

Professional Development for an Evolving Earth Science Workforce

Robert R. Downs and Robert S. Chen

rdowns@ciesin.columbia.edu, bchen@ciesin.columbia.edu

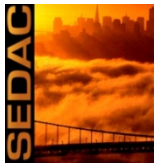
NASA Socioeconomic Data and Applications Center (SEDAC)
Center for International Earth Science Information Network
(CIESIN)
The Earth Institute, Columbia University

EARTHCUBE 2014 ALL HANDS MEETING
Washington, DC, 24-26 June 2014

EarthCube Community Workforce Development Panel Session
Wednesday 25 June 2014



Session Description

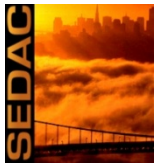


The EarthCube community is faced with various challenges, opportunities, and choices for enabling Earth science. *Technology is evolving rapidly and new tools and techniques are being created and enhanced* to enable community members to do more individually and collaboratively. *Workforce development opportunities can assist community members in their efforts to improve* their capabilities and knowledge. A panel will describe workforce development opportunities that are available for the Earth science community and engage in a discussion with the audience on how the EarthCube community can improve by leveraging these opportunities.

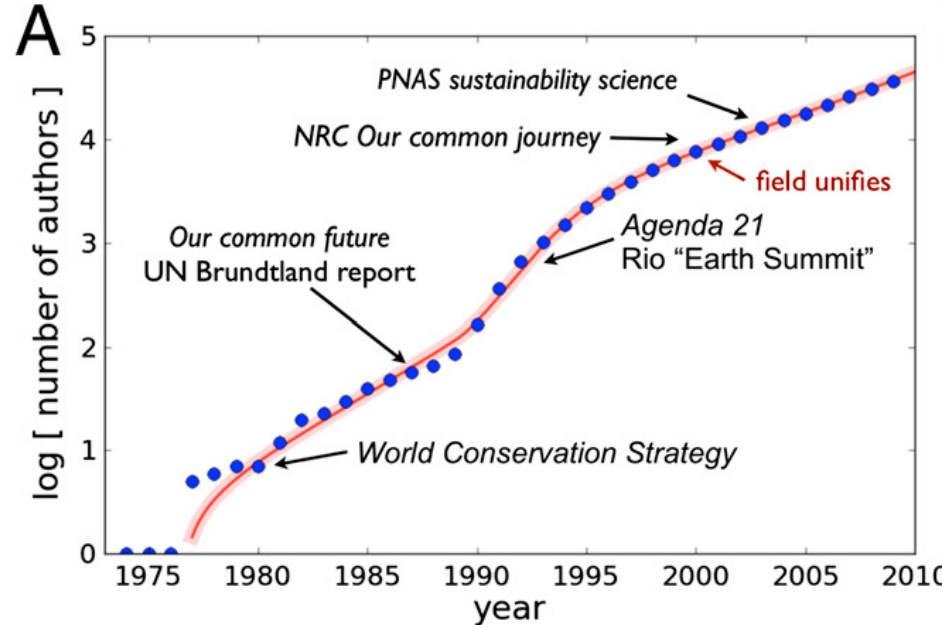


Characteristics of Sustainability Science

(Adapted from Downs and Chen 2013)



- Growing field of research
 - More than 37,000 distinct authors of more than 20,000 papers published 1974-2010 (Bettencourt & Kaur, 2011)
 - Doubling time of ~8 years
- Investigations of natural and social systems
 - Informing sustainability research and practice
- Interdisciplinary: natural, social, health, and engineering sciences
 - Collaboration by researchers from multiple fields
- Studies combine natural and social science data
 - Utilizing “big data” and “long-tail data”



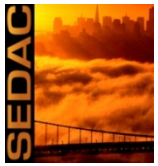
Bettencourt and Kaur, 2011, *PNAS* 108(49):19540-19545



