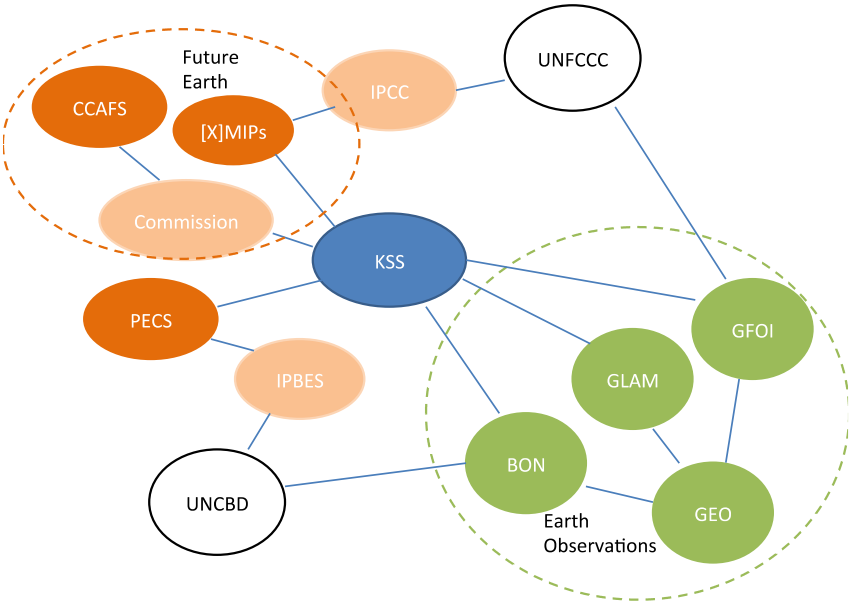


Figure 2. A simplified view of selected initiatives in the knowledge landscape reproduced with permission from Bob Scholes).

[2] See Annex 5 for expansion of acronyms

Other meeting sessions covered topics that require further exploration with the KSS Partnership. The importance of mobilizing outside the "usual" communities to resolve the operations / research split was noted as was the need to avoid a "build it and they will come" approach to cyberinfrastructure (CI) development by focusing on early engagement with a broad range of CI users (e.g., large agricultural companies). On the topic of decision sciences, the need to avoid confusing policy makers with decisions was articulated. Participants recognized the urgency of multi-scale capability that isn't restricted to individual landscapes or aboveground processes and the need to incorporate quantification of uncertainty and risk into KSS activities. In comments returned by a number of meeting participants, guidance has been provided about the ways to structure the domains within KSS, key factors to consider, examples to follow, situations and issues to avoid, and specific opportunities projects, segments, and cases within our network for funding opportunities.

At the close of the ORNL meeting in November 2012, a consensus was established that there was significant value in pursuing the structures and concepts that the KSS network has developed to date, but it was time to transition to a more ordered, intentional mode. There was also consensus that there is significant potential to create shared, curated space where willing partners with clearly stated aligned objectives and complementary capacities can come together to share data, analytics, problems posed and problems solved at the land/water/energy nexus using structured approaches that track the principles, scoping and organization of KSS.

To mobilize 21st century tools for sustainable land management, the loose federation that is the KSS Partnership constitutes a community of practice with shared principles and vocabulary that is exchanging insights (with an explicitly international scope) and pursuing collaborative activities.[3] Collectively, the KSS Partnership wields powerful resources, but to progress it must develop a shared definition of success in a 1 to 5 year timeframe (e.g. real outcomes in KSS Cases and development of shared virtual space) and determine who will hold responsibility for KSS functions.

Participants affirmed the commitment to action learning and the appropriateness of an informal governance structure for KSS in which self-mobilizing groups collaborate and learn from one another. Partners agreed that a "community of practice" with "nodes" working in a federated, coordinated partnership will best realize KSS goals and allow the Partnership to navigate the many issues at critical boundaries with harmonized ground-up approaches. Groups of like-minded individuals will coordinate dialog between KSS Cases and the Partnership framework. As an outcome, examples of successful communities of practice will be assembled where the focus is coordinating diverse approaches to collective action across national and disciplinary boundaries. Also, a draft governance structure document will be developed with recognition of the need to monitor, adapt and evaluate the network itself as well as a draft strategic visioning plan and implementation document.

[3] For example, USDA funds have been leveraged for KSS-style activity embedded within two projects (dairy, bioenergy).

A team has been participating in biweekly leadership calls and will shift to solidifying the KSS Partnership structure and governance anchored in a series of “nodes” allowing nationally based and funded activities to federate within the KSS structures. This team also will progress to define interfaces and ability to cross those interfaces with aligned global technical communities such as AgMIP and other MIPs, Environmental Virtual Observatory, the Global Soils Map and others, which were mapped in exercises at this meeting.

Following the meeting, a team has come together to i) extend the draft and test the KSS Case Framework document with the deadline of a workshop at the Santa Fe Institute to review and finalize it; and ii) develop a white paper focused on a sample “slow variable” soil carbon with the deadline of a meeting of the International Union of Soil Scientists on soil carbon in Madison, WI in June, 2013.

Outcome Mapping & Pathways to Impact

Outcome Mapping is but one way to document theories of change. Other options exist with similar intent but differing in visualization. Outcome Mapping allows ‘trained skeptics’ to engage in a process that doesn’t appear too linear while avoiding oversimplification or over complication – significant fears after lack of clarity in language. Outcome Mapping is one step in a process that works towards identifying measures and collecting information for evaluation and adaptation. It is fair to say that the greater balance of effort related to impact processes resides is in the data collection, analysis and reporting.

The starting position of the mapping process is to determine the three core triple bottom line outcomes that KSS is targeting. Representatives from across the KSS community can then undertake the actual Outcome Mapping process, where focused discussions about the causal network through which knowledge is translated and adopted, leading to behavioral change and ultimately triple bottom line outcomes takes place. The result is a clear set of pathways described in enough detail to be relevant to clusters of partners and cases where impacts on the 1-3 year time horizon are relevant. The clear benefits arising from Outcome Mapping emerge as a mechanism to cause discourse on the various theories of change that are allowed to co-exist without rigorous and systematic testing and debate. This also has the added advantage of sharing ownership and hence commitment over compliance to KSS planning and strategy.

2013 KSS Calendar

- Next full KSS Partnership meeting--to be determined. We will be looking for funding to support travel and also Bellagio-style fellowships to assemble study teams for short term working sessions in new space at the US Forest Service’s federal laboratory in Madison, WI which is now hosting Jahn and LeZaks under an MOU with the USFS that is currently in negotiation. Since the ORNL meeting, Columbia’s Earth Institute has indicated an interest in partnering with us on this objective.

- Chesapeake Bay Watershed Case meeting, May 1-3, 2013, Annapolis, MD to develop the work plan from ORNL meeting (see details below).

- Wales and EVO case development meeting, Feb 8, Bangor, Wales.

- Decision sciences/Governance and User interfaces, participatory processes and learning systems meeting, host Deb Niemeier, 20-22 March Davis, CA in conjunction with the Climate Smart Agriculture conference and CCAFS CRP meeting.

- AgMIP/ORNL Interface Development Sprint, April-June 2013.

- Molly Jahn to University of Florida 4/2-4/3 for “Sustaining Economies and Natural Resources in a Changing World: Key Role of Land Grant Universities” meeting.

- Santa Fe Institute meeting, Dates TBD - very small ‘by invitation’ meeting to finalize the KSS Framework. Leads: Deb Niemeier, Henry Neufeldt, Dennis Ojima, Molly Jahn; SFI contacts: Nina Fedoroff and Luis Bettencourt, Working session: KSS Case Framework document.

- Soil carbon workshop at International Union of Soil Scientists Madison, WI, 3-6 June 2013. Finalize our soil carbon “canonical slow variable” working paper. Any KSS Case could benefit from a set of approaches to allow the dynamics of soil carbon to be considered in decision-making. Alfred Hartemink is lead organizer; Dennis Ojima is lead on KSS white paper on soil carbon as a canonical slow variable.

- US NSF Workshop on governance, risk and decision-making, 20-21 June 2013 Incline Village, Nevada, organized by Deb Niemeier and colleagues. Several KSS Partners have submitted abstracts for consideration to participate in this workshop.

- A meeting has been set in Sweden, 11-12 June 2013 before the Tallberg Forum. Discussions have advanced with Tallberg Foundation partners on our presence in the Forum itself. We have partnered with Aled Jones, Anglia Ruskin University's Sustainable Development Institute, the UK Institute and Faculty of Actuaries to build the Pre-Forum meeting with attendance by insurance, credit and finance, and the UN Global Compact to bring global agricultural and food companies to the pre-Forum meeting and the full Tallberg Forum. Fundraising for the Forum will commence soon jointly with Columbia University and will include support for ongoing fellowships to allow teams from across KSS to assemble together for short working sessions.

Upcoming Deliverables

Elevator Speech – Bronwyn Harch, Paul Barnett, Molly Jahn and David LeZaks
To be complemented by a short slide deck that is a KSS overview.

White Paper – David LeZaks with input from the KSS Partnership
Detailed written product (a "white paper") that captures the foundation for the KSS partnership in the literature and in existing activities, provides a brief overview of each of the major discussions underway in our Partnership and sets next strategic and specific tactical steps toward improved knowledge systems for sustainable landscape management.

Outcome Mapping & Pathways to Impact – Paul Barnett, Bronwyn Harch, David LeZaks and Molly Jahn

Strategic Visioning Plan and Governance Structure Documents – KSS Leadership

---

Summaries from major meeting sessions

"Mapping" intersections among KSS Partners and Projects

A central function of KSS is connecting partners with relevant capacities to focused challenges in sustainable landscape management. This requires the construction of a virtual "shared space" or "commons" that becomes the operationalized KSS Partnership. Before projects and programs can jointly undertake activities that advance "prototype components" of KSS, potential collaborators need a way to locate areas of shared interest and complementary capacity. Through an interactive exercise, meeting participants plotted existing initiatives and organizations onto four "map" surfaces:

- The four knowledge system dimensions of KSS[4]
- A KSS Case: the Chesapeake Bay Program
- KSS-relevant cyberinfrastructure components
- A diagram illustrating the concept of "slow" variables: Soil carbon

Within the context of the meeting, pattern detection and the relative placement of existing initiatives and organizations was directed toward identifying intersections and opportunities for collaboration.

These "maps" will be edited, further refined, posted, and/or published to highlight KSS partners' complementary efforts as well as opportunities to advance the synthesis of improved knowledge management systems anchored in decision-making on landscapes.

