Stream A: Cyberinfrastructure and Cloud Computing for Environmental Modeling

Session A1: Leveraging Cyberinfrastructure to Advance Scientific Productivity and Reproducibility in the Water Sciences

Organizers: Jonathan L. Goodall, Brian C. Miles

Description: Expanding the theoretical power and policy relevance of computational water science requires improved scientific reproducibility and researcher productivity. The developing field of cyberinfrastructure provides the software, hardware, and social networking tools to advance reproducibility and productivity in the water sciences. We seek submissions illustrating the development and application of cyberinfrastructure to answer science and policy questions of water availability, quality, and natural disasters. Potential topics include: systems and standards for sharing water data and models; semantics, ontologies, and provenance data for water science workflows; workflow and modeling frameworks that enable inter-model or cross-site comparisons.

Session A2: Sharing Scientific Environmental Data and Models

Organizers: Stephan Mäs and Lars Bernard

Description: The role of information infrastructures for the exchange of scientific data and simulation models as well as the documentation of research results is more and more growing. It is widely recognized that such infrastructures can support the creation of new scientific communities and stimulate the interdisciplinary collaboration to solve common scientific issues.

The exchange of environmental data in such exchange platforms has particular requirements and issues like the time-consuming metadata generation for simulated data, the usually complex description of data provenance, the support of distributed geoprocessing and collaborative model development, and many others.

This session aims at bringing together the researchers involved in the implementation and development of scientific data infrastructures as well as environmental researchers working with such platforms to discuss the current state of the art and the requirements and issues to address in future. Topics include, but are not limited to:

- E-science and cyber infrastructures for environmental research
- scientific (spatial) data infrastructures and data exchange
- metadata descriptions of simulation outputs
- distributed geoprocessing
- collaborative model development

Session A3: Innovative Architectures and Approaches of Cloud and Mobile Technology for Environmental Modeling

<u>Organizers</u>: Olaf David (CSU), Wesley Lloyd (CSU), Jim Ascough (USDA)

<u>Description</u>: Cloud computing addresses the need in information technology to gain access, increase capacity, or add capabilities very quickly without investing in and administrating own infrastructures while lowering capital and maintenance costs. Cloud computing supports the dynamic provisioning of computational and storage resources to enable elastic scaling on demand. Cloud infrastructures are easily accessible via subscriptions or as pay-per-use service. For scientific modeling and simulation, clouds provide a tremendous opportunity to tap into vast computing resources with a lower investment cost opposed to traditional High Performance Computing (HPC) approaches. Nimbus, iPlant, or CSIP are just a few efforts which explore the potential of cloud computing for scientific applications. The focus of this session will be the customization and application of such innovative methods for modeling, spatial processing, model calibration, or output analysis.

We seek new and innovative solutions for environmental modeling that solve a broad range of complex problems. Possible contributions to this session may include:

- The use of cloud computing for environmental models in general, approaches using public or private clouds for environmental research
- Data provisioning to support environmental modeling in the cloud, including approaches to distributed data management using distributed caches, as well as relational SQL and non-relational NoSQL databases.
- Data sharing and other distributed and scalable techniques which support hosting large data sets (e.g. geospatial data)
- Applications of Map Reduce frameworks such as Hadoop for spatial modeling, model calibration, or uncertainty analysis.
- Leveraging Graphical Processing Units GPUs (in conjunction with clouds) to speed up model computation through support many simultaneous parallel computations.
- Data provisioning, deployment, and use of cloud based models via mobile technologies.
- Comparison of cost/benefit ratios and efficiencies of cloud solutions versus HPC/cluster or GPU offerings for environmental modeling; experience using commercial offerings.

Session A4: Smart and Mobile Devices Used for Environmental Applications

<u>Organizers</u>: Gerald Schimak and Denis Havlik

<u>Description</u>: Thanks to a smartphone (r)evolution, the smart sensing devices with networking capabilities are not only inexpensive but often already deployed on the field and waiting to be used for the greater good. Moreover, these devices are on the way to become a primary communication and information platform for a majority of the world's population.

The promise of inexpensive or "zero price" ubiquitous sensing and crowd tasking has sparked an avalanche of cross-domain research and development activities. In some cases, the results exceeded all expectations. Nevertheless, the traditional users of environmental information remain skeptic concerning the quality and usability of the information from humans and inexpensive sensors.

In this session, the participants will discuss their approaches, models, visions and experiences with use of smart and mobile devices in environmental applications as well as in the cross-domain applications with strong environmental bias – including, but not limited to "environmental risk & crisis management", "environment and health" or "environment and traffic".

The presenters should cover the issues of feasibility, usability, data quality, and reliability of the applications using the smart and mobile networked devices in one or more of the following contexts:
• Opportunistic sensing: where and how can we use existing smart devices, for instance smartphones or sensors built in the vehicles?
• Human sensing: what can we gain from subjective and objective observations by volunteers and/or professional surveyors?
• Inexpensive sensing: what can we gain by attaching additional low-cost sensors to existing platforms or by deploying a dedicated network of inexpensive mobile sensing devices?
• Crowd tasking: coordination of professional and volunteer field workers, especially in the context of observation reporting and quality assurance.

This sessions is going to be organized as an ISESS 2013 follow up.

Session A5: Parallel Simulation of Environmental Phenomena

Organizers: Ralf Denzer and Peter Fitch

Description: Growing environmental data availability and growing needs of large scale environmental simulations lead to the requirement to run simulations faster, more responsive and more effective, in particular for ensemble simulations and for simulations with multiple models. There have been a number of efforts to parallelize simulation on computing clusters and distributed web-service-based environments, but it appears that these attempts have so far not been leading to a systematic approach.
At the same time cloud infrastructures and technologies emerging from the Big Data domain offer new possibilities for environmental simulation.
The aim of the session is to exchange experiences made, to find good practices and to contribute to a systematic approach which will lead towards recognized and re-usable distributed computing patterns.
The session welcomes a) practical papers which demonstrate experience with parallel simulation, b) papers identifying generic requirements, c) conceptual papers which lead the way towards systematization, d) state-of-the-art overview papers and e) papers showing use of novel technologies.