Bettencourt and Kaur, 2011, *PNAS* 108(49): Supporting Information 1-5



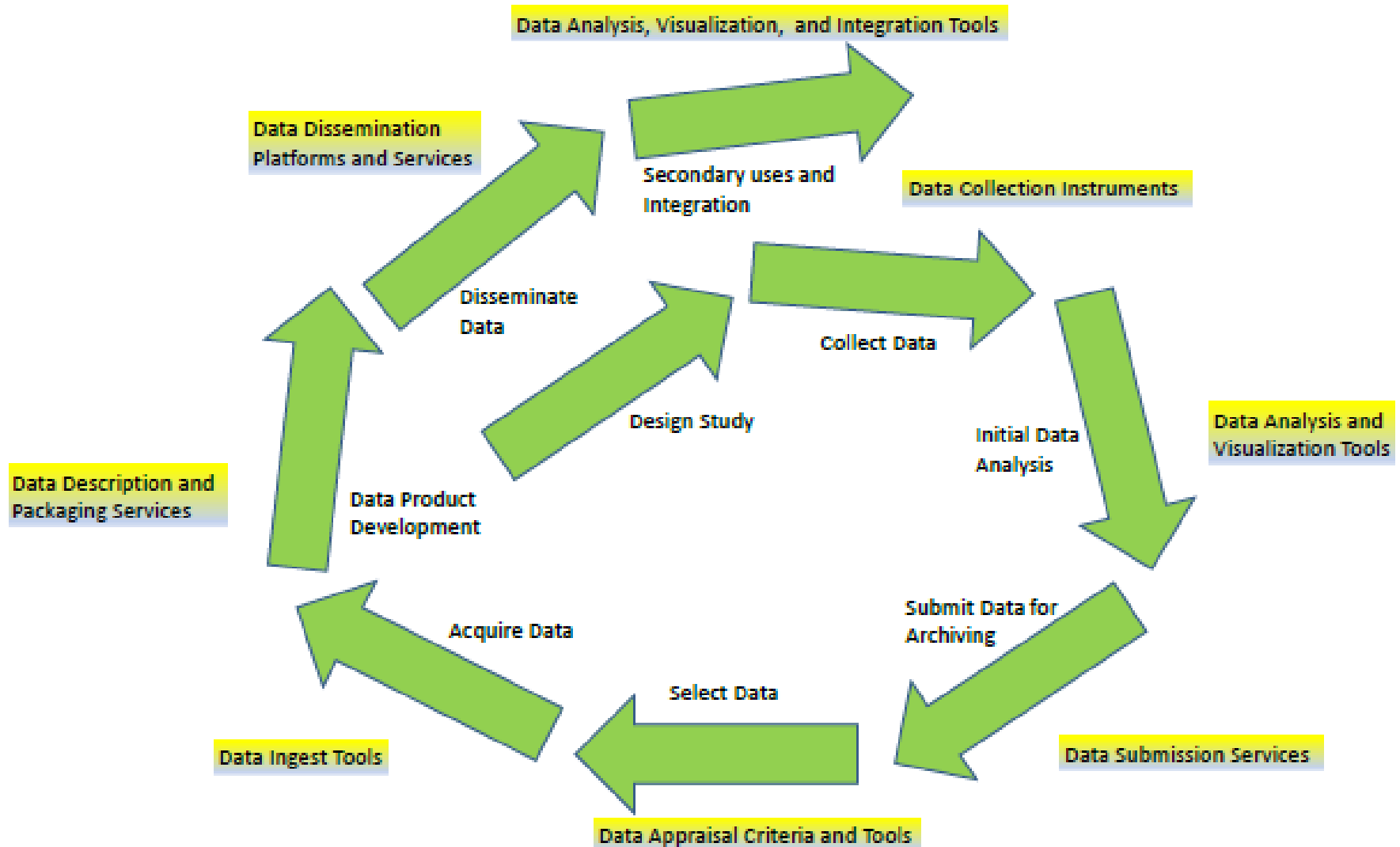
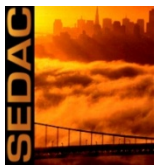
eScience Opportunities and Challenges



- Many projects developing eScience tools
 - New tools are applicable throughout data lifecycle
 - Open science promotes sharing of data and tools
- Data-driven science requires tools
 - Tools to reproduce results of previous studies
 - Tools to integrate multiple datasets
 - Tools to visually represent aspects of data
- Using new tools often requires new skills
 - Absence of documentation constrains tool usage
 - Instruction on tools can reduce learning curve

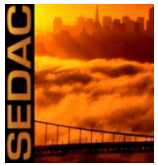


Tool Usage Opportunities in Data Lifecycle





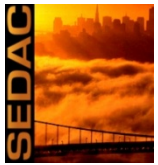
Reported EarthCube Workforce Development Needs



- Meetings of Young Researchers in Earth Science (MYRES) Needs:
 - "Many researchers were not trained to collect and report data in a format that would be usable for other researchers" (Hajeck, 2012: 2)
- EarthScope needs:
 - "main limitation is time to learn to use tools" . . . "virtual institute for community software" ... "Training and documentation for software and data centers" (Gurnis, 2012: 4)
- Stratigraphy Experimentalists Need:
 - "Need for expertise in data issues within our community -No expert resources to call on for guidance and assistance in management -Need training for data management for students, etc. from the beginning of the project -Many institutions do not offer IT support to investigators" (McElroy et al., 2012: 3)
- EarthCube Critical Zone Immediate Needs:
 - "Training and support to increase the overall computational and data handling skills of the CZ science community at all levels, from taking the first steps beyond spreadsheets to contributing to open-source scientific software projects" (Aufdenkampe, 2013: 4)



