

# Building a Sediment Experimentalist Network (SEN): sharing best practices for experimental methods and data management

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## INTRODUCTION

Laboratory experiments in geomorphology and sedimentology provide compelling visualizations and insight into processes that shape the landscape and generate stratigraphy. Taking water and sediment as the basic ingredients, experiments produce physical analogues to mountain, valley, river, delta, and submarine environments, offering rich information on the linkages between modern processes and the sedimentary record of Earth history (Paola et al., 2009). However, contemporary experiments produce large volumes of dark data in ad hoc formats (i.e., data that are not in digital format or not accessible from the internet). These data are therefore impractical to other Earth scientists who could reuse them and accelerate the pace of discovery. Because cross-disciplinary communication and collaboration are becoming critical for providing rich new research opportunities (e.g. Montanez and Issacson, 2013), we must find a community-scale solution for improving data preservation and re-use.

We describe a new effort to determine and address needs and promote consensus responses of scientists and educators in the Sedimentary Experiment community. The initiative will coordinate community discussion and activity to help facilitate best practices in experimental methods and in the storage, archiving, and dissemination of experimental data. This will result

in a more informed, capable, and efficient scientific enterprise. This article summarizes the motivation, current activities, implications, and avenues for broad participation of the group that is spearheading this effort, the Sediment Experimentalists Network (SEN).

## DATA RESCUE

Modern technology is changing rapidly and is constantly inundating our vocabulary with terms like big data, interoperability, the cloud, and altmetrics (alternative metrics for the impact of scholarly work, including tweets, blog mentions, bookmarks, shares, citations in Wikipedia, and so on). In parallel, evolving laboratory technologies allow larger amounts of data to be collected at ever faster rates. Resolution of digital photos, videos, and topographic scanning has been increasing rapidly. Just as LiDAR (Light Detection And Ranging) has expanded opportunities but generated new challenges for Digital Elevation Models, laboratory sensing technologies producing terabytes of data have inspired but overwhelmed Earth-surface experimentalists' capacities for scientific interpretation. Data from these laboratory experiments come from diverse sources including images, lasers, sonar and doppler acoustics, physical samples, and an innumerable array of unique devices. What portion of



*Figure 1: Community experiments at the 2013 Stratodynamics Workshop.*

these data will eventually make it to the public domain through publication or the internet? Currently, the answer is very little. Unanalyzed, hidden, or forgotten data are a wasted resource that have been paid for by hard-earned grants. Other potential data users, such as modelers and field scientists seeking calibration and validation for their work, are losing out on an opportunity to reuse knowledge.

Surface process laboratories pose unique challenges to data and tool sharing. Some larger laboratories have staff to help run experiments, but commonly single graduate students are in charge of the design, execution, and archiving of experiments and experimental data. In the best-case scenario, plans, tools, and data end up in a repository like the National Center for Earth Surface Dynamics Data

Repository (<http://repository.nced.umn.edu>), where metadata are logged and archived with the data. In a worst-case scenario, nothing more than a paper referencing a small subset of the total data collected is ever released to the public. Even well-documented datasets can be hard to compare and reuse. This has created a culture in which most studies use mostly new data (collected at great cost of time and money) and older data are rarely analyzed further. In order to improve this situation, change must start in the planning stages of the experimental process and in the training stages of new scientists.

Experimentalists acknowledge that the current situation is wasteful of time and knowledge. In two recent town hall gatherings at the AGU Fall Meeting, participants expressed basic questions

such as “Who can we consult for best practices?” and “Where is a centralized resource?” In response to these comments, in late 2011 the Sediment Experimentalists group initiated a contact list of interested investigators. We invited anyone who wanted to be part of a self-educating community of experimentalists. Our goal is to provide information about resources and current activities that advance experimental research and learning. One tool used to promote knowledge of ongoing experiments is the Sediment Experimentalists Fusion Table (address (<http://goo.gl/bi4ng>)). This has served as a quick and easy tool to share information about existing and in-progress experiments, including contact information and links to data.