Session A6: Semantics, Metadata and Ontologies of Natural Systems

Organizers: Ioannis N. Athanasiadis, Ferdinando Villa, Ronald van Nooyyen, Alla Kolechkina, and Andrea Rizzoli

Description: This session aims to collect contributions addressing the various challenges and recent developments in the area of applying semantic technologies to the environmental sector. Topics include but not limited to:

- the use of semantics to facilitate search and discovery of environmental resources;
- linked open data approach to support interlinking of environmental data on the internet;
- semantics of model integration, model linking and scientific workflows;
- the role of semantics in integrated modelling efforts;
- standardization of access protocols and metadata vocabularies
- current efforts for modelling natural systems semantics

Workshop A1: Scientific Computing in the Cloud

Organizers: Tom Purucker

Description: The accessibility and functionality of cloud computing continues to increase, cloud service provider offerings range over infrastructure-, platform-, software-, and network-as-a-service availability, while the development and maintenance costs of such systems continue to decrease compared to personal computer software development models. Federal agencies are pursuing mechanisms to be able to access or create secure cloud environments and many private companies have already taken advantage of these technologies to deliver scalable solutions that require considerable computing power. With these developments, cloud computing for scientific applications holds tremendous potential to scale computationally intensive models in an accessible manner and increase the transparency and educational utility of science models.

This workshop aims to expose the participant to current technologies that address the above mentioned opportunities by introducing some basics on how to conduct scientific computing on a platform-as-a-service (PaaS) cloud computing platform (e.g., Google App Engine). These platforms make it relatively easy to build, maintain, and scale science applications. These cloud development approaches can allow science models to be run in a web browser, and the models themselves can be more easily parameterized, efficiently run, and transparently documented. Security, source code, and quality assurance issues will also be discussed. There are also clear gains for addressing science model integration issues, models that are currently on diverse computing platforms can be brought together into a dedicated web application with a unified interface. This approach can be a boon for decision support systems for the assessment of environmental problems, which often have existing software solutions originating out of different environmental disciplines with a range of technology-dependent implementations.

Workshop A2: Hydrology in the Cloud – A World Water Online Hands-On Tutorial

Organizers: Steve Kopp, Stefan Fuest, Gonzalo Espinoza

Description: In recent years we have seen a transition from data sharing through static file downloads and analysis performed on individual desktop computers, to accessing data as dynamic services, and performing analysis as services on remote computers. This workshop will focus on hydrologic applications of web services accessed through World Water Online, a collaborative effort of the University of Texas Austin, Esri, Kisters, and Microsoft Research.

The workshop format will start with a short system overview followed by instructor-led demonstration tutorials for you to follow and perform on your computer.

Things you will learn through these tutorial exercises

*   What data and analysis tools are available and how to use them in your software/project

*   Using web services to understand the hydrologic and environmental characteristics of your area

*   Using online GIS to answer common environmental questions

*   How to publish your own services

For this workshop you need nothing more than a laptop with a web browser and an interest in water resources. You don't need to understand web services, cloud computing, GIS, XML, REST, or any other technical details.

This workshop is useful for water resources professionals looking for an easier path for their daily work, and to understand how you can empower others to leverage your work through web services. The workshop is also valuable to all science disciplines who need access to, or analyze water resources and related information.

Stream B: Integrated Environmental Modeling

Session B1: Research Infrastructures for Integrated Environmental Modeling

Organizers: Antonio Parodi, Andrea Clematis, Rick Hooper

Description: In order to understand how pressures such as climate change and infrastructure developments impact the environment we need model not just physical, chemical and biological parameters individually, but also how these parameters interact to affect the whole system. Environmental systems couple many natural processes and simulating them accurately demands modeling them in a similar fashion. Integrated environmental modeling seeks to achieve this by assembling collections of linked (model and data) components, supporting different aspects of the combined system.

At the heart of this challenge lies the ability to have easy access to model and data components, assembling them according to recognized standards and facilitating collaboration between the appropriate scientific and ICT communities. This is of particular importance because ICT methods are often aimed at satisfying general needs resulting in a gap between specific modeling chain requirements and available tools.

This session is intended to attract interest and promote discussion between scientists, who develop and use environmental models and data and the ICT communities who typically provide the necessary infrastructure and tools. It accompanies an associated workshop where such modelling and data tools will be demonstrated and discussed.

Session B2: Semantic Interoperability of Models in Intelligent Environmental Decision Support Systems (IEDSS)

Organizers: Miquel Sànchez-Marrè, Karina Gibert, René Bañares Alcántara, Joaquim Comas, Michaela O'Prea, Manel Poch Espallargàs, Jean Philippe Steyer, Franz Wotawa

Description: Single AI techniques such as Rule-based reasoning, Fuzzy models, Case-based reasoning, Qualitative reasoning, Artificial neural networks, Genetic algorithms and programming, Model-based reasoning, Bayesian networks, and Multi-agent systems provide a solid basis for construction of reliable and real applications, but there is the general agreement among researchers that a Semantic Interoperability of AI/Maths/Stats Techniques is the main open challenge in this field. Interoperability is the ability of two or more systems or components to exchange information and to use the information that has been exchanged. Additionally, when the components share a common understanding of the information model behind the data being interchanged, semantic interoperability is achieved. Thus, this is the proposed main issue for the session. IEDSS are present in the environmental management process at different levels such as hazard identification, risk assessment, risk evaluation and intervention decision-making, but there

is neither a well-defined methodology or framework for the development of IEDSSs nor for Model integration nor for Model recommendation techniques nor for Benchmarking and validation of IEDSSs. Outstanding applications and case studies of IEDSSs with important contributions are also welcome. Other open issues can be addressed, such as the spatial reasoning, temporal reasoning, and uncertainty modelling and management in IEDSSs. These are the open challenges to be addressed by the session papers, and special emphasis will be given to Environment's sake issues. The session will establish a discussion platform for Artificial Intelligence (AI) and Environmental researchers involved in the development of techniques, frameworks, software platforms or applications in the Intelligent Environmental Decision Support Systems (IEDSS) area. Session participants may come from all Environmental Science and Artificial Intelligence or Statistical Modeling fields.

Session B3: Integrated Hydrodynamic, Hydrological, Water Quality, and Ecological Models

Organizers: Mohamed Ali Bek, Saleh Mohamed Shalaby

Description: Wetlands, lakes and lagoons in coastal regions are important for people and for biodiversity yet often the science base needed to manage these multi-purpose resources effectively is inadequate. This session is focused on the development of integrated models for the coastal lakes region and aims to attract input for the best practices for the field of hydrodynamic, water quality modeling and this may include:

- Developed hydro-ecological models to facilitate better understanding of environmental systems and to investigate future environmental change scenarios.
- Developed models which are integrated with applications of remote sensing and field data.
- Developed models that can benefit from Appling historical information, from geo-archaeology to sediment records.
- Models that can examine the case for integrated science involving environmental change research and quality controlled aquatic monitoring.