[4] (a) Decision Processes and Decision Support; (b) User interfaces, participatory processes and learning systems; (c) Modeling and Scenario Building; and (d) data, information and knowledge assets relevant to sustainable provisioning at the land/water/energy nexus.

All maps are contained within the appendix. The original versions are also located on Basecamp, where they can be downloaded and edited with the Xmind application (free; http://www.xmind.net/).

Case Framework and Case Tracking Strategies

Having converged on the strategy of working through geographically bounded projects or programs as a foundational approach, the KSS Partnership has explored approaches for converting these into mutually informative KSS Cases. These explorations, led by Deb Niemeier, Dennis Ojima, Henry Neufeldt and Molly Jahn, have taken the form of a draft Case Framework intended to serve as the mechanism by which "cases" are introduced into the KSS community and to enable scanning for commonalities, patterns or work modes across cases. Plenary presentations by Dennis Ojima and Henry Neufeldt introduced the work undertaken to date that ground the Case Framework in social-ecological system characteristics, e.g., communities and their livelihood strategies, ecosystem services and dynamic space and temporal relationships, e.g., climate change impacts and responses, sustainable development pathways and managing for resilience and change. The goal of the Case Framework is to structure a dialog within and between KSS cases that are designed to allow for the detection of commonalities (challenges and successes), patterns, or work modes that will allow us to leverage one-off customized demand-driven solutions to more generalized approaches for information provisioning and knowledge management more generally.

Major challenges in the conceptualization and implementation of the Case Framework include reconciling various information and knowledge sources from theory of social-ecological systems with the practice of development strategies to meet provisioning services and livelihood goals and identifying possible linkages between drivers of change and the slow and fast variables of the social-ecological system in ways that enhance our ability manage adaptively and sustain services and enhance livelihoods. Some of the key elements of socio-ecological system dynamics that would be captured by the Case Framework include agents of change, e.g., market changes, values and goals, seasonality of rainfall, institutional relationships (formal and informal) which determine the major trade-offs for different groups across a variety of sites/scales and those with an emphasis on ecosystem services, livelihood resources and outcomes, and social and institutional processes.

Meeting these challenges will require a greater appreciation of the coupled socio-ecological system, improved ability to value ecosystem services and the ability to scale across social-ecological system dimensions and cross-boundary linkages of place and time of observational systems and methods, case studies, experiments, and model analyses. In addition, multiple stressors from and on the coupled system will need to be considered, along with incorporating historical aspects and timescales of social and environmental changes. There are many strategies and tools available to interact within and between KSS Cases to apply the Framework (e.g., research panels, simulations, surveys) that can be drawn from a typology of methods for approaching challenges with

different levels of complexity, uncertainty and potential for negative social-ecological impacts (adapted from Forrester et al, 2006).

Building on the preceding work as well as reflections from systems ecology, geography and other technical communities, a breakout group began to address these challenges. The following value proposition was offered as a foundation for KSS Partnership-KSS Case Interactions:

- Facilitated access to insights from implemented interventions and resulting insights with a focus on the multiplication of benefits in other cases.
- Facilitated access to other communities beyond those immediately obvious to communities tackling sustainability challenges.
- Access to data, information, knowledge assets, access to data and information management platforms, access to virtual "shared space" where contributed platforms, tools, protocols, can be better mobilized.

In addition to the value proposition, a set of principles and protocols were proposed to help mediate the dialog between the KSS Partnership and KSS Cases, whereby programs or projects transition into mutually information cases.

The proposed KSS Case Principles include:

- Recognition of the value of dialog with place-based activities.
- Forward looking scope and capacity to track changes in multiple dimensions.
- Sustainability challenges require recognition of socio-ecological systems and system dynamics, e.g., a holistic frame of a challenge, recognition of need to work across scales and categories of impact, fast and slow variables.
- Participatory processes are critical in polycentric systems of governance (i.e., role of information in constructive dialogs).
- Reproducibility and validation of results are important, as is the communication of uncertainty.
- A knowledge system relevant to sustainable provisioning will include the four KSS dimensions: (a) Decision Processes and Decision Support; (b) User interfaces, participatory processes and learning systems; (c) Modeling and Scenario Building; and (d) data, information and knowledge assets relevant to sustainable provisioning at the land/water/energy nexus.
- Cases are projects that have some common dynamics and commitments that may allow informative comparisons.
- "Failures" of all types are informative and valuable.
- Contributions of all types will be recognized in shared space.
- Appropriately addressing issues of equity in respect human well-being.
- The scales at which socio-ecological systems operated are nested and while system boundaries must be established and respected; smaller and larger scales must be respected.
- Sector renewal is important to consider across all types of capital (financial, natural, produced, human, and social).
- All data, information and knowledge assets must be temporally and geo-referenced, with supporting metadata and provenance, to the extent possible.

The proposed KSS Case Protocols include the consideration of:

- Inclusion of the minimum set of criteria needed for making comparisons between cases (actual criteria are TBD).
- Collection and maintenance of data/information in formats that facilitate reusability, discoverability, accessibility, and interoperability to promote long-term stewardship.
- Incorporate both top-down and bottom-up roles in information-sharing frameworks
- Pathways for sustained funding
- Addressing cross-scale and cross-time linkages
- Hierarchy theory suggests must always go at least " a level up and a level down"
- Offer a KSS model typology that may facilitate cases' access to relevant existing capacities.
- Offer a KSS tool/analytics typology with particular emphasis on visualization approaches, integrated tools that allow for scenario development e.g., Regionally intensive modeling areas (RIMAs), data management, information provisioning.
- Offer standardized ways to report outputs.
- Manage specific intersections with KSS cyberinfrastructure/shared space-ethical, legal and social implication (e.g., implications for this type of collaboration and interaction, sensitive data classes identified, rules of engagement).
- Suggest processes/approaches for managing uncertainty, categories of important estimations.
- Case tracking mechanisms, sets of holistic leading, lagging indicators of potential interest, complex emergent properties of systems moving in the "right" or "wrong" direction, examining changes in behavior.

Next steps in the Case Framework and Case Tracking strategies include revising and refining the KSS Case Framework, principles and protocols, distributing them for comment throughout the KSS Partnership and beginning to approach KSS Cases to apply these tools.

Collaborative opportunities in the Chesapeake Bay Watershed

KSS Cases define specific opportunities and prospective partners for proposals and other funding options and define near term next steps and interfaces of interest to the KSS Partnership more generally. By exploring a specific case, we can test the assertions of the KSS Partnership and leverage customized, demand-driven solutions from one case to others toward more generalized approaches to sustainability challenges.

The KSS Case Framework (see Goal #3) structures the interaction between the KSS Partnership and KSS Cases. The Case Framework will contain a set of principles and protocols that help to structure this dialog and propose pathways to mobilize insights, strategies, tools and other resources relevant to place-based sustainability challenges. The intent of this dialog is to provide to colleagues within each case useful insights, approaches, and resources that may not be immediately obvious in the original frame of their challenge. We intend to test the utility of the Case Framework across multiple

cases to find ways to better detect commonalities and compare and contrast insights for and from cases, each of which is defined by a community tackling sustainability challenges at the land/water/energy nexus.

Plenary presentations by Gary Shenk and Kevin Sellner introduced the Chesapeake Bay Watershed as a prospective KSS Case. The restoration of the Chesapeake Bay has been more than a 3-decade effort. In that time, some progress has been made to reduce nutrient and sediment loads across the watershed, but many challenges remain including: plateaus in progress, regional nutrient imbalances, litigation, impacts from agriculture, models for use in management and at the local level, integrating social science into management, and linkages between water quality and fisheries.

The presentations outlined near-term goals in the form of specific challenges listed below that could be facilitated by KSS partners as well as “offers” to the KSS Partnership that included a summary of lessons learned, overview of a sophisticated mature complex governance structure, experts and expert communities, data / models / publications / products, letters of support from this high-profile effort, and an opportunity to apply capacities to an existing management/science interface to provide real-world test environments for sustainability science and other more theoretical efforts.

To highlight the potential parallels between large scale landscape management efforts in very different parts of the world, the plenary presentation by Mike Grundy and Peter Fitch introduced advances in the Great Barrier Reef Catchment Management Initiative, focused on the eReefs project to house fragmented knowledge assets and provide decision support through an integrating database. They shared some lessons from this initiative including the need for champions to address socio-cultural problems, more robust integrated social science, and improved transparency. Other regions around the world that face parallel challenges, such as in the San Francisco Bay, Gulf of Mexico and Puget Sound were also discussed. CSIRO, the Queensland government, and associated Australian organizations involved in the management and research of the Great Barrier Reef, including the James Hutton Institute in Scotland, etc. could generate more efficient and powerful approaches with the potential to reveal novel pathways for progress in the Chesapeake.

Two breakout group discussions highlighted the following opportunities for KSS engagement in the Chesapeake Bay Watershed, organized around six challenges issued by the Chesapeake Bay Program:

1. Next steps toward a Modeling Laboratory

A next step that has been proposed for the CBP by the US National Academies of Science (USNAS) is an R&D modeling lab that would address long-term issues with the capability to integrate scientific advances back into the management model. We explored the possibility of building a partnership toward an independent modeling laboratory that would best leverage existing capabilities and investments and provide input to modelers whose work has immediate impact on working policy and management.

Exportable insights from the CBP for KSS include:

- The scientific foundation for decisions must be viewed as trusted and independent with output structured in decision-relevant formats that address the multi-dimensionality of the landscape, its people, and economies.
- Boundary organizations that serve as science translators between research and practice have proven to be invaluable in guiding informed management and relevant research.
- There is recognition of the importance of networked feedback, e.g., research to operations / operations to research.

Next steps for the CBW as a KSS Case include:

- Explore comparable efforts toward the type of modeling lab described by the US NAS in use and/or development in other contexts, such as model intercomparison projects (AgMIP, WaterMIP, ISI-MIP) and the protocols they use.
- Continue dialog with CSIRO, BOM (Bureau of Meteorology), and other Australian colleagues who have experience in the governance of these types of projects. Work in the Great Barrier Reef and SE Queensland are exemplars where a modeling lab was an "independent voice" in providing an objective, good quality independent resource and that was phased into operations in relevant time scales for decision making. CSIRO colleagues will be invited to a CB follow-up meeting in Annapolis in 2013.
- Engage KSS Partners who volunteered in the breakout sessions in the modeling lab development, including representatives from the following institutions: Oak Ridge National Laboratory (Anthony King & Peter Thornton), Pacific Northwest National Laboratory (Cesar Izaurralde -Regional Intensive Modeling Area, USDA AFRI CAP), Pennsylvania State University (Armen Kemanian, Chris Duffy), and the Environmental Virtual Observatory (Gordon Blair, Bridget Emmett, Yehia El-Khatib).