Coincident with the formation of the Sediment Experimentalists, the NSF-spearheaded EarthCube initiative has been taking shape. EarthCube “aims to transform the conduct of research through the development of community-guided cyberinfrastructure to integrate information and data across the geosciences.” In mid 2012, EarthCube began funding a series of End-User Domain workshops in order to collect requirements from the scientific community to spread to the cyberinfrastructure community. With the support of EarthCube, an inaugural workshop with broad international participation was held on 11-12 December 2012 at the Morphodynamics Laboratory, University of Texas, Austin. The workshop brought together on-site and virtual participants with experimental, modeling, and field expertise in the disciplines of Earth-surface processes, geomorphology, and stratigraphy. The primary goals of the workshop were (1) to convene participants to consider grand challenges in morphodynamics, geomorphology, and stratigraphy that can be addressed using physical experiments; (2) to share current and potential advanced experimental

technologies to meet these challenges; (3) to generate, develop, and frame innovative ideas on community standards for data and metadata related to sediment experiments; and (4) to explore solutions to meet needs for data dissemination. Breakout group discussions addressed current and future needs for the community’s grand challenges. Such focused dialogue enhances the ability of our community to respond to current and future opportunities. International ties and future commitments were forged. A detailed report is available at <http://goo.gl/rwzmMr>.

The 2012 workshop included an experiment in the University of Texas Sediment Transport and Earth-surface Processes (STEP) basin. The participants communicated actively from the design stage of the experiment and showed the greatest interest in the effect of sediment supply changes on deltaic surface processes and stratigraphic development under back-tilting subsidence. The experiment was broadcast using webinar equipment and on-site and virtual participants interacted dynamically during the experimental runs. Data for the runs were posted at the Sediment Experimentalists Fusion Table

available to the public for further analysis projects. The workshop demonstrated the feasibility of collaborative experiments with multiple institutions addressing research questions together as a group.

A second workshop was held on 28-30 August 2013 at Nagasaki University, focusing on stratodynamics - a research framework for understanding sedimentary processes, geomorphology, and genetic stratigraphy using morphodynamics. The international workshop brought together participants for talks, poster sessions, discussion sessions, and community experiments. Four community experiments illustrated concepts from topics of active research (Figure 1). One experiment developed deltas over different bathymetry to examine shoreline response. A second demonstrated cyclic steps using a bimodal sediment source and high-density fluid flux. A third produced bedforms from density currents traveling from a less dense to a more dense layer. The fourth showed the reaction of a delta to a rising sea level. The community experiments served multiple roles - discussion and education for experimentalists and non-experimentalists, the chance for