Workshop B1: Using Research Infrastructures for Integrated Environmental Modeling

Organizers: Quillon Harpham, Ilya Zaslavsky, and Bert Jagers

Description: In order to understand how pressures such as climate change and infrastructure developments impact the environment we need model not just physical, chemical and biological parameters individually, but also how these parameters interact to affect the whole system. Environmental systems couple many natural processes and simulating them accurately demands modeling them in a similar fashion. Integrated environmental modeling seeks to achieve this by assembling collections of linked (model and data) components, supporting different aspects of the combined system.

At the heart of this challenge lies the ability to have easy access to model and data components, assembling them according to recognized standards and facilitating collaboration between the appropriate scientific and ICT communities. This is of particular importance because ICT methods are often aimed at satisfying general needs resulting in a gap between specific modeling chain requirements and available tools.

This workshop will allow integrated environmental modelling and its associated data environments and tools to be debated and demonstrated. It is intended to promote discussion between scientists, who develop and use environmental models and data and the ICT communities who typically provide the necessary infrastructure and tools. It accompanies a session with a similar theme where a selection of associated papers will be presented.

This workshop is organized by members of the DRIHM (www.drihm.eu), DRIHM2US (www.drihm2us.eu) and SCIHM (scihm.org) projects, aimed at providing ICT services on distributed and interoperable e-infrastructres to enable hydro-meteorological research. However, contributions from the broader integrated environmental modeling community are explicitly called for.

Stream C: Environmental Modeling Uncertainty Issues

Session C1: Complexity, Sensitivity, and Uncertainty Issues in Integrated Environmental Models

<u>Organizers</u>: Jim Ascough, Francesca Pianosi, Timothy Green, Thorsten Wagener, Olaf David, and Giorgio Mannina

<u>Description</u>: The purpose of this session is to provide a forum for a set of presentations focusing on complexity, sensitivity, and uncertainty issues in integrated environmental models. The session offers an opportunity for: 1) investigating what complexity and uncertainty mean for models and the way we approach modeling, i.e., how do we meet the challenge of solving modeling problems where time delays, feedback loops, non-linearity, and system interconnectedness increase complexity and make prediction particularly difficult; 2) increasing awareness of the significance of various sensitivity and uncertainty analysis techniques in the development and application of integrated environmental models; and 3) discussing and critically evaluating the contribution of these techniques to improved modeling of environmental systems. Objectives include communicating state-of-the-art information on complexity, sensitivity, and uncertainty methodologies, and identifying research directions and potential collaborations for improving these methods in the context of integrated environmental modeling. Suitable complexity, sensitivity, and uncertainty topics for the session include, but are not limited to:

Model Complexity

- How to address "problems of scale" for complex models (e.g., how to express, evaluate, and understand the results of complex models).
- Identification of the relationships between model complexity and external factors such as computational performance, simulation software, animation capabilities, modeler expertise, etc.

Sensitivity Analysis

- The use of sensitivity analysis (SA) to gain insights into key sources of uncertainty in order to prioritize additional data collection or research efforts, increase understanding of model behavior, and provide insights for model calibration and model reduction.
- Practical strategies for local/global SA given models with large parameter sets or high computational requirements: design of experiment, emulation techniques, monitoring and improving convergence and accuracy.
- Key criteria in selecting SA methods for different modeling structures and problems.

- Integration of probabilistic and non-probabilistic approaches to expand SA to unquantifiable sources of uncertainty like model structure, modeling assumptions, "value" parameters, etc.
- Visualization techniques for effective communication of SA results.
- Limitations and promising new advances/directions for SA methodologies in environmental models.

Uncertainty Analysis

- Scale effects in uncertainty analysis (UA) of integrated environmental models.
- Uncertainty propagation in complex, environmental models with large parameter sets or high computational requirements.
- Development and evaluation of UA methods that appropriately consider subjective and qualitative factors.
- Evaluation of uncertainty in model outputs with respect to decision making or risk management objectives.
- Assessing and quantifying information requirements (e.g. theories, data, models) to reduce predictive uncertainty in environmental models.
- Methods for identifying and managing structural uncertainty and bias in integrated environmental models.
- Assessment of uncertainty in socio-economic models.

Session C2: Accounting for Uncertainty in Decision Support by Treating Model Assumptions as Scenarios

Organizers: Tony Jakeman, Sondoss El Sawah, Joseph Guillaume

Description: Supporting decision-making on environmental problems fundamentally helps decision makers address uncertainty about future events and the future response of a system. Scenarios are an established means of reasoning about the former, while uncertainty analysis methods have historically been preferred for the latter. However, a model typically captures a single representation of a system's operation and can therefore also be seen as a scenario. Rather than only focusing on external drivers, creating scenarios with alternate model assumptions, parameters and model structures can therefore help reason about uncertainty in the response of a system. This concept already underlies soft systems methods, exploratory modelling, robust decision making, the method of multiple working hypotheses and multi-model ensembles. Uncertainty analysis methods can also be considered to generate large ensembles of scenarios, albeit with additional probabilistic information.

These existing methods have for the most part evolved independently. This session therefore aims to bring together the variety of researchers and practitioners who treat model assumptions as scenarios, either explicitly or by making use of multiple models in their work.

The session will be accompanied by a workshop aimed at synthesizing a position statement and research agenda on the use of scenarios to address uncertainty in model assumptions.

Topics might include advances in:
- Eliciting and linking multiple views/mental models to model assumptions
- Addressing multiple problem definitions in modeling
- Vulnerability analysis in terms of uncertain model assumptions
- Scenario discovery from ensembles of model structures and parameters
- Analysis and use of multi-model ensembles
- Creation and use of best and worst case models
- Applications of robust decision making with multiple model structures and parameters
- Stakeholder engagement presenting model assumptions as scenarios
- Visualization of model ensembles as a set of scenarios
- Critical and reflective approaches for identifying and questioning judgments underpinning analysis and modeling boundaries
- Use of uncertainty analysis techniques to generate and examine alternate model assumptions

Stream D: GIS and Visualization

Session D1: GIS and Environmental Modeling for Decision Support

<u>Organizers</u>: Johannes van der Kwast, Ruediger Schaldach, and Florian Wimmer

<u>Description</u>: The use of Geographical Information Systems (GIS) in environmental modeling provides a means of analyzing changes in the spatial as well as the temporal domain. In order to better integrate GIS and environmental modelling, new software frameworks have been developed to perform cartographic, dynamic and stochastic modelling. Furthermore, these frameworks can include optimization and data assimilation techniques. Scripting languages like Python, R and Matlab are more and more used for this purpose.