Reported EarthCube Workforce Development Needs (continued)



- EarthCube Sedimentary Geology Workshop participants identified challenges
 - “Lack of training needed to use cyber resources” (Chan and Budd, 2013: 4)
 - Training modules for database creation and entry, search tools, analysis and visualization” (Chan and Budd, 2013: 5)
- EarthCube workshop for Biogeochemistry and Fluvial Sedimentology Communities identified need
 - “Online training webinars” (Kettner et al., 2013: 5)
- EarthCube Modeling workshop participants need:
 - “It is critical that there be training and workforce development in support of modeling” (Arrigo et al., 2013: 2).
- EarthCube Sedimentary Geology Needs
 - “training on data curation, data management, and policy issues; innovative educational programs that merge computer science and geoscience” (Ramdeen, 2013)

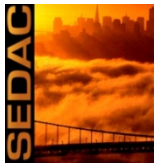


EarthCube Capability Needs: End-User Workshops





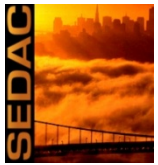
Workforce Development is Essential to EarthCube's Success



- Established scientists are generally too busy to go back for formal educational programs; need flexible, efficient modules that can be fit into available time
- Acceleration of change in science, data, and tools suggests the need for lifelong training and education opportunities
- As new tools proliferate, important to promote interoperability, coordination, and consistency in access, training, and support to improve user learning
- New tools and initiatives, especially those based on community or open source approaches, need a critical mass of users to survive and therefore need to support training of new users and the development of advanced users



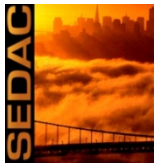
Workforce Development Recommendations for the EarthCube Community



- Enable professional development when needed most
 - Develop free online workforce development resources for use by the Earth science community
 - Provide on-demand just-in-time learning modules that can be completed by learners in an efficient manner
 - Link learning resources to software, tools, and applications
- Life-long learning will be needed to actively contribute to Earth science infrastructure efforts
 - Promote the availability of free workforce development resources for Earth science
 - Develop sequential open courses to establish “learning paths” for Earth science community members
 - Create an inventory of learning resources to foster discovery and use
 - New challenges require new opportunities to learn



References



- Arrigo J, Brown J, Kellogg L, Hwant L, Peckham S, Tarboton D. 2013. Executive Summary: EarthCube Workshop Results, EarthCube Modeling Workshop for the Geosciences, Boulder, CO, April 22-23, 2013. <http://earthcube.org/page/end-user-workshops>
- Aufdenkampe AK, Duffy CJ, Tucker GE. 2013. Executive Summary: EarthCube Workshop Results. Engaging the Critical Zone Community to Bridge long Tail Science with Big Data. University of Delaware, January 21-23, 2013. <http://earthcube.org/page/end-user-workshops>
- Chan M, Budd DA. 2013. Executive Summary: EarthCube Sedimentary Geology Workshop. University of Utah, March 25-26, 2013. <http://earthcube.org/page/end-user-workshops>
- Downs RR, Chen RS. 2013 Sustainable Science Needs Sustainable Data. 2013 Fall AGU Meeting. IN11D. San Francisco, CA, December 9, 2013
- Gurnis, M. 2012. Executive Summary: EarthCube Workshop Results. EarthCube End-User Domain Workshop for EarthScope. Arizona State University, Tempe, AZ, October 29-30, 2012. <http://earthcube.org/page/end-user-workshops>
- Hajek, E. 2012. Executive Summary: Workshop Results. Meetings of Young Researchers in Earth Science (MYRES) V: The Sedimentary Record of Landscape Dynamics. Salt Lake City, UT, August 8, 2012. <http://earthcube.org/page/end-user-workshops>
- Kettner A, Aufdenkampe AK, Carey A, Gomez B, Guo L, Johnson S, Peucker-Ehrenbrink B. 2013. Integrating Inland Waters, Geochemistry, Biogeochemistry, and Fluvial Sedimentology Communities. Executive Summary: EarthCube Workshop Results. April 24-26, 2013. Boulder, Colorado <http://earthcube.org/page/end-user-workshops>
- McElroy B, Hsu L, Kim W, Martin R, 2012. Executive Summary: EarthCube Workshop Results. Calling All Experimentalists- Experimental Stratigraphy. University of Texas at Austin, December 11-12, 2012. <http://earthcube.org/page/end-user-workshops>
- Ramdeen S. 2013. Developing Cyberinfrastructure for Earth Science: an Opportunity for Collaboration. Dlib Magazine, 19(5), 6. DOI: 10.1045/may2013-ramdeen