Big Data Are All the Rage—For Mountains, Too

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Big data. For some, it is a vaguely apocalyptic term; for others, it represents a new era of understanding our environment and ourselves. Today, big data are being harnessed in ever more innovative ways that simply were not possible when we only had small sets of data to work with. Although mountain system research does not yet produce the vast quantities of data that are now common to other fields, there are nevertheless many data that, if pooled, could provide new insights into how mountain socioecological systems function. As the Mountain Research Initiative's Concerted Efforts progress, it becomes clear that it is time for the mountain research community to harness the lessons and power of at least "medium data" to develop a stronger, evidence-based understanding of both the generalities and the specificities of mountain systems.

Creating big data from mountain observations

The growing recognition of the power of data is probably partially responsible