Another important evolution in GIS and modelling is the use of Web2.0 capabilities and web-based GIS tools. These are potentially useful to present complex spatial, temporal and probabilistic modelling results to the end users to support them in making decisions on environmental management. Real-time data and time series in Spatial Data Infrastructures (SDI) and crowd-sourced data from mobile apps can be used as inputs for environmental models and for data assimilation. Mobile applications linked to forecasting models and GIS data can for example assist farmers to make a proper decision to optimize yields.

This session seeks answers to the following questions. What is the state-of-the-art in commercial and open source software in combining GIS and environmental modelling? How is the interoperability of these frameworks with existing GIS software and models? Do they need to be coupled (soft/hard), or integrated in a spatial decision support system? How to deal with different spatial and temporal resolutions? What are intuitive ways to present complex model results to decision makers or local stakeholders? What are the experiences with end users using decision support tools that integrate GIS and environmental modelling and how can this be improved?

For this session, we invite papers presenting (1) novel modelling frameworks or decision support systems that are integrating GIS software and environmental models and (2) innovative GIS technologies that facilitate the use of spatial data in environmental modelling. In particular, we are interested in papers that demonstrate how these software solutions are used for practical decision making and environmental planning. We also invite contributions from GIS experts, modelers and ICT experts working at discipline interfaces, both covering conceptual approaches and practical experience of combining GIS and environmental modelling. Furthermore, we would like to invite end users of GIS-based decision support tools to learn from their experiences and needs.

Session D2: Virtual Reality, 3D Applications, and Immersive Visualization

<u>Organizers</u>: Eric Whiting and Derrick Turner

<u>Description</u>: Commodity instruments and sensors have experienced exponential growth in both the velocity and volume of data that they can collect. The field of environmental sciences has experienced an especially significant increase in available information.

Many consumer cameras now capture images containing more than 20 million pixels in a single frame; three-dimensional scanners collect data points at rates of millions of points per second. Proper analysis and study of this data deluge is a significant challenge. Even the latest 30" screens have total resolutions of around 4 Megapixels – a small fraction of the data that needs to be analyzed.

A potential solution to these challenges is an affordable, commodity-based, 3D immersive visualization environment. We interpret our 3D world in a native 3D format through the inter-ocular distance between our eyes and mental processing abilities. A native 3D display environment reduces some of the cognitive load and allows interaction with very large datasets.

This session invites presentations related to applications of virtual reality, 3D, and immersive visualization in environmental modeling.

Stream E: Environmental Modeling for Health and Human Issues

Session E1: Data Acquisition, Management and Processing for Sustainability Appraisal

Organizers: Marina G. Erechtchoukova and Peter A. Khaiter

Description: The concept of environmental sustainability requires management decisions which satisfy current needs without compromising the interests of future generations. It stipulates the necessity to predict the development of natural resources with and without human impact. Simulation models and computer-based systems are widely recognized as useful and, sometimes the only, tools for assessing sustainability of a relevant decision. There exist sustainability indices and assessment and reporting frameworks for evaluation of sustainability. However, the multi-dimensional and inter-disciplinary nature of the concept of sustainability requires selection of issue-specific indicators at appropriate temporal and spatial scales. Methodologies for model application and quantitative methods for sustainability appraisal are yet to be elaborated and enhanced. Nevertheless, the necessary steps in application of these methods are data collection and processing aimed to identify trends and patterns of ecosystem reactions to external perturbations.

The session invites contributions on application of quantitative tools (models, methods and frameworks) evaluating sustainability of environmental decisions with the focus on data and information requirements, strategies for data acquisition, management and processing. Papers on data and information requirements, conceptual data models, approaches to data analysis for sustainability appraisal and case studies are welcome.

Session E2: Environmental Modeling of Human Health Effects from Global to Local Scale

Organizers: Stefan Reis, Massimo Vieno, Michael Wimberley and Tomohiro Oda

Description: In recent years, computing power and data storage capacities have been growing rapidly, enabling models to increasingly cover large spatial and temporal scales in ever higher spatiotemporal resolution. Currently applied models are often running at resolutions of meters to hundreds of meters (local), kilometers (regional) and up to 100s of kilometers (hemispheric/global), with various approaches being utilized to connect these scales. At the same time, environmental sensors are generating unprecedented volumes of data, from earth observation using satellite remote sensing to local, smart sensor networks (e.g. personal sensors and other low-cost monitoring). And while these developments lead to a context in which models at all scales can draw upon a rich landscape of data products, modelers are still frequently faced with challenges related to up- or down-scaling, nesting and boundary conditions, uncertainties and

sensitivity to data and process understanding. These challenges may occur in different contexts and for different research questions, but are inherent to all modelling approaches when applied across scales.

In parallel, there is a growing understanding that many local effects and environmental problems may have underlying causes that are far away from the observed impact. Global climate change, hemispheric and trans-boundary transport of air pollution and the distribution of persistent organic pollutants into remote regions of the world are just a few examples. Environmental drivers are closely linked to the Global Burden of Disease (GBD), with intricate relationships between the causes and effects from global to local scales.

This session aims at bringing together environmental modelers working on a wide range of applications, including, but not limited to:

- Modeling emissions, atmospheric transport and environmental fate of air pollutants, greenhouse gases, pathogens and vector-borne diseases;
- Global to local scale climate modeling;
- Integration of Earth Observation (EO), remote sensing and smart sensor network data in environmental modelling at different scales, including personal sensors;
- Modeling the environmental fate of chemicals across all environmental media;
- Modeling spatial and temporal aspects of human health effects and their environmental determinants, including epidemiological and exposure-effect models.

Workshop E1: Integrating Modeling and Smart Sensors for Environmental and Human Health

Organizers: Stefan Reis, Edmund Seto, and Amanda Northcross

Description: Models have become a widely used, indispensable tool in assessing environmental effects on human health. Applications include, but are not limited to, the modelling of environmental processes such as the atmospheric dispersion and environmental fate of pollutants, the quantification of human exposures to these pollutants, and estimation of the potential burden of disease based on exposure-response relationships and risk factors. Models have also found important uses in examining the accidental or natural release of chemicals, radionuclides or volcanic ash. Generally, models are validated against measured data, which may come from few, typically sparsely distributed routine monitoring stations, or often costly short-term field measurement studies. In both cases, the spatial and temporal performance of models is evaluated against few observed data points.