2. Better Integration of Social Sciences

While the significance of contributions from economists, sociologists, and other social scientists is fully recognized and there is a strong commitment to reflect outcomes of importance in human dimensions, it is a goal to better integrate these capabilities, relevant analytical and descriptive approaches, and other insights from these fields in the participatory processes of research, management, and policy of the Chesapeake Bay.

Exportable insights for KSS from the CBP include:

- Importance of participatory processes from the inception of a task; importance to understand land managers' values and specific needs, leverage decision science, and track outcomes in multiple dimensions across scales.

Next steps for the CBW Case in KSS include:

- Investigate social incentive structures that result in the increase of "private" data sharing that result in both public and private benefit.
- ORNL, University of Tennessee, and Penn State will share current approaches to develop common language and metrics to communicate environmental benefits

of bioenergy crops as an example that may be more broadly relevant. Can valuations of ecosystem services create new public-private partnerships that adequately subsidize development of new markets? (Interested attendees: Esther Parrish, Virginia Dale, Cesar Izuarralde, Tom Richard)

- Explore methods to effectively communicate the full suite of benefits to alternative landscape management practices

3. Spatially Explicit Modeling and Management

Spatial location within the watershed is important for designing management strategies and predicting outcomes. Much work has been done to develop approaches that explore tradeoffs in the implementation of practices with respect to costs and benefits across multiple scales in the watershed. Additional approaches to move from point information to gridded estimations would be of general importance and interest. This is one important task for the proposed Modeling Laboratory. How is a sustainable landscape designed, what are the components, and how are they spatially arranged? How can a decision tool or a system of related decision tools be created that consistently evaluates management alternatives at the large scale for state and federal policy-makers and also at the small scale for local governments and individual landowners? How can uncertainty from these models and tools be effectively and efficiently communicated?

Exportable insights include:

- Knowledge systems have multiple scales, and the decision tools need to be scaled accordingly. There is still a mismatch of scale and need to integrate knowledge resources.
- Modeling tools need to enhance the understanding of local benefits, inclusive of the multiple dimensions of sustainability.

Next steps include:

- ORNL will explore the use of high performance computing resources for the community.
- Penn State will integrate nutrients in spatially explicit hydrologic models.
- Work toward organizing AgMIP interface development sprint (C. Porter / A. Ruane)
- CSIRO and associated Australian organizations can share experiences about how to demonstrate local benefits – sustainability and profitability of farms, recreation.

4. Connect water quality indicators to fisheries outcomes

There are links between nutrients, temperature, habitat, and fish populations, but there is limited modeling from hydrodynamic-water quality models to living resources. Thereafter, how well are these connected to policy and management?

Exportable insights include:

- Understanding and communicating high-level, integrating indicators of sustainability.

Next steps Include:

- Investigate the connections between water quality and macroinvertibrates and fisheries as developed by ORNL for the Vonore Bioenergy Project. Do those relationships hold in Pennsylvania streams? (Parrish & Dale)
- Distill lessons learned from the estuary / coastal system and leveraging for climate community and CB Watershed.
- Investigate how NOAA's fisheries modeling are applied in the CBW area.
- How is the responsibility of multi-scalar challenges (stream→bay) distributed between local, state, and federal agencies?
- Highlight successful strategies that have been used and opportunities to implement them at larger scales.

5. Large-scale nutrient imbalances

These imbalances have become a national problem, and are deeply embedded in the structure of 20th century US agriculture. What are the alternatives for the 21st century?

Exportable insights include:

- Interventions in a system must acknowledge the nested scales at which the landscape of interest sits and changing the scale of future.
- Interventions might be necessary to improve sustainability outcomes across multiple scales.

Next steps include:

- Investigate opportunities for biofuels, including winter grasses and combustion of chicken litter for energy.
- Open dialogs with agriculture groups and industries in the CB Watershed and the Midwest.
- Penn State will demonstrate profitable dairy systems with radically reduced nutrient inputs and exports. These can be used to generate scenarios to help understand water quality benefits. (Kemanian, Karsten, Richard, Duffy)

6. Partnering

There is a need to improve the state of institutional and individual partnering, especially where there is the potential for shared benefits.

Exportable insights include:

- The role of the outstanding exemplars – Champions for Change.
- Groups and individuals willing to network and promote sustainable practices help drive positive change. Can we leverage positive interactions outside the Bay region to assist where a CB historic antagonism has impeded the identification of ways forward?

Next steps include:

- Leveraging the relationship between University of Tennessee Extension and NRCS farm groups.
- Extract lessons learned from the estuary / coastal system and leveraging for the climate community and CB Watershed.
- Extract lessons learned and successful strategies employed in the CBW (and other areas) and assess the opportunities to share and implement them at larger scales.

- Aligning critical strategic partners and champions of change
    - Mediators (L. Fowler, A. Swanson, CB Commission)
    - Actuaries (M. Jahn)
    - Agribusiness – producers and processors (M. Jahn)
    - Farmers (M. Jahn)

Following the breakout group meetings, the following near-term outputs were identified:

- Summarize the output of "mapping" exercises from the Chesapeake Bay Watershed (CBW), slow variable (soil carbon) and cyberinfrastructure (See Appendix) to illustrate interactions, overlaps, and potential alignment between that can be leveraged for partnership building
- Continue the development of the principles and protocols in dialog with the CBP / CBW Case (and other cases) to refine the structure of the existing and future dialog between KSS Cases and the KSS Partnership, as programs or projects transition into mutually informative cases.
- Capture shared lessons from other KSS Partners that are immediately relevant to the challenges and opportunities with the CBW. Immediately available examples can be drawn from SE Queensland (via CSIRO), Great Barrier Reef, AgMIP, Vonore Bioenergy Project, Florida Everglades, and others.
- Develop the structural and operational requirements for a Knowledge System for Sustainability that would be developed with a focus on and in the CBW.
- Identify the role that outstanding exemplars can play as champions of change in the CBW. Steps to build capacity across scales from individuals to institutions can be taken by highlighting proof of concept projects, test beds, and through focused field days of relatively small-scale "good" examples that have the potential to scale.
- Recognize that scaling up from small-scale benefits to large-scale implementation has its own science with theory and better practices.
- Plan for a meeting hosted by the community that leads the work in the Bay region to advance these outputs, track the progress of the following "next steps", and future planning. Currently aiming for a meeting in Annapolis, MD in May, 2013.

Progress in the Cereal Systems in South Asia (CSISA) Initiative

After the conclusion of the main KSS meeting, representatives from CSISA, ORNL and other KSS Partners met to continue a series of conversations started at the June 2012 KSS meeting, rooted in CSISA's data, information and knowledge needs. The following summarizes the collaboration between CSISA and ORNL:

Meeting the challenges of sustainable intensification are becoming increasing knowledge intensive, especially as agricultural systems adapt to climate extremes and apparent climate changes. Data-rich countries like the United States are poised to quickly respond to this challenge by leveraging a wealth of crop production, environmental, natural resource, and socio-economic data. Our colleagues in most developing countries are not so fortunate, and lack access to high-quality geo-referenced data. The Cereal Systems Initiative in South Asia (CSISA) is working with

scientists at the Oak Ridge National Laboratory to overcome the present scenario by exploiting the value of remotely-sensed information of crop conditions and by deploying computation algorithms that can 'fill the gap' where the network of weather stations is limited. Just as crucially, CSISA and Oak Ridge will partner on developing access and visualization portals to ensure broad-based access to these new data sources.

Advances in informatics and modern communication technologies also offer pathways for accelerating on-farm innovation. CSISA is working with partners like Digital Green to take advantage of outreach platforms such as community-based video that works to extend new technologies to large numbers of farmers. The impact of this approach is very high, in part because farmers themselves share impressions of new technologies.

ORNL is also preparing a proposal to NASA, led by Peter Thornton on surface weather data with uncertainty quantification for terrestrial ecosystem process models.

Abstract:
We propose to extend and improve an existing surface weather data product, providing essential land-atmosphere boundary conditions to terrestrial ecosystem process models. Our approach delivers a rigorous quantification of data product uncertainty that can be directly incorporated in modeling analyses. Our team recently released a first-ever surface weather dataset with 1-kilometer spatial resolution and daily temporal resolution over the conterminous United States, Mexico, and southern Canada, for a 32-year period of record (1980-2011) (http://daymet.ornl.gov). This dataset and the system used to generate it, referred to collectively as Daymet, was originally designed to provide forcing data for land process models and continues to serve that community, particularly in support of the demanding requirements for regional and continental-scale high-resolution ecosystem simulation. In the process of generating this data product, we have identified a number of targeted extensions and improvements that would significantly advance its utility in meeting the research goals of the terrestrial ecosystem modeling community. We have identified four areas where rapid progress can be made to address specific needs for surface weather products in the land process modeling community: 1) application of current Daymet algorithms to countries and regions around the globe, supported by existing compilations of station data, producing 1 km^2 gridded products for the longest possible period of record (varies by country); 2) targeted augmentation of current surface observation synthesis products by merging multiple existing datasets under a consistent format; 3) modification of current Daymet algorithms to enable application in regions with low density of surface observations; and 4) expansion of existing Daymet algorithms to provide long wave radiation and sub-daily temporal resolution.

Many KSS Partner organizations have contributed letters of support for this proposal including the World Agroforestry Centre, the International Maize and Wheat Improvement Center (CIMMYT), CSIRO Ecosystem Sciences, The Agricultural Model Intercomparison and Improvement Project and the ORNL Distributed Active Archive Center for Biogeochemical Dynamics.

The Cyberinfrastructure Components of a KSS

A primary objective of this meeting was to facilitate and support collaborations that can result in structured KSS prototypes that break new ground in adaptive management of provisioning demands from terrestrial ecosystems. These collaborations aim to connect partners with relevant capabilities and tools to Cases with focused challenges. Within each case, cyberinfrastructure (CI) components[5] will form the "backbone" elements needed to operationalize KSS concepts and begin testing benefits and evaluating strategies.

To inform the development of CI components within KSS Cases, several presentations shared lessons from existing knowledge management platforms. These presentations included an overview of the Vital Signs Africa initiative by Bob Scholes, a program anchored in the Millennium Ecosystem Assessment that is focused on cost-effectively generating information that is sufficient for use and appropriate to the African IT context so that it can be scaled out across Africa. Budhu Bhaduri described the advances made on decision support of bioenergy infrastructure through geospatial technology and informatics under the Knowledge Discovery Framework. Yehia El-Khatib explained the strategies used to engage decision makers around discrete use cases (e.g., local flooding) from the beginning of the Environmental Virtual Observatory (EVO) pilot and shared plans for Phase 2. John Crittenden shared the metamodel workflow[6] for decision support in complex, adaptive urban systems that recognize their "bottom-up" emergent properties (i.e., unpredictable, produce large events, resistant to change).