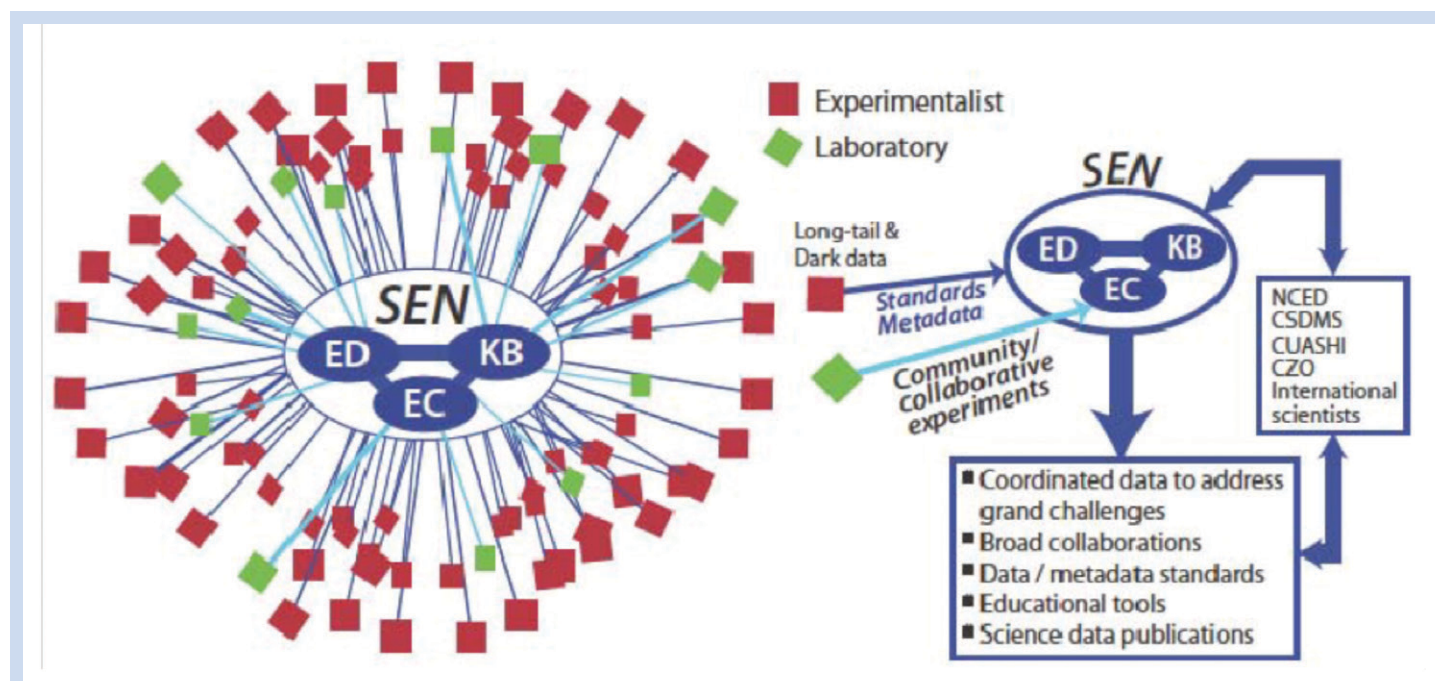


Figure 2: The main components of SEN and expected synergies.

participants to learn experimental methods by setting up the runs, and hands-on experience producing the type of data that SEN strives to document and preserve.

Discussions from the town halls and workshops emphasized commonly cited needs: There is no centralized place to deposit information and data. There are no widely-agreed upon standards or guidelines to facilitate interoperability and reuse. One participant suggested a phone hotline for data questions, and others expressed the need for a forum where cross-disciplinary discussions could occur. There is wide recognition that rebuilding of tools is a waste of time, but no one prioritizes proper data management in the heap of existing daily tasks. Although many of these needs are similar across different disciplines, the pathway toward meeting these needs may require specialized, though interoperable, disciplinary solutions.

## THE PATH FORWARD

Using feedback from the previous discussion, we have identified three areas for future activities of the Sediment Experimentalist network: (1) a Knowledge Base (SEN-KB), (2) Standards/Education (SEN-ED), and (3) Community Experiments (SEN-EC) (Figure 2). The Knowledge Base will provide a centralized place for people to post and request experimental data and

methods descriptions. The Standards and Education group will provide training, especially for early career scientists, in order to promote a culture of data sharing and data stewardship. The Community Experiments activities will offer a testbed for collaborative work involving data and tools sharing among many investigators spanning a range of career stages and geographic locations, including educators and international scientists.

Big data is already transforming many aspects of our society, from social networking to global business. Earth-surface scientists, whose resources are limited, cannot afford to be left behind in this wave of technological transformation. In an idealized future of seamlessly-networked geophysical data, it is not unreasonable to expect vast improvements in scientific productivity and application to resolving societal challenges. However, many obstacles lie in the path toward this ideal. These challenges are not just technical; they also require serious thought about such questions as how to provide proper attribution both for original creators and secondary users of experimental datasets. Our hope is that data and knowledge will be rescued from inaccessible dark data storage, and more frequent communication between investigators will accelerate learning and

production of results and analysis.

We welcome all comments and participation with the goal of properly representing the community that uses data from surface process experiments. Please join us by visiting <https://sites.google.com/site/sedimentexperimentalists/>.

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