On the other hand, the capabilities and availability of cheaper, more sensitive and sophisticated environmental sensors for gases, particulates, noise and other environmental components are beginning to enable researchers to collect data in unprecedented spatial, temporal and contextual detail. These sensors range from bespoke devices designed for specific applications, to more mainstream smartphone applications and generic location based services. Both have potential for closing a crucial gap between the availability of few high precision sensors deployed for regulatory monitoring and the lack of monitoring away from urban areas. In addition, low-cost sensors, alongside remote sensing products, are perhaps the only viable option for gathering vital data in the developing world, where both environmental and health data is often non-existent and no infrastructure for fixed-site monitoring is likely to be established. However, new, citizen science

and crowd-sourcing applications of sensor technologies can also play an important role in enable access to data which have been deemed beyond reach even a few years ago. Moreover, within environmental exposure science, the concept of big data and the emerging area of exposomics will need to rely on a seamless integration between ever evolving environmental models, with increasing spatial and temporal resolution, and a vast amount of sensor-based data to quantify relationships, validate models and gain a better understanding of the detailed interactions between humans and their environment.

This workshop will bring together modelers, sensor experts and environmental health researchers with the aim of providing a forum to:

•   Discuss and develop a common understanding of the mutual benefits of better integrating models and sensors at different spatiotemporal scales;

•   Explore new ways of dealing with precision and the validation of models with data from different types of sensors;

•   Develop a roadmap for testing model-sensor integration and discussing the lessons learned in a joint position paper.

Following an introductory position talk, few selected highlight presentations (up to 5 mins each) will set the scene, while the focus will be on discussion and interactive discourse.

Stream F: Software and Model Design

Organizers: Nagesh Kolagani, Alexey Voinov and Michael K. McCall

Description: Technologies for measuring, mapping and monitoring environmental change that have a significant impact on the social and economic fabric of communities, rural and urban, are spreading rapidly. Although a number of these new complex technologies involve local community stakeholders in their deployment, very few include community stakeholders in the design and development.

There are semi-participatory data collection approaches that engage local community members with such technologies in field applications and data collection. Such approaches using local people and local skills for traditional environmental data observation, with methods including sampling, recording and measurement devices, have been in use for a century: "Citizen Science Observatories", etc. But increasingly there are community-based surveys with new technologies: iPaqs, Android and other smartphones, using GPS, sensors, digital cameras, participatory video, social media, etc. which have been deployed in Europe, Africa, Asia and Latin America.

However, with respect to the understanding and modeling of the environmental issues, and thus eventually to potential management, the practice commonly involves external experts studying the problem, preparing their scientific models and presenting externally-selected possible solutions to the stakeholders. And, community stakeholders usually lack capacity to understand these complex models and the full impact of the alternative solutions. These approaches implicitly do not give much credence to the local (indigenous) technical knowledge of local people in their local environmental contexts, and therefore the models and proposed solution fail to make use of this ITK. A more effective participatory approach would be for local stakeholders to be involved in the modeling exercise from the beginning, incorporating and integrating their 'local expert' technical knowledge with that of the external experts and facilitators.

Modeling efforts with a fuller involvement of stakeholders are becoming possible with development of many easy-to-use visualization tools, such as participatory GIS, VGI and 3D technologies. These tools engage stake holders at various levels, making it easier for them to understand and use complex models and their results. The external experts can work with these tools to solicit information from stakeholders as well as to communicate results to them.

This session and the linked workshop will critically examine and assess existing cases, or proposed efforts, that develop tools with user-friendly interfaces which are predicated on recognizing, valuing, and collaboratively utilizing local expertise in environmental knowledge. It seeks to bring together academic experts, action researchers and practitioners to explore recent developments in modeling with stakeholders. It invites papers on such efforts and on visualization technologies that can help in these efforts.

Session F4: Interaction Design for Environmental Information Systems

Organizers: Daryl H. Hepting, Steven Frysinger, and Markus Wrobel

Description: Environmental Informatics (or enviromatics) is a maturing subject with interdisciplinary roots. The application of information and communication technology (ICT) to the environment is emerging as one of great importance as the health of our planet gains priority on research agendas. Modelling is an important aspect of enviromatics, but it is not the only one.

In order for all citizens to participate in decision-making, both the collection and utilization of environmental data must be democratized. Cloud-based platforms that support visual analytics to explore global-scale databases in personally meaningful ways; mobile solutions that allow effective participation in citizen science and contribution to international databases; and handheld solutions to interacting with local data are some examples that can help to achieve the goal. Underlying the larger benefits of enviromatics as a tool for policy decisions is the architecture that enables those decision-making processes. To maximize the value of the enviromatics infrastructure, interaction design must be an integral part of the architectural plan. From a citizen's perspective, can ICT help with specific decisions and with placement of those decisions in an appropriate context for action? We seek to put work on interaction design and human computer interaction into the context of enviromatics, with the goal of understanding how to draw on and apply existing knowledge to enviromatics so that efforts are focused on refinement and adaptation instead of reinvention. Topics include, but are not limited to: usability analyses; decision psychology; task analyses (including, for example, decision support); validation of ICT tools; human-computer interface design; and human performance evaluation. In each of these, we encourage consideration of various platforms, from mobile smartphones to the cloud.

Session F5: Advances in Environmental Software Systems

Organizers: Ioannis N. Athanasiadis, Robert Argent, Ralf Denzer, Andrea E. Rizzoli, Gerald Schimak, David Swayne

Description: Understanding the complex relationships between humans and the environment is becoming more and more important. The efficient and sustainable management of environmental systems is essential to provide essential services such as water, for drinking and irrigation, preserving ecosystem diversity, guaranteeing food security, and an acceptable air quality, to name a few. As the scale of the challenge is rising, the need for sound methodological approaches to assist environmental managers is strong as ever, and environmental modelling and decision support systems (EDSS) can package and deliver such approaches.

Software systems have made huge progress in the last decade, and EDSSs are taking advantage of that progress. In this track we want to discuss, appreciate and evaluate the impact of software engineering methods and computing tools in the implementation and delivery of modern environmental modelling and decision making systems. Topics include distributed and cloud computing, social computing, crowdsourcing, the semantic web and ontologies, open linked data, big data and non-SQL databases, GPU and parallel computing, advanced visualization techniques, agile programming and domain-specific languages, and their use in environmental software applications.

We seek papers that demonstrate a unique contribution to environmental research as well as to

computer and computational science. Case study papers from practical applications where the informatics content has had a significant impact on a particular environmental issue are welcomed.

Workshop F1: Modeling With Stakeholders: Old Problems, New Solutions

Organizers: Nagesh Kolagani, Alexey Voinov and Michael K. McCall

Description: Please refer to the description provided for Session F3. This linked session and workshop will be scheduled to allow participants from the session to join the workshop and continue discussions on solutions for modeling with stakeholders.