Through two breakout group sessions, participants explored several operational challenges, including, how to construct a "shared virtual space" in which Partners support the development of KSS prototypes by contributing data, information and knowledge assets; How zones within this shared space can be defined and managed to create responsible information sharing environments that advance the KSS Partnership's goals; and how KSS partners can identify and address key gaps that can be the focus of future development and investment (e.g., robust data, information and knowledge assets in human dimensions; a robust and defined community of scholars focused in decision sciences). Addressing these challenges can be summarized under the high-level principles: *adapt, adopt, invent.*

Discussions in the breakout group focused on building the necessary foundations within the community to support future engagement in the development of KSS components, infrastructure and other tools. These discussions can be summarized under the following tasks:

Scoping

Across the diversity of KSS Partners, there was agreement to develop a common set of principles and processes that would align existing resources, prioritize development of new tools and facilitate the use of these knowledge products.

[5] e.g., cloud computing, semantics, ontologies, workflows, security, in situ data sensors and data processing schema.
[6] i.e., infrastructure demand -> options -> build components -> local, regional, global impacts.

These general cyberinfrastructure principles include:

- Reusability
- Discoverability
- Accessibility
- Interoperability

In addition to the above principles, which are at the core of any modern cyberinfrastructure, a number of best practices were identified that could be used to asses data, models and other tools in relationship to the goals of KSS and the creation of a "shared virtual space." These include:

- Machine readable data services
- Documented provenance
- Data sharing agreements and licensing
- An assessment of where an asset falls in the following spectrum: Metadata > Standards > Formats > Community Profiles > Systems > Prescriptions
- Metrics to value contributions to a federated organization
- Development of a database of Essential Sustainability Variables / High Value Data Assets for each case, and those that apply across cases.
    - What the levels of uncertainty around each variable?
    - Where are the major gaps?

Within each case, Peter Fitch suggested that an "iterative development framework" be used to identify and prioritize interventions, develop workable solutions, demonstrate the solution to stakeholders, garner feedback and improve upon the "tool" (Figure 3). Lessons learned from this development process could then be captured and distilled, increasing the potential impacts, both for decision-makers and for scientists and others involved in the development process.

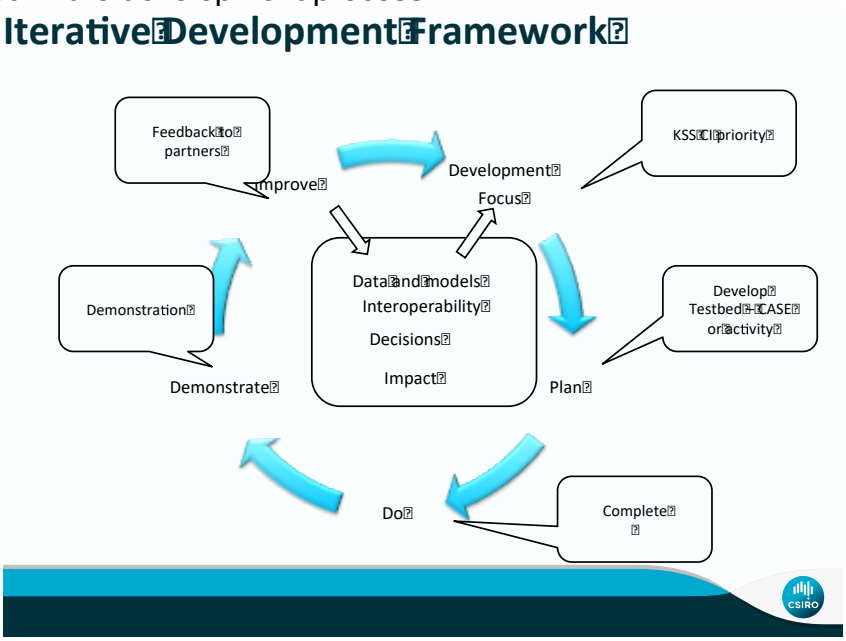


Figure 3: Iterative Development Framework, contributed by P. Fitch (CSIRO)

Near-term next steps

A high priority in the creation of a shared virtual space is to use a methodology that distinguishes the characteristics of these resources according to their suitability, completeness and attainment of the general CI characteristics list above (Reusability, Discoverability, Accessibility and Interoperability).

Maturity models are one methodology to assess the quality of data, models, and other tools in relation to the goals of KSS, and can be applied to relevant resources within a case, or across generally available resources. As demonstrated in the meeting by Peter Fitch, a maturity model developed for data shared on the Internet can be assigned a varying number of "stars" (0-5) based on openness, shareability, completeness, etc. A rubric for a KSS maturity model would need to be further refined. An example is included below (Table 1).

The output of a maturity model exercise could also be used as a preliminary gap analysis and to illustrate organizational, technological and analytical capacities that are housed within KSS Partners member institutions, as well as in the broader innovation ecosystem.

Table 1: Example "Maturity Model," contributed by P. Fitch (CSIRO)

★	Available on the web (whatever format) *but with an open license, to be Open Data*
★★	Available as machine-readable structured data (e.g. excel instead of image scan of a table)
★★★	as (2) plus non-proprietary format (e.g. CSV instead of excel)
★★★★	All the above plus, Use open standards from W3C (RDF and SPARQL) to identify things, so that people can point at your stuff
★★★★★	All the above, plus: Link your data to other people's data to provide context
	*http://www.w3.org/DesignIssues/LinkedData.html

Several participants highlighted programs that offer potential support to KSS prototype and cyberinfrastructure development. Carleen Maitland (PSU) offered insights for designing an NSF-sponsored KSS Research Coordination Network (RCN) focused on CI. Support for RCNs can be $500,000 over 5 years. She also pointed to NSF's Cyber-SEES program as a viable funding source and noted that it is explicitly multidisciplinary and requires participation by social scientists. Cesar Izarraulde drew attention to the new national social environmental synthesis center with linkages to PNNL (directed by Margaret Palmer), which seeks to connect policy makers and scientists and which might be able to offer facilitation services to KSS. This center currently has two calls for proposals that are due 25 January 2013 on Water, People, and Ecosystems and Globalization and Socio-Environmental Systems.

ANNEXES

I. Meeting Participant List

First Name	Last Name	E-mail	Institution
Paul	Barnett	Paul.Barnett@csiro.au	CSIRO
Tim	Benton	T.G.Benton@leeds.ac.uk	University of Leeds
Budhu	Bhaduri	bhaduribl@ornl.gov	Oak Ridge National Laboratory
Bob	Cook	cookrb@ornl.gov	Oak Ridge National Laboratory
John	Crittenden	john.crittenden@ce.gatech.edu	Georgia Tech
Virginia	Dale	dalevh@ornl.gov	Oak Ridge National Laboratory
Mark	Downing	downingme@ornl.gov	Oak Ridge National Laboratory
Yehia	El-khatib	yehia.elkhatib@gmail.com	Lancaster University
Peter	Fitch	Peter.Fitch@csiro.au	CSIRO
Chris	Forest	ceforest@psu.edu	Pennsylvania State University
Lara	Fowler	lara.fowler@gmail.com	Pennsylvania State University
Chris	Gingerich	Chris.Gingerich@gatesfoundation.org	Gates Foundation
Mike	Grundy	Mike.Grundy@csiro.au	CSIRO
Jay	Gulledge	jgulledge@ornl.gov	Oak Ridge National Laboratory
Bronwyn	Harch	Bronwyn.Harch@csiro.au	CSIRO
Susan	Heinz	heinzsl@ornl.gov	Oak Ridge National Laboratory
Cesar	Izaurralde	cesar.Izaurralde@pnnl.gov	Pacific Northwest National Laboratory
Gary	Jacobs	jacobsgk@ornl.gov	Oak Ridge National Laboratory
Molly	Jahn	mjahn@cals.wisc.edu	University of Wisconsin - Madison
Shujiang	Kang	kangs@ornl.gov	Oak Ridge National Laboratory
Armen	Kemanian	kxa15@psu.edu	Pennsylvania State University
Anthony	King	kingaw@ornl.gov	Oak Ridge National Laboratory
Keith	Kline	klinekl@ornl.gov	Oak Ridge National Laboratory
Chris	Lenhardt	lenhardtc@ornl.gov	Oak Ridge National Laboratory
David	LeZaks	lezaks@wisc.edu	University of Wisconsin -

			Madison
Carleen	Maitland	cmaitland@ist.psu.edu	Pennsylvania State University
Andrew	McDonald	A.McDonald@cgiar.org	CIMMYT
Christine	Negra	christine@ideapaths.org	Consultant
Henry	Neufeldt	h.neufeldt@cgiar.org	World Agrofestry Center (ICRAF)
Dennis	Ojima	dennis@nrel.colostate.edu	Colorado State University
Esther	Parish	parishes@ornl.gov	Oak Ridge National Laboratory
Cheryl	Porter	cporter@ufl.edu	University of Florida / AgMIP
Ben	Preston	prestonbl@ornl.gov	Oak Ridge National Laboratory
Tim	Rials	trials@tennessee.edu	University of Tennessee
Dan	Ricciuto	ricciutodm@ornl.gov	Oak Ridge National Laboratory
Tom	Richard	trichard@psu.edu	Pennsylvania State University
Alex	Ruane	aruane@giss.nasa.gov	NASA / AgMIP
John	Sanseverino	sanseverinoj@ornl.gov	Oak Ridge National Laboratory
Bob	Scholes	bob.scholes@gmail.com	CSIR (S. Africa)
Kevin	Sellner	sellnerk@si.edu	Chesapeake Research Consortium
Willis	Shem	shemwo@ornl.gov	Oak Ridge National Laboratory
Gary	Shenk	GShenk@chesapeakebay.net	Environmental Protection Agency
Peter	Thornton	thorntonpe@ornl.gov	Oak Ridge National Laboratory
Suresh	Vannan	santhanavans@ornl.gov	Oak Ridge National Laboratory
Dali	Wang	wangd@ornl.gov	Oak Ridge National Laboratory
Brian	Wee	bwee@neoninc.org	National Ecological Observatory Network
Tom	Wilbanks	wilbankstj@ornl.gov	Oak Ridge National Laboratory
Bai	Yang	yangb@ornl.gov	Oak Ridge National Laboratory
Andre	Zerger	A.Zerger@bom.gov.au	Bureau of Meteorology

II. Meeting agenda

Knowledge Systems for Sustainability – Advancing Toward Prototypes

Hosted by the Oak Ridge National Laboratory and the University of Wisconsin-Madison
November 26-28, 2012

Purpose

This meeting gathers a partnership of individuals and representatives of major projects and programs that generate, curate, and/or deliver data, information, tools, analytics, and knowledge assets relevant to sustainable landscape management. Participants have a commitment to harnessing our collective knowledge with the goal of improving the relevance of our work to decision-making with regard to humanity's more sustainable, sufficient and equitable provisioning at the land/water/energy nexus. Our goal is to exit this meeting with:

- Concrete agreements among willing partners with relevant, complementary capacity that deliver on the objectives of our Partnership and that advance specific efforts as "Cases" nested with the broader context of KSS activities
- Expressions of interest that set shared paths to build defined pieces of knowledge systems that better support adaptive management and decision-making on landscapes, which are subject to provisioning demands.

