Second State-and-Transition Simulation Modeling Conference

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The U.S. Geological Survey (USGS) co-hosted the Second State-and-Transition Simulation Modeling (STSM) Conference, along with The Nature Conservancy, Apex Resource Management Solutions, and AIMS Environmental Science. The conference was held at the USGS Fort Collins Science Center on 16–18 September 2014. Participants came together to share applications and methods for simulating scenarios of environmental change over time and to discuss integrating STSM with climate and ecological models. Users of landscape STSM tools and software, including the most recent software platform, ST-Sim, as well as older software such as VDDT, TELSA, and the Path Landscape Model, were in attendance. The group represented more than 50 ecosystem, land change, reclamation, and conservation scientists from both the United States and Canada discussing recent STSM findings, techniques, and potential uses in landscape modeling. The event included a one-day training session on the use of ST-Sim, the latest generation of STSM freeware, followed by two days of presentations by scientists and land managers on current research applications.

This conference was only the second time STSM developers and users have gathered to share their collective knowledge of STSM capabilities and applications for natural resource management and landscape monitoring. Presentations highlighted the breadth of applications of the STSM framework, from local, to regional, to national extents. Topics included modeling land-use and land-cover change, forest and rangeland management, fuels planning, invasive plant management, wetlands management, climate change and habitat modeling, carbon modeling, ecological restoration and reclamation, and the management of wildlife habitat. Dr. Tom Loveland, director of the USGS Land Cover Institute, gave the keynote address, highlighting the evolution over time from land cover mapping to land change science. He stressed the importance of continuous earth observation monitoring for parameterizing models and defining plausible future land change scenarios and projections.

Oral presentations began with a discussion of the history and evolution of STSM modeling platforms, their theoretical underpinnings, how they diverge from stationary Markov chain models, and new

spatially explicit simulation capabilities and dynamics in ST-Sim. Subsequent talks focused on several overarching themes: (1) model parameterization techniques and tools; (2) historical reconstructions; and (3) scenario-based applications (i.e. climate, policy, mitigation, management scenarios). For model parameterization, talks ranged in focus from the variety of spatial imagery inputs available for use in ST-Sim, developing input data to spatially constrain landscape transitions over time, and downscaling of global gridded data sets for use in regional modeling applications. Presentations on historical reconstructions examined historic and projected carbon storage trends in the United States as well as the range of variability in fire-adapted ecosystems. Scenario-based research included future projections of landscape condition, habitat availability, and species presence under alternative climate and land use futures, to simulating landscape response given different management techniques for invasive species eradication and post-disturbance land reclamation.

The final hours of the conference were dedicated to an update on recent ST-Sim software development, and a group-wide discussion on top user-defined priorities for future software improvements. Major recent developments include new parallel processing capabilities, and the ability to initiate software processes from a Python or R command line. The current STSM modeling community yielded the following recommendations for continued development and growth of the ST-Sim modeling platform.

- Improved user forums to foster a stronger community practice
- Improved software documentation
- Ability to document source data directly within the model library
- Additional community commitment and related software tools to include validation of STSMs
- A library of STSM models that have been developed by users.

During the final discussion, it became clear that ST-Sim has become a "community" modeling software platform; that is, a platform whose development is driven by users. As such, many of the suggestions by the group aimed to improve usability. For example, it was widely agreed that ST-Sim models should be easily transferable and thoroughly documented (i.e., source data to software specifications). Improved visualization of state-and-transition diagrams was also requested, as these diagrams are most commonly used to facilitate stakeholder input in model parameterization and scenario development. Both users and developers agreed that future development of the ST-Sim software would be best suited for interfacing with external modeling frameworks and outputs, rather than directly incorporating features such as hydrologic modeling already available in other software.

More details on the meeting program can be found here: http://www.stsm2014.org/. Summary research articles will be published as conference proceedings in the forthcoming special issue of AIMS Environmental Science, an open access journal http://aimspress.com/aimses/ch/index.aspx. A follow-up STSM user conference is being planned for late fall of 2016.