Workshop F2: Conceptual Models and Getting Feedback on DSS and Modeling Research in its Early Stages

Organizers: Richard Sojda, Robert Argent, Carlo Guipponi, Brian McIntosh, Alexey Voinov

Description: Conceptual modeling and knowledge engineering can, and often should be, the initial stage of most modeling and decision support research and development. It is a critical step, but often it can be difficult to receive useful feedback on early ideas. This workshop will present the basics of conceptual modeling in an initial presentation. Then, a limited number of researchers will be allowed to present their conceptual models and receive feedback from workshop participants. The format of this workshop will include presentations on proposed projects with feedback and discussion on proposed conceptual models.

Workshop F3: Standards for community-oriented documentation of model components and global data fields

Organizers: Georgii Alexandrov, Forrest Hoffman, Kazuhito Ichii

Description: This workshop is aimed to developing voluntary consensus standards that can be used by modelers to bring their model components and global data fields to the form suitable for model inter-comparison, or for inclusion into multi-model ensembles.

Workshop F4: Complexity in Agent-based Models

Organizers: Carsten M. Buchmann, Zhanli "Jerry" Sun, and Cheng Guo

Description: Agent- or individual-based models offer, in principle, the possibility of explaining patterns and dynamics of complicated and diverse systems on the basis of individual level processes. The flexibility of the ABM model framework may lead many researchers into temptation to add details and therefore to increase model complexity. When over parameterized models are then to be evaluated, for example by extensive sensitivity analyses, it becomes obvious how hard it is to handle such complex systems, for instance to fully understand the dynamics and to make robust predictions. Model complexity may limit the learning value (pay-off) as well as the generality and transferability of insights gained by a specific modeling exercise. After decades of experience in agent-based modeling it is still a great challenge to choose the right level of model complexity for the specific question(s) addressed.

Stream G: Data Mining and Algorithms for Environmental Modeling

Session G1: Using Simulation Models to Improve Understanding of Environmental Systems

Organizers: Richard P. Hooper, Steven Weijs

Description: Simulation models can be used to increase our understanding of environmental systems, particularly when used in a combined field and modeling program. Papers are solicited on both the techniques and case studies of such use of simulation models. Techniques include automatic calibration methodologies, performance metrics, measures of information content of data series and information requirements of models, and new model inversion approaches. Case studies in which model results are used to refine system understanding and generate additional research hypotheses are also appropriate for this session.

Session G2: Data Mining for Environmental Sciences (s-DMTES IV)

Organizers: Karina Gibert, Joaquin Izquierdo, Miquel Sanchez Marre, Ignasi Rodriguez-Roda, Serena Chen, Geoff Holmes, Antonio Ciampi, Ioannis Athanasiadis

Description: Fourth Session on Data Mining as a Tool for Environmental Scientists (S-DMTES-2014) This session is strongly linked with W-DMTES2014, fifth iEMSs DMTES workshop (workshop G1), and aims to approach and to promote the interaction between the Environmental Sciences community to the Data Mining community and related fields, such as Artificial Intelligence, Statistics or other fields to discuss the contribution of Data Mining techniques to Knowledge Discovery in Environmental Sciences, as well as to make data mining techniques more accessible to environmental modelers and to give data miners and developers a better idea of the needs and desires of the environmental community. The session will introduce interested parties to a range of data mining techniques and a selection of software packages. We also invite submissions of papers and presentations of interesting applications of data mining to environmental problems. New or improved techniques or methods are welcome, as well as innovative applications. Particularly welcome in this edition, contributions stressing the benefits of a Data Mining approach versus a more classical one. For this particular contributions, please include comparison of data mining results with regards to the ones obtained under the classical approach

Workshop G1: Second Joint Workshop on Environmental Data Mining and Intelligent Decision Support Systems

Organizers: Karina Gibert, Miquel Sanchez Marre, Ignasi Rodriguez-Roda, Joaquim Comas, Joaquin Izquierdo, Ioannis Athanasiadis, Serena Chen, Geoff Holmes,Antonio Ciampi

Description: This workshop (Workshop G1 W-DMTES-2014) aims to provide a global perspective of the complete and complex process of transforming raw data into really useful decisional knowledge in environmental domains. Data Mining processes transform the data into relevant information, and permits to induce decisional knowledge from it, even taking into account the doctrinae corpus in the target domain, when available. Intelligent decision support systems can use this knowledge to provide rational support to the complex decision making process in front of high levels of

uncertainty, multifactors influences and, eventually, different experts opinions. The combination of both disciplines provides highly powerful tools for better knowledge of environmental systems as well as better control and management, highly linked to the new field of Data Science. This joint workshop is in close connection with Session G2 S-DMTES-2014 on Data Mining for Environmental Systems and Session B2, S-IEDSS-2014, this year devoted to Semantic Interoperability of Models in Intelligent Environmental Decision Support Systems sessions. The workshop pretends to promote the interaction among the Environmental Sciences, the Data Mining and the Intelligent Decision Support Systems communities and related fields, to discuss the joint contribution of Data Mining techniques and Intelligent Decision Support Systems to Knowledge Discovery in Environmental Sciences and Data Science, as well as to make both data mining techniques and Intelligent Decision Support Systems more accessible to environmental modellers and to give data miners and knowledge engineers a better idea of the needs and desires of the environmental community. The workshop will have an introduction from the organizers to orient discussion and will provide synthesis of the advances presented in both G2 and B2 sessions. Participants in S-DMTES'2014 and/or session IEDSS'2014 are specially invited to take active participation in this workshop. Part of the workshop will be devoted to launch a new collaborative service available in the iEMSs society website to be updated on publications in the field of Environmental Data Mining

Workshop G2: Analyzing and Synthesizing Results from Complex Socio-ecosystem Models with High-dimensional Input, Parameter and Output Spaces

Organizers: Dawn Parker, Gary Polhill, Tatiana Filatova, Michael Barton, and Terry Dawson

Description: In the last decade, agent-based modelers have made substantial progress to identify compelling research questions, design models to investigate them, and develop methods to bring real-world data into models at both the creation and evaluation stage. Since the models we design have stochastic elements and many potential parameter combinations, multiple model runs that sweep parameters are conducted, creating large quantities of computationally generated, hyper-dimensional, "big data" from which we hope to extract answers to research questions on coupled socio-ecosystems. Yet we lack appropriate methods to mine, analyze, and synthesis large-scale model output data in order to answer our questions. Traditional analysis methods for mapping relationships between input parameters and output data—in both real-world and computational data—are designed for data that are linear, continuous, and normally distributed. However, data from models of complex socio-ecological systems can be non-linear, discontinuous, and power-law distributed. Following the model of the successful workshop on documentation protocols for agent-based models in Leipzig, 2012, this workshop will explore the requirements of this community for data analysis and synthesis, the ways in which they are similar to and different from other big data use cases, and will review existing and developing methodologies, with a view to developing a joint paper on the topic as a product of the workshop.