We will:

- Identify intersections between existing projects and programs to define initial areas of activity and focus on the development of prototype components within KSS Cases. Initially this work will progress by co-creating "maps" on which existing initiatives and organizations are located in relation to the four knowledge system dimensions[7], relevant cyberinfrastructure components, a KSS case, and to illustrate the concept of "slow variables" in our systems. These "maps" will be used to create a product that can be posted, published and further refined to highlight KSS Partners' complementary efforts through partnerships and gap filling to advance the synthesis of improved knowledge management systems anchored in decision-making on landscapes.
- Introduce two major "Cases" that have drawn intensive investment: the Chesapeake Bay Watershed in the USA, and the Great Barrier Reef Catchment Management program in Australia.
- Review and test the concepts, approaches and tools for catalyzing the conversion of geographically bounded "projects" or "programs" with aligned intentions into mutually informative "KSS Cases" through knowledge-to-action/action-to-knowledge approaches.
- Demonstrate how each Case represents an opportunity to test the assertions of the KSS Partnership, and will allow us to leverage case-specific customized demand-driven solutions to more generalized approaches as we learn to manage information and knowledge that can be leveraged to improve outcomes in human dimensions under the lens of sustainability.

[7] (a) Decision Processes and Decision Support; (b) User interfaces, participatory processes and learning systems; (c) Modeling and Scenario Building; and (d) data, information and knowledge assets relevant to sustainable provisioning at the land/water/energy nexus.

- Move to connect Partners with relevant capabilities and tools to those with focused challenges within structured prototypes. This process should use existing capacities and leverage the work of the cyberinfrastructure team assembled at this meeting.
- Work together toward a short slide deck that is a KSS overview and a detailed written product (a "white paper") that captures the foundation for this effort in the literature and in existing activities, provides a brief overview of each of the major discussions underway in our Partnership and sets next strategic and specific tactical steps toward improved knowledge systems for sustainable landscape management.

Monday 26 November

6:00pm	**Reception and Introductions** Welcome – Gary Jacobs, Director, Environmental Sciences Division, Oak Ridge National Laboratory (ORNL) (Shuttle departs from Hampton Inn @5:30pm, departs from restaurant @9pm)	Peerless Restaurant 320 N. Peters Rd., Knoxville

Tuesday 27 November

7:30am	Pickup at Hampton Inn & Suites for transport to DOE Oak Ridge National Laboratory (Badged attendees on bus, others in individual cars)	
8:00am	Badge pickup at ORNL	Building 5200, Tennessee B and C
8:15am	Continental Breakfast	
8:30am – 9:00am	**Purpose of Meeting - Meeting the needs of Cases through partnerships, integrated information and knowledge sharing—operationalizing knowledge systems toward decision-making** Molly Jahn & David LeZaks – Welcome and Introduction Tom Richard – KSS Partnership Principles Bronwyn Harch – Australia and the KSS Tim Benton – The KSS Partnership and the UK's commitment to frontier science toward sustainable development and global food security Gary Jacobs and Jay Gulledge – ORNL and Knowledge Systems for Sustainability and Security	Christine Negra
9:00am – 10:00am	**The "Case" concept in context of knowledge systems for sustainability** *Objective: update meeting participants on the leading candidates*	

Session I	*for KSS cases and review and test the concepts, approaches and tools needed to transition geographically bounded "projects" or "programs" to "KSS Cases."*	
	Update on the Case Framework concept *(15min)* The "Case Framework" is the mechanism by which we introduce "Cases" into the KSS community, scanning for commonalities, patterns, or work modes across cases. This process will illuminate specific invitations for partnership from the Case, and will allow us to leverage case-specific demand-driven solutions to more generalized approaches. Cases define specific opportunities and specific prospective partners for proposals and other funding opportunities and define near term next steps and interfaces of interest to the Partnership more generally.	Dennis Ojima, Deb Niemeier (i.a.) & Henry Neufeldt
	Application of the "Case" approach to the Chesapeake Bay Watershed *(20min)* Near term goals of the Chesapeake Bay Program that could be facilitated by KSS Partners Alignment of Chesapeake Bay Program "Showcase Watersheds" and DOE ORNL's Little Tennessee Watershed/Vonore Sustainable Bioenergy Project (Virginia Dale, Esther Parrish, Tim Rials, Sam Jackson)	Gary Shenk & Kevin Sellner
	The Australian commitment to Integrated Approach to Great Barrier Reef Catchment Management *(20min)* (Note Bob Scholes, CSIR, S. Africa will be arriving on Tuesday to discuss Vital Signs: Africa)	Mike Grundy
10:00am – 10:15am	**Break**	
10:15am – 11:45pm Session II	**Mapping foundational investments, approaches and technologies for knowledge systems for sustainable management of landscapes** *Goal: Begin to define the scope of a virtual "shared space" or "commons" that becomes the operationalized KSS Partnership* *Objective: Co-create "maps" that illustrate the relative placement of existing initiatives and organizations in relation to* four knowledge system dimensions, a map specific for the Chesapeake Bay Program, one specific to cyberinfrastructure, and one to illustrate the concept of "slow" variables. *These maps can then be edited, further refined, posted, and/or published. These maps will highlight our partners' complementary efforts in the KSS structure and*	Christine Negra & David LeZaks

opportunities for collaboration to be explored in subsequent sessions.

Existing initiatives and organizations to be mapped:	
Ameriflux – Bai Yang	National Socio-Environmental Synthesis Center – Tony Janetos
Daymet – Peter Thornton	Knowledge Management Initiatives in the CGIAR – Henry Neufeldt & Constance Neely, i.a.
Australian Bureau of Meteorology's Environmental Information holdings – Andre Zerger	Agricultural Model Intercomparison and Improvement Project – Cheryl Porter
Knowledge Discovery Framework and KBase-Budhu Bhaduri	Major programs & efforts at Columbia U/NASA Goddard / CIESIN– Alex Ruane (AgMIP)
Global Soils Mapping Initiatives – Mike Grundy	Environmental Virtual Observatory – Yehia El-khatib
AgTrials, Dataverse & other more general CGIAR data initiatives – Cesar Martinez	Australian modeling efforts; Sustainable Agriculture Flagship – Mike Grundy
Distributed Active Archive Center (DAAC) for Biogeochemical Dynamics & CIESIN DAAC– Chris Lenhardt & Bob Cook	Australia's environmental cyberinfrastructure – Peter Fitch
National Ecological Observatory Network – Brian Wee & Virginia Dale	DOE Bioenergy Research Center Program/DOE Office of Science investments – Cesar Izaurralde
Web services and workflows – Suresh Vannan	Sustainable Climate Risk Management Strategies – Chris Forest
Workflows and data / model integration – Armen Kemanian & Chris Duffy, i.a.	MsTMIP – Bob Cook
High performance simulation framework development – John Crittenden & Dali Wang	The NEWBio Consortium and other Penn State initiatives – Tom Richard
USDA National Agricultural Library – Molly Jahn	Volunteered initiatives

11:45pm – 1:00pm	**Working Lunch**	
Session III	Knowledge management, sustainable development & food security: Relevant global initiatives in the UK, G8, G20 & CGIAR (25min)	Tim Benton
	Australia's National Plan for Environmental Information The Australian Bureau of Meteorology (25min)	Andre Zerger
	Perspectives, reflections & wrap up	Tom Wilbanks

1:00pm – 3:00pm	**Concurrent breakout groups** **Frontiers for Collaboration: Operationalizing knowledge systems for sustainability**	
Session IV, breakout 1	***1. Collaborative opportunities in the Chesapeake Bay Program: near term activities and potential linkages*** *Objective: The restoration of the Chesapeake Bay has been a 3-decade effort. Since that time, some progress has been made to reduce nutrient and sediment loads across the watershed. There are still many challenges faced by the Bay including: regional nutrient imbalances, impacts from agriculture, models for use in management and at the local level, integrating social science into management, and linkages between water quality and fisheries. This breakout session will focus on two near term issues of interest to the KSS Partnership and to those working in the Bay: The concept of a "modeling lab" proposed in a recent US National Academies of Science document and the need to effectively and fundamentally integrate social dynamics in the Program's work.*	Gary Shenk, Kevin Sellner & Christine Negra
Session IV, breakout 2	***2. KSS Framework and Case Tracking strategies: Insights from major inter/national commitments*** *Objective: The current KSS Case Framework, the mechanism by which we transition projects to mutually informative cases, will be reviewed in light of the Australian experience in the BOM and ongoing research at CSIRO, the UK NERC, in African sites linked by monitoring commitments and others. The need for mutually understandable "case tracking" approaches will also be discussed.* We will review the current draft of our KSS Case Framework and Case Tracking documents to be distributed at the meeting. We will work to incorporate reflections from the systems ecology, geography and other technical communities, and from other partners interested in learning to "see" and track commonalities across Cases in time frames relevant for adaptive management and governance. We will also define a community interested in developing and testing approaches that facilitate importable and exportable insights and tools for KSS cases. This discussion will focus on approaches to manage the diverse array of relevant data/information and knowledge assets in a given case, indicators & other ways to track dynamic system components, and common technical approaches that facilitate the creation of responsible information sharing environments, that promote participatory	Dennis Ojima, Henry Neufeldt & Molly Jahn

	approaches to adaptive management, and allow visualization and other analytics helpful for managing immediate and sustainable "provisioning" challenges at the land/water/energy/climate nexus.	
Session IV, Breakout 3	***3. The Cyberinfrastructure Components of a KSS I***: Objective: Within each case, cyberinfrastructure components will form the "backbone" elements needed to operationalize the KSS concepts and begin testing benefit and evaluating strategies. Potential topics for discussion could include cloud computing, semantics, ontologies, workflows, security, *in situ* data sensors and data processing schema. *Tasks:* • Define work plan, goals and trajectory for KSS Cyberinfrastructure working group • Development of an NSF sponsored Research Coordination Network proposal • Propose sessions for Day 2 Session VIII breakout groups	Carleen Maitland, Dali Wang, Budhu Budhendra, Peter Fitch, John Crittenden & David LeZaks
3:00pm – 3:15pm	**Break**	
3:15pm – 4:00pm Session V	**Plenary Discussion – Capturing and distilling observations from the frontiers for collaboration**	
4:00pm – 5:15pm Session VI	**Operationalizing knowledge systems – Introducing the concept of prototypes and identifying first steps** How will we construct shared virtual space into which key partners can contribute platforms, components, data, information and knowledge assets, tools and analytics to prototypes that have potential relevance for adaptive management of provisioning demands from terrestrial ecosystems? How will zones within this shared space be defined in relation to our Partnership's goals and managed to create responsible information sharing environments? How can the development of these prototypes recognize and commit to address key gaps in this initial meeting structure, e.g. robust data, information and knowledge assets in human dimensions, a robust and defined community of scholars focused in decision sciences, etc.? Reflections from cyberinfrastructure breakout group (Session IV, Breakout 3) – John Crittenden	Carleen Maitland, Dali Wang & John Crittenden