Stream H: Applications of Environmental Modeling

Session H1: Environmental Modeling, Software, and Data to Support Quantitative Microbial Risk Assessments (QMRAs)

<u>Organizers</u>: Gene Whelan, Jeffrey Soller, Yakov Pachepsky

<u>Description</u>: The session will discuss various aspects of Quantitative Microbial Risk Assessments (QMRAs) or approaches that could potentially support QMRAs. A QMRA can be considered a microbial version of the existing protocols for assessing chemical risk: 1) problem formulation, including problem definition and data collection; 2) occurrence, fate, transport, and exposure assessment; 3) health effects assessment including dose-response relationships and health endpoints; and 4) risk characterization including sensitivity, variability, and uncertainty analyses, and evaluation of decision points. A major difference is that microbes are living organisms with in unique variability and uncertainty. A traditional QMRA characterizes the risk of illness associated with exposure based on pathogen densities determined through monitoring activities, or by modeling microbial release from sources of contamination and fate and transport to the receptor location. The risk of illness is estimated using pathogen doses and dose-response models. A QMRA can also be used in reverse to establish microbiological water quality guidelines and standards. The analysis step of a QMRA can be implemented via a computer-based data delivery and modeling system that integrates interdisciplinary, multiple media, exposure and effects models and databases. This source-to-outcome approach allows an expanded view of relevant cause-and-effect relationships, which facilitates consideration of management options related to source terms and their fate, transport, and effects pathways. Hence, a suite of integrated environmental modeling tools appropriately lend themselves to support QMRAs.

Topics include, but are not limited to:

- Software Tools relevant to QMRAs
- Microbial Agents and Vectors
- Microbial Source Tracking
- Fate and Transport Models
- Hazard Identification Models
- Exposure Assessment Models
- Dose-response Assessment Models
- Risk Characterization Models
- QMRA Data Requirements and Availability
- QMRA Case Studies
- Databases and Related Software Infrastructure Technologies
- Relationships between Rates and Equilibria of Microbial Processes and Environmental Conditions

Session H2: Water Resources Management and Planning – Modeling and Software for Improving Decisions and Engaging Stakeholders

<u>Organizers</u>: Julien Harou, Andrea Castelletti, Patrick Reed, Amaury Tilmant, David Rosenberg, and Joseph Kasprzyk

<u>Description</u>: Growing global water scarcity and expectations of effective stakeholder engagement continue to challenge analysts to create and use more sophisticated and appropriate tools. New strategies for developing and managing water resource systems at regional and national scales are required given population growth, economic development, growing environmental concern and the non-stationary of future hydrology and hydrologic extremes. Regionally-specific water management and planning issues almost invariably require customization of existing software tools, models and planning frameworks. In this session we look at a range of water management tools that have been customized for particular contexts. We focus on unique institutional, economic and political contexts, in addition to geographic or hydrological considerations. Hydro-economic models, trans-national resource modeling, planning under multiple sources of uncertainty including institutional uncertainty, integrated models that consider human or institutional agents, climate adaptations, land use and other changes will be covered in addition to a range of other topics. Presenters will emphasize what features of their tools, models and frameworks made them ideal to study a particular context. Are they flexible and adaptable, can such tools be ported and applied in a different context? Generally this session will seek to advance the tools, software and methods of advanced regional water resource planning and management.

Session H3: Agro-Ecosystem Modeling for Spatial Solutions to Watershed Conundrums

<u>Organizers</u>: Tim Green, Jim Ascough, Olaf David, Riccardo Rigon, Mark Walbridge

<u>Description</u>: As human population increases and global climate changes, we face challenges of conserving and managing water for agricultural, ecological and human demands. Agro-ecosystem hydrological modelling tools can address complex system interactions in space and time for different soils and climates. Impacts of variable land use and management may be assessed in terms of water quantity and quality at field to watershed scales.

This session invites papers on simulation tools for proposing and evaluating solutions to emerging problems in diverse agro-ecosystems over a broad range of scales. Spatially explicit models of bio-geo-physical interactions may simulate the hydrologic and agronomic responses from spatially distributed land use, management, and weather conditions. Existing and projected climates may drive agro-ecosystem responses, for which land management adaptation strategies can be developed over space and time. Specific topics may address, for example:

- Routing water and nutrients from field to watershed scales,
- Cropping system responses to water deficits,
- Plant responses to changing atmospheric CO_2 and climates,

- Agro-ecosystem responses to land-use/land cover change,
- Spatially focused conservation practices,
- Model and parameter uncertainty and scaling behaviors, and
- Model evaluation against long-term monitoring data.

Session H4: Modeling for Low Carbon Economies

Organizers: Alexey Voinov, Klaus Hasselmann, and Thomas Berger

Description: The science of complex systems distinguishes linear from non-linear dynamics. Simpler systems can often be satisfactory described by linear models, but complex systems require non-linear models that can capture more of the characteristics of such systems, such as thresholds, feedback loops, avalanche effects, and irreversibility. Linear systems can be validated by aligning models to the past and using the model to predict the future. Non-linear systems, however, are often time- asymmetric - they can be explained with the wisdom of hindsight, but are not always predictable.

Most current models of climate change and carbon emission assume the immediate past is a reasonable guide to the future. They struggle to represent the complex causal structures and time-asymmetries of many socio-natural systems. There is need to integrate the classic models of meso-scale processes with our best understanding of multi-scale space-time patterns and the transitions that are likely to occur between now and 2050.

The session invites presentation of modelling tools, decision-support systems and applications that strive to inform national and international policy and management communities working to make the transition to a low-carbon economy. In particular we will discuss:

- Linked models of climate and economics;
- Trans-disciplinary model integration, including integration between quantitative and qualitative (conceptual) models;
- Analysis of system shocks and transitions;
- Models of renewable energy (in particular bio-energy and bio-economy);
- Modeling climate adaptation and mitigation;
- Modeling human behavior and analysis of interaction between modeling results and human decision making.

Session H5: Systems Modeling and Climate Change: A Systematic Methodology for Disentangling Elements of Vulnerability, Adaptation and Adaptive Capacity

Organizers: Russell Richards, Oz Sahin, Marcello Sano, Brendan Mackey, and Flavio Augusto Pinto Siabatto

Description: A systems approach to modelling is suited to climate change assessments because it acknowledges the challenges in disentangling the impacts of, and responses to, climate- and non-climate-related drivers. This is supported by the growing realization that models developed and

used for local- and regional-scale climate change impact (and vulnerability) assessments must integrate key drivers, processes and responses that interact within, and have an influence on, the system that is being investigated. Furthermore, this integrative approach requires multidisciplinary and even trans-disciplinary input, which fosters collaboration between researchers, decision-makers and (other) stakeholders. For our session, we encourage papers that highlight the development and use of integrated models for exploring and evaluating climate change impacts, resilience and vulnerability and for identifying and elaborating management responses for adaptation and adaptive capacity enhancement. This includes case study demonstrations of using systems modelling approaches and conceptual papers introducing a new method/tool.

Session H6: Environmental Fluid Mechanics - Theoretical, Modeling and Experimental Approaches

Organizers: Carlo Gualtieri, Bert Blocken, Dragutin T.MIhailovic

Description: Environmental Fluid Mechanics (EFM) is the scientific study of transport, dispersion and transformation processes in natural fluid flows on our planet Earth, from the micro scale to the planetary scale. Stratification and turbulence are two essential ingredients of EFM. Stratification occurs when the density of the fluid varies spatially, as in a sea breeze where masses of warm and cold air lie next to each other or in an estuary where fresh river water flows over saline seawater. Turbulence is the term used to characterize the complex, seemingly random motions that continually result from instabilities in fluid flows. Turbulence is ubiquitous in natural fluid flows because of the large scales that these flows typically occupy. The processes studied by EFM are of paramount importance for the environmental quality of the natural air and water systems as well of the urban systems interacting with the hydrosphere and the atmosphere. For this session papers reporting observational, experimental, numerical and theoretical investigations would be welcome. So the Session will be organized in two parts: Theoretical and Numerical aspects (Part 1) and Applicative, Software and Experimental issues (Part 2).

This session could tentatively cover the following topics:

- Diffusion, turbulent dispersion and mixing of environmental contaminants in natural and engineered water systems and in the atmosphere
- Processes at the environmental interfaces in soil, atmosphere and natural waters
- Turbulent flows
- Building physics
- Nonlinear processes in environmental fluid mechanics
- Two-phase and multiphase flows
- Stratified flows
- Transport of water and chemicals in the soil
- Water quality processes in surface and sub-surface systems
- Air quality processes in urban environment

Session H8: New Challenges for Agricultural Systems Modeling and Software

<u>Organizers</u>: Ioannis N. Athanasiadis, Marcello Donatelli, Dean Holzworth, Cheryl Porter, Val Snow

<u>Description</u>: Global food security, climate change and extreme events are raising new challenges for modelling agricultural systems. Recent developments aim to improve both agricultural models and their software implementations that now need to facilitate massively parallyzable computations, inter-comparison in ensemble modelling, and integration into larger frameworks.

This session aims to gather methodological, technical and application contributions or overview papers suggesting a research agenda for the future. Contributions are sought from process-based modelling groups around the world, dealing with agricultural systems in its various aspects.

Workshop H1: Workshop on Spatially Explicit Land-Use Modeling

<u>Organizers</u>: Joerg A. Priess, Dagmar Haase, Christian Schweitzer, Steffen Lauf

<u>Description</u>: Among the multiple spatially explicit tools, which are currently applied to study land-use change, this workshop will highlight two current spatially explicit modeling approaches to discuss different options for assessing land-use dynamics in urban (H2DCA Household Decision Dynamics for Cellular Automata) and rural contexts (SITE modeling framework). We will present and discuss different methods to represent decision-making, and ways to analyze factors relevant for the allocation of land-use. We will also present and discuss forms to couple land-use models e.g. to improve the representation of decision-making or environmental processes in urban and rural systems (simulation of impacts & feedbacks), and the potential advantages and limitations related to model coupling.

The workshop organizers will provide the models together with a case study and respective training data sets to enable participants to run simulations. References are provided for workshop participants who are interested in model details and recent applications.

Workshop H2: Modeling Tools for Energy and the Environment

<u>Organizers</u>: David Koehler, David Solan, Randy Lee, Dan Ames,

<u>Description</u>: This workshop could host developers of environmental modeling tools, such as PVMapper:

Developing tools for siting utility-scale renewable energy projects is the forte of a team of professionals led by Dr. David Solan of the Center for Advanced Energy Studies (CAES) Energy Policy Institute (EPI). The Team, which includes engineers, software developers and researchers from Idaho National Laboratory (INL), Brigham Young University (BYU), Boise State University (BSU), Idaho State University (ISU), and University of Idaho (UofI), are currently engaged in the development of an open source GIS tool (PVMapper.org) for siting utility-scale solar energy sites. This application builds off expertise previously gained by the Team from development of the Line Siter Tool (a demonstration GIS tool for siting new power line routes) –http://linesiter.com and the Virtual Renewable Energy Prospector (an internet-based GIS tool for finding feasible potential renewable energy development sites) – http://gis-ext.inl.gov/VREP.

The PVMapper project is funded under the Department of Energy (DOE) Energy Efficiency and Renewable Energy's (EERE) SunShot Initiative. This open-source GIS siting tool is designed to allow utility-scale solar developers to compare multiple potential sites with a focus on reducing balance of system (BOS) soft costs. These soft costs include variables such as proximity to power infrastructure, endangered species habitat, and potential social implications (e.g., NIMBY, preference areas for development, etc.).

While PVMapper is designed specifically for utility-scale solar energy siting it has several inherent strengths which make it well suited for other renewable siting technologies, as well as nuclear or fossil-fuel electricity generation siting applications. First, it is flexible and expandable. The open-source framework that has been developed for PVMapper provides scalability by adding new modules (tools) and GIS data layers, both of which help to keep the application up-to-date and relevant after the development project has ended. Secondly, PVMapper includes a social risk component that integrates survey responses, customized to a specific technology, to develop GIS layers that indicate cost increases or developmental delays resulting from potential opposition from citizens and interest groups. Thirdly, and perhaps most importantly, the build-in scoreboard provides a multi-criteria comparison of development sites, including the ability for the end-user to alter weighting factors used to score each site. Finally, the reporting function provides background information, including metadata and calculations used, which are often critical for establishing trust and data for funding agencies, investors and other prospective end-users. Other potential uses of the platform from PVMapper: High-voltage powerline siting and planning, Wind Energy, Geothermal, Hydropower, Coupled Renewable Energy System, Nuclear Power, Natural Gas, Bio-Energy.