	Designing an NSF sponsored KSS Research Coordination Network focused on KSS cyberinfrastructure – Carleen Maitland ***Sample Platforms for Knowledge Management*** • Knowledge Discovery Framework – Budhu Bhaduri • The Environmental Virtual Observatory Pilot and plans for Phase 2 – Yehia El-khatib • High performance simulation framework development for multi-component environmental modeling – John Crittenden & Dali Wang	
5:15pm	**Break for the day**	
6:00pm	**Dinner** Conversations focused on development of prototypes are encouraged. We may have a large room, buffet style service and tables with topics for informal interactions (Shuttle departs from ORNL @5:30pm, departs to Hampton Inn @9pm)	Calhoun's 10020 Kingston Pike, Knoxville
Wednesday 28 November		
7:45am **8:15am**	Bus pickup at Hampton Inn & Suites Continental Breakfast	Building 5200, Tennessee B and C
8:30am – 8:45am	**Synthesis of key progress from Day 1, goals for Day 2**	Christine Negra
8:45am – 10:00am Session VII	**Operationalizing KSS – Identifying actionable next steps, new relationships and leveraging existing investments** • How can we structure the "KSS Platform" as a learning system? • How can (or should) KSS anchor in existing global initiatives e.g., GEO, ICSU, Merton Initiative, and other major big data and monitoring initiatives? • Identifying existing components to address shared high priority next steps; identify major missing components • How will we use the Chesapeake Bay Program as a case to	Peter Fitch, Budhu Bhaduri & Carleen Maitland

	advance their immediate interest in a "modeling laboratory" as an opportunity to explore concrete next steps of benefit to this team?
	• Review general components of Prototype Knowledge Systems
	• Systems for Sustainable Landscape Management
	• Tools
	  ▪ *KSS Case Portal, The KSS Case Framework and harmonized approaches to Case Tracking* – Henry Neufeldt
	  ▪ *Project Mapping Tools* – Budhu Bhaduri
	  ▪ *Vital Signs: Africa* – Bob Scholes
	  ▪ *Regional Intensive* Modeling *Areas* – Cesar Izaurralde
	  ▪ *AgMIP and the possibility for an Interface Development Sprint at ORNL in 2013* – Cheryl Porter & Alex Ruane
	  ▪ *Cyberinfrastructure* – Carleen Maitland, Dali Wang & John Crittenden
	  ▪ *Ethical, Legal, Social Implications of responsible information sharing environments* – Chris Lenhardt	

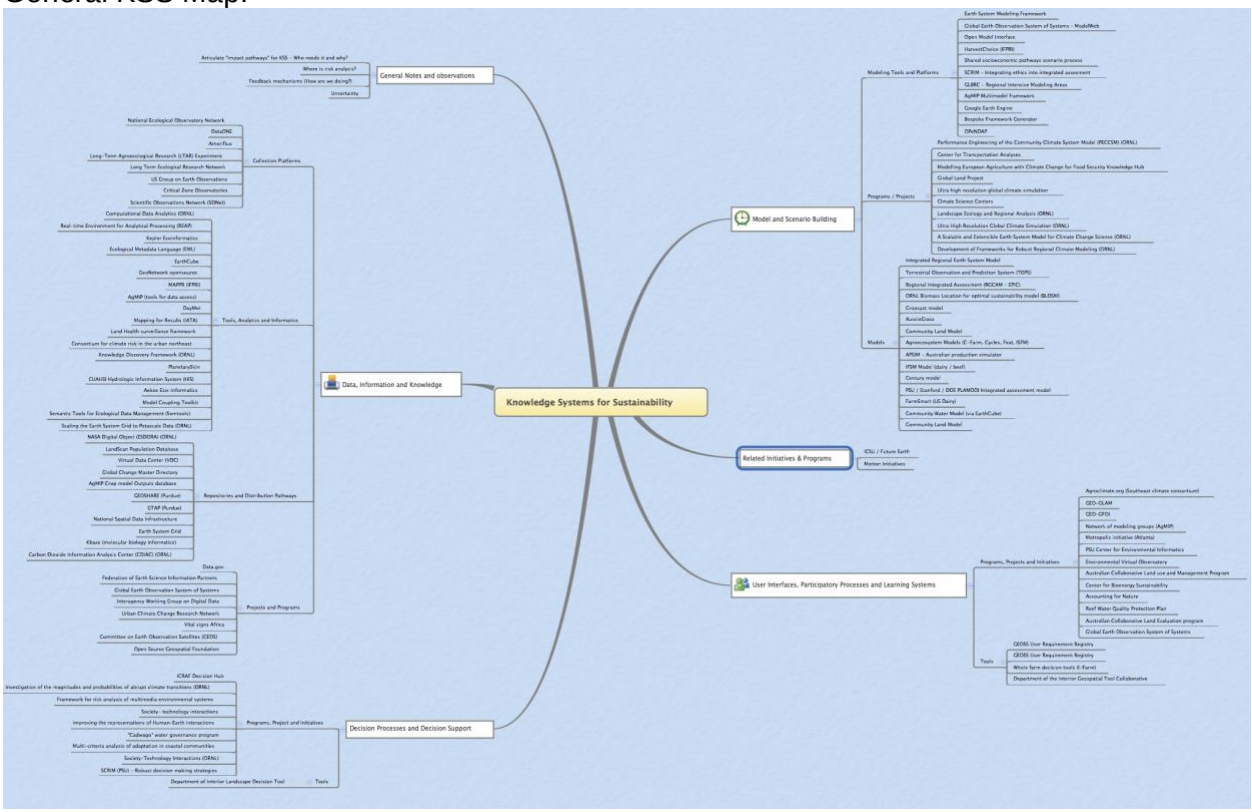
10:00am – 10:45am Session VIII	**Connecting foundational investments, approaches and technologies to KSS Cases through the development of Prototype and Prototype components** We will build off mapping exercises from Day 1 and the cyberinfrastructure discussions to identify specific collaborations / investments that are central to KSS but are broader than just collaborations within Cases *Individual break out groups will be determined in the previous session.*	
10:45am – 11:00am	**Break**	
11:00am – 12:00pm Session IX	**Discussion of Next Steps and Actions** • What are the next steps toward building a commons for Knowledge Systems for Sustainability? Where should the emphasis be placed soonest and who will steward the effort? • What are specific aligned commitments already in place at major institutional partners that can be linked or aligned without major new resources? • Review next steps for developing the Case Framework and meeting the needs of Cases by leveraging existing investments • What specific resources are needed to advance in each area of	Christine Negra

	interest and commitment? What are the plans to get those resources in place? • Request volunteers to work on the Tallberg Forum invitation and program development • Next steps in 2013 for the KSS Partnership	
12:00pm	**Meeting Adjourns** (Shuttle departs to hotel @12:30pm, taxis can be arranged to the airport)	
12:30pm – 2:00pm	**Meeting de-brief, report preparation plans** (any meeting attendees with late flights are welcome to stay)	
3:00pm –	**Cereal Systems in South Asia; Vital Signs Africa Case meeting** Interested KSS and ORNL colleagues are welcome to participate: **KSS and the CGIAR** Andrew McDonald, Henry Neufeldt **ORNL and KSS colleagues with special interests in this topic** **Working Dinner** **Thursday AM ORNL tour for Andy McDonald and Bob Scholes**	Ocoee, Bldg 1505, room 190

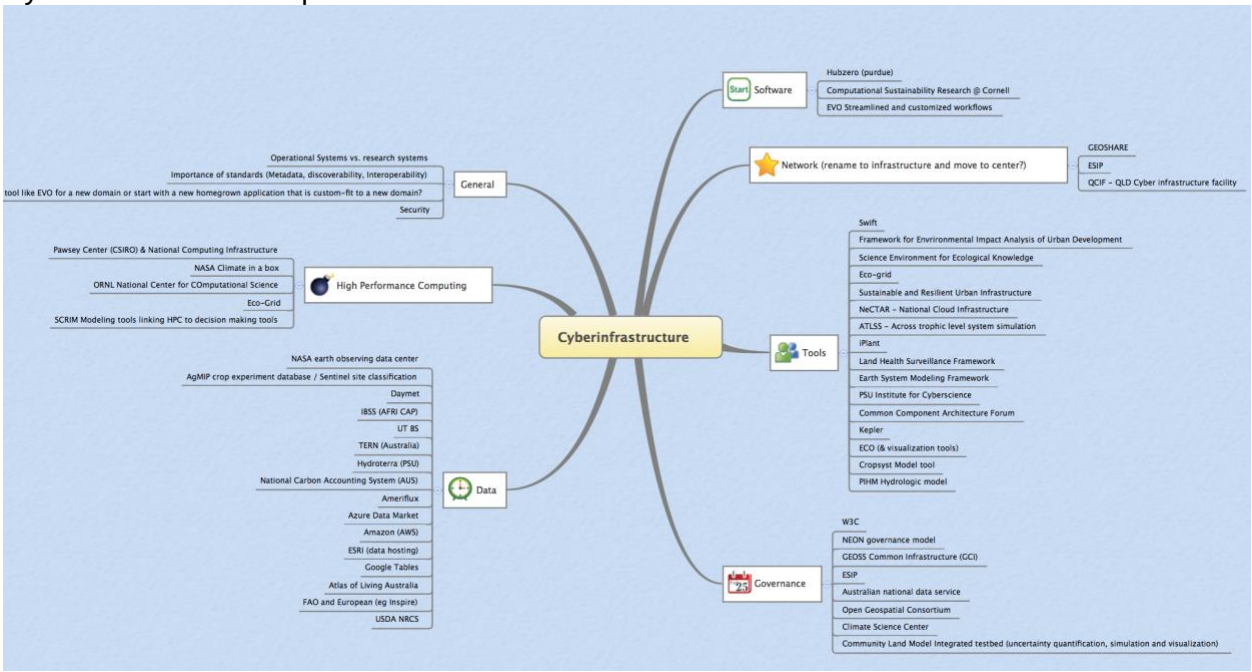
III. Output of “mapping” exercise

The original versions of these maps are located on Basecamp, where they can be downloaded and edited with the Xmind application (free; http://www.xmind.net/).

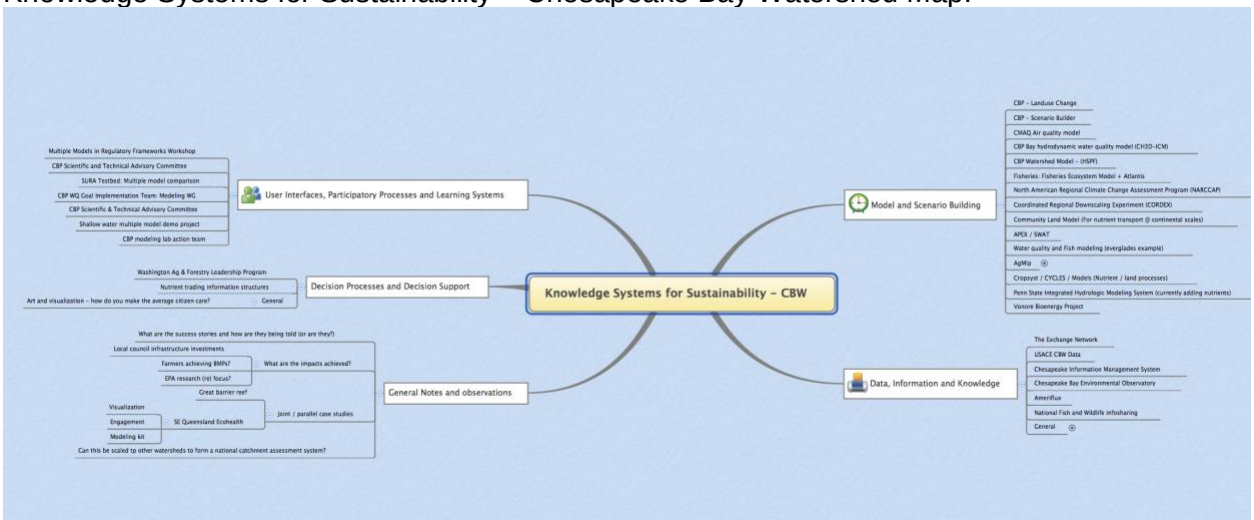
General KSS Map:



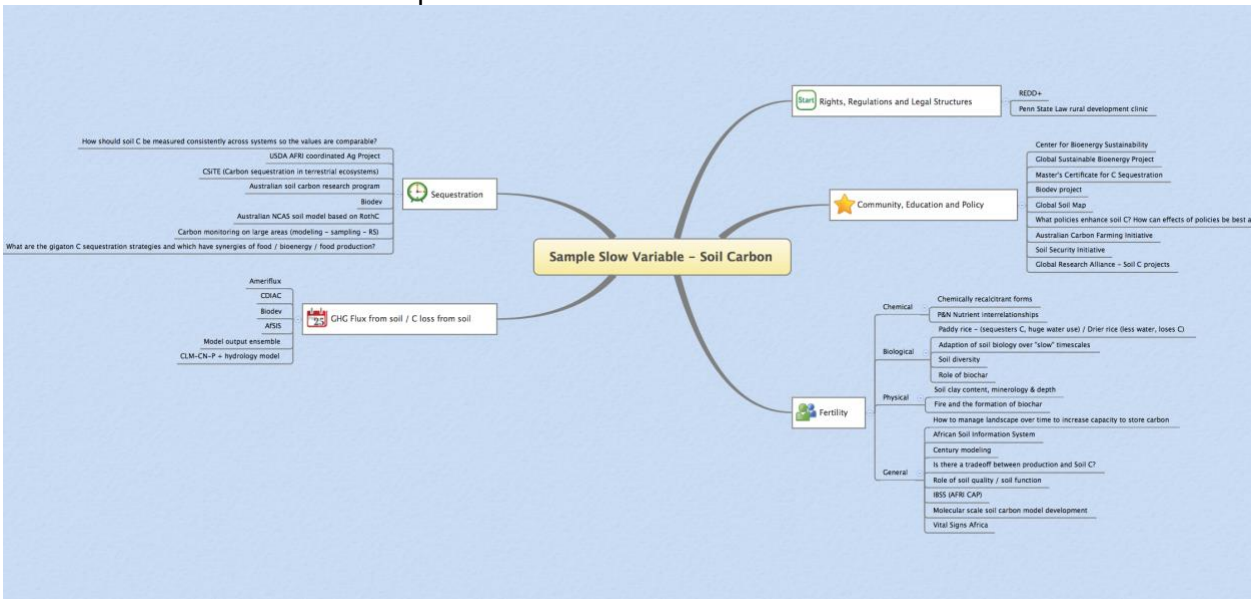
Cyberinfrastructure Map:



Knowledge Systems for Sustainability – Chesapeake Bay Watershed Map:



Slow Variable – Soil Carbon Map:



IV. Knowledge Systems for Sustainability: Guiding Principles for Collective Effort

1. KSS partners join with the conviction that this effort is important, indeed essential, to advancing sustainable management of landscapes. Each partner should have the goal and the expectation that their individual contributions will generate sufficient synergies that they and their organizations will get more out of their participation than they give. Benefits of participation include sharing innovative ideas, technologies, and strategies, connections with potential sponsors and other stakeholders, and opportunities to leverage each other's resources to maximize impact.

2. There will be many KSS partners that engage for specific purposes and periods of time, and a few that are deeply engaged for the long term. The KSS core leadership will consist of those partners that are engaged for the long term, and that make exceptional and ongoing contributions to advancing the collective effort, through intellectual, organizational, financial, or other tangible commitments.

3. We recognize that many funding opportunities come with geographical, institutional, and methodological constraints. Core leadership will coordinate with each other and with other relevant KSS partners in developing teams for specific opportunities. Decisions about membership on proposal teams will be transparent and discussed during regular leadership calls.

4. Partnerships are set in a context of action research and action learning processes and methodologies. With “Knowledge to Action” a central theme in our efforts, we recognize this will require models of activity and support that will be unfamiliar to many, and will be uncomfortable for some. We will strive to break down such barriers and achieve synergies with both internal and external stakeholders

5. We hold paramount our respect for the intellectual contributions of each partner. When funding constraints limit the financial involvement of members of the leadership team, they will still have the opportunity to "opt in" with their own resources. Decisions about authorship on publications and will reflect the intellectual contributions made to that particular piece of scholarship, and will be shared with the other members of the leadership team in a transparent fashion, prior to publication whenever possible.

6. When the contributions of a member of the leadership team subside to a level that no longer evidence deep, long term engagement and exceptional ongoing contributions, core leadership will discuss this situation and offer respectful feedback.

V. KSS Acronyms

Acronym	Name	Website
AgMIP	The Agricultural Model Intercomparison and Improvement Project	http://www.agmip.org/
Agree	-	http://www.foodandagpolicy.org/
BFS	USAID Bureau for Food Security	-
BISA	The Borlaug Institute for South Asia	http://tinyurl.com/cx6xdmy
CBW	The Chesapeake Bay Watershed	
CCAFS	Climate Change, Agriculture and Food Security (CGIAR research program)	http://ccafs.cgiar.org/
CGIAR / CG	Originally the Consultative Group on International Agricultural Research, now the Consortium of International Agricultural Research Centers	http://www.cgiar.org/
CIMMYT	International Maize and Wheat Improvement Center	http://www.cimmyt.org/
CIMMYT	Centro Internacional de Mejoramiento de Maíz y Trigo (CGIAR center)	http://www.cimmyt.org/
CRP	CGIAR Research Programs	http://www.cgiarfund.org/cgiarfund/research_portfolio
CSIRO	Commonwealth Scientific and Industrial Research Organisation (Australia)	http://www.csiro.au/
CSISA	Cereal System Initiative South Asia	https://sites.google.com/site/csisaportal/
DoD	United States Department of Defense	http://www.defense.gov/
DOE	United States Department of Energy	http://energy.gov/
DOI	United States Department of the Interior	http://www.doi.gov
EarthCube	-	http://earthcube.ning.com/
EVO	Environmental Virtual Observatory	http://www.evo-uk.org/
GEO	Group on Earth Observations	http://www.earthobservations.org/index.shtml
GEO-BON	GEO Biodiversity Observation Network	http://www.earthobservations.org/geobon.shtml
GEO-GFOI	GEO Global Forest Observations Initiative	http://www.earthobservations.org/art_011_003.shtml

GEO-GLAM	GEO Global Agriculture Monitoring initiative	-
Geoshare	-	http://www.geoshareproject.org/
GEOSS	The Global Earth Observation System of Systems	http://www.earthobservations.org/geoss.shtml
HubZero	-	http://hubzero.org/
IC	Intelligence community	-
ICRAF	World Agroforestry Centre (CGIAR center)	http://www.worldagroforestrycentre.org/
IFPRI	International Food Policy Research Institute	http://www.ifpri.org/
ILRI	International Livestock Research Institute (CGIAR center)	http://www.ilri.org/
IPBES	Intergovernmental Platform on Biodiversity and Ecosystem Services	http://www.ipbes.net/
IPCC	Intergovernmental Panel on Climate Change	https://www.ipcc.ch/
IRRI	International Rice Research Institute (CGIAR center)	http://irri.org/
KAUST	King Abdullah University of Science and Technology	http://www.kaust.edu.sa/
M&E	Monitoring and evaluation	-
MACE	Multi Agency Collaboration Environment	http://www.macefusion.com/
NASA	National Aeronautics and Space Administration (US)	http://www.nasa.gov/
NCD	Non-communicable disease	-
NERC	Natural Environment Research Council (UK)	http://www.nerc.ac.uk
NOAA	National Oceanic and Atmospheric Administration	http://www.noaa.gov/
ODNI	Office of the Director of National Intelligence	http://www.dni.gov/
ORNL	Oak Ridge National Laboratory	http://www.ornl.gov/
PECS	ICSU Programme on Ecosystem Change and Society	http://www.icsu.org/what-we-do/interdisciplinary-bodies/pecs/
PM-ISE	Program Manager - Information Sharing Environment	http://ise.gov/
PNNL	Pacific Northwest National Laboratory	http://www.pnl.gov/
PSU	The Pennsylvania State University	http://www.psu.edu/
UNCBD	Convention on Biological Diversity	http://www.cbd.int/

UNFCCC	United Nations Framework Convention on Climate Change	http://unfccc.int/
USAID	United States Agency for International Development	http://www.usaid.gov/
USDA	United States Department of Agriculture	http://www.usda.gov
USGS	United States Geological Survey	http://www.usgs.gov/
WB	The World Bank	http://www.worldbank.org/

VI. The Knowledge Systems for Sustainability Collaborative – Overview

The Knowledge Systems for Sustainability Collaborative is focused on the formulation of new types of knowledge systems that can more adequately contribute to decision-making about how valued services are accessed from landscapes that, in aggregate, determine longer term, larger scale trajectories toward "safe operating space" for human beings and the planet. The Collaborative is an international network of partners across academia, government and business who have realized the importance of certain categories of canonical failures related to provisioning challenges at the land/water/energy nexus and who collectively seek to illuminate disruptive opportunities to innovate and understand risks of defaulting to business as usual. This Collaborative is built around a shared virtual space across national, disciplinary and organizational boundaries to test the assertion that by linking disparate spatially and temporally specific information together that integrate human and ecological dimensions, we may build systems that better inform current and future decisions, and better describe, hence value risk. The disciplinary solutions of the past will ultimately fail for these new categories of Global challenges and risks. The KSS Collaborative dismantles traditional disciplinary boundaries to adapt, adopt and invent our way through the transition from an economy focused on maximizing productivity and growth at almost any cost, and an economy that better delivers sustainable livelihoods for all.

Imagining and implementing solutions to our most wicked problems (those that are complex, interdisciplinary, with positive and negative feedback loops) will require a shared vision and communities of practice committed to better mobilizing the investments across the public and private sectors. In the absence of robust, objective, useful information, critical decisions are made by default for political, financial, or other reasons, unconstrained by science and are likely to deliver outcomes that neither balance our individual and collective needs now or in the future. We also currently lack sufficient mechanisms to learn from certain persistent, repeatable failures related to provisioning challenges at the land/water/energy nexus, and in constructing a new knowledge system, we must be able to learn both from our successes and our failures.

Our concept of a knowledge system has five intersecting dimensions: (a) Decision Processes and Decision Support; (b) User interfaces, participatory processes and learning systems; (c) Modeling and Scenario Building; (d) data, information and knowledge assets relevant to sustainable provisioning at the land/water/energy nexus; and (e) Cyberinfrastructure. We acknowledge that none of these dimensions on their own have world-changing attributes, but together they can help to shed light on the

impacts of individual and collective choices have on landscapes and ecosystems, and begin to communicate this knowledge to the people actually making the decisions, from the farmer to the supply-chain manager to the policy maker. Clearly an integrated, comprehensive and fully geo-referenced knowledge foundation is an essential asset for any number of critical conversations unfolding now, including but not limited to projections of the consequences of climate change on productivity, optimized sustainable management of productivity and biodiversity, science towards land management decision support, the science foundation for environmental markets, and the consequences of land management decisions on weather and climate. Any system we frame now obviously must scale from local to planetary frames.

The role that the Collaborative has taken on is to stimulate coordination and collaboration as opposed a single centralized resource. We use geographically defined "cases" anchored in a common framework to work systematically across scales and geographies to access and link data, information and knowledge assets to decision-making through a learning knowledge system. The structured dialog within and between "cases" are designed to allow for the detection of commonalities (challenges and successes), patterns, or work modes that will allow us to leverage one-off customized demand-driven solutions to more generalized approaches for information provisioning and knowledge management more generally. It will be in these dialogues between knowledge system and case, case and knowledge system we expect to build our communities of practice. It is also where we intend to gain and interpret data and insights about the value of systems thinking and tools with particular relevance to sustainability challenges and the value of integrated demand in catalyzing the creation of coherent data layers and our ability to pull across those layers with analytics that work across scales and dimensions. Within each "case" and across the five intersecting "dimensions," we are working to build communities of practice that generate, curate, and/or deliver data, information, tools, analytics, and knowledge assets relevant to sustainable landscape management.

Our goal is to catalyze the creation of an adaptive knowledge system that leverages decades of investments in science, and generations of human ingenuity (represented in both successes and failures) to mobilize sophisticated approaches to decision-making in the face of complexity and uncertainty and help to guide governance structures that are responsive to the most urgent 21st century needs. Some of the core questions that the Knowledge Systems for Sustainability Collaborative is working to address include:

What is the current state of our data, information and knowledge resources that describe socio-ecological systems across multiple scales of time and space as they related to i)reusability, ii) discoverability, iii)accessibility, iv)interoperability?

How can we facilitate access to data, information, knowledge assets, access to data and information management platforms, access to virtual “shared space” where contributed platforms, tools, protocols, can be better mobilized?

What are the current pathways of knowledge production and consumption? How can that process be democratized? What are the inefficiencies of these pathways and how can technology and governance improve the efficiency of these pathways? What are the ethical, legal and social implications of the democratization of these types of knowledge?

What opportunities exist to import, share, leapfrog or cross-pollinate cutting edge technologies, tools and approaches from the private sector and military and intelligence communities toward building responsible information sharing environments toward navigating tradeoffs, tipping points and decisions in a knowledge-to-action and action-to-knowledge mode?

How can decision support be provided in complex, adaptive systems with high levels of uncertainty?

How can the successes / failures of interventions within a socio-ecological system be tracked? How can we learn from these interventions and the “exportable insights” that they produce?

What is the value proposition for this new mode of knowledge management, sharing and transparency? How can we create trust by silo breaking? How can we create bridges between old and new economics?

What new innovative instruments and approaches will be needed to manage our individual and collective risk? What gaps in knowledge need to be filled / bridges between knowledge silos need to be built for this transformation?

If staying within safe operating spaces for humanity on earth is our goal, how does that translate to individual and collective decisions? How do individual actions that move us away from that safe space reflect on current / future social, governance and business practices?

What does an innovation ecosystem that supports the mobilization of a Knowledge System for Sustainability look like? What components exist? What are the gaps? Who are the willing participants?

How can the democratization of knowledge more efficiently inform the financial and policy environments?

How can we create communities of practice around all of the above questions?

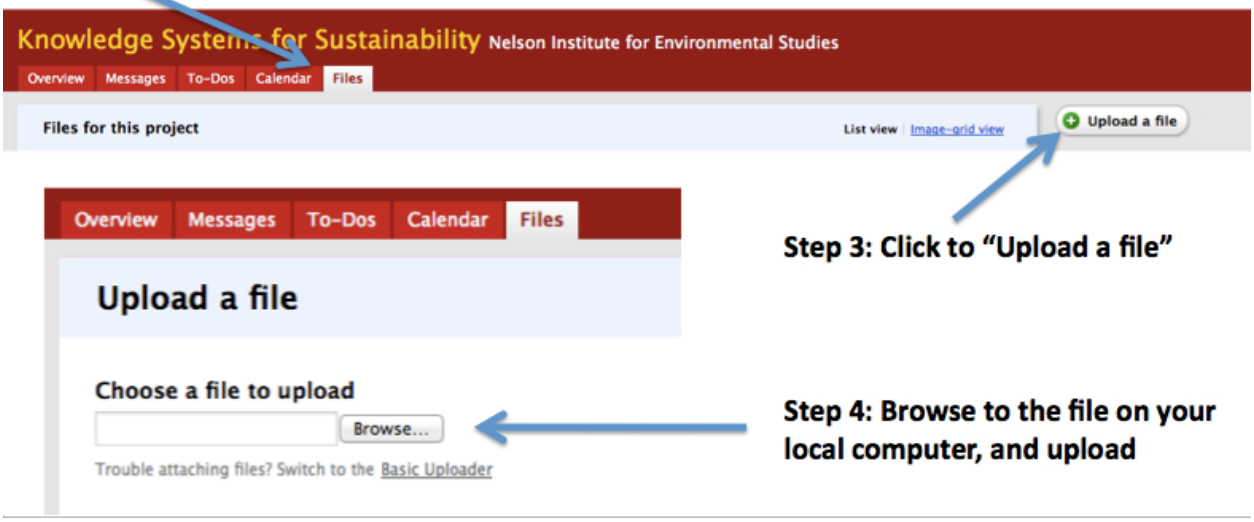
Ongoing conversations aim to unearth underlying areas of uncertainty that, once recognized, will beg attention from leaders and strategists within business, public service and academia. We gather those who are working in these areas, testing new ideas and trying out new ways to approach the global challenges of our time - and in this way, experiencing at first-hand what is possible and what is not - and why. The importance of a modernized knowledge system for the sustainable management of landscapes to approach these challenges is clear. We have already experienced various economic and policy shifts connected to agricultural practices and food systems that internalize a few of most obvious and immediately disruptive environmental and social costs of our current practices. The need for intensified investment and re-orientation of existing activities will require a more sophisticated formulation of the challenges we manage through choices connected to our food systems and diets. Individual and collective decision-making is only informed and not determined by objective information; however, the obvious and urgent need to better integrate information and mechanisms to feed back a more complete representation of consequences of particular choices are now widely recognized. With this recognition, we have the opportunity to renovate scientific, political and governance infrastructures and processes to democratize the production of knowledge and closer abut science and decision-making processes on landscapes.

In summary, this Collaborative is constructed to conceive, develop, and evaluate new theories and practices of data, knowledge and information management toward more informed decision-making, and the creation of new knowledge, especially at the boundaries of current understanding. Elements of such a knowledge system already exist and can be leveraged to mobilize these resources toward providing decision-makers with insights on managing multidimensional trade-offs across landscapes. A cohesive, coherent and targeted approach toward integrated knowledge management that define new knowledge systems for more sustainable management of landscapes is essential to move more rapidly toward productive resilient landscapes. The grand challenges of the early 21st century affect every aspect of current social and physical frameworks. With billions threatened by food insecurity, diet- and climate-related health threats, radical extinctions of biota and threats to essential natural resources, the time to renovate global trajectories toward a condition that might be characterized as "safe operating space" is past due. Any significant adjustments toward more sustainable outcomes will occur by changing real decisions on the ground at scale.

VII. Basecamp Project Management Instructions

Step 1: Login to Basecamp
https://wiscgrad.basecamphq.com
(contact LeZaks@wisc.edu if you need your password reset)

Step 2: Click on "Files" tab



Step 3: Click to "Upload a file"

Step 4: Browse to the file on your local computer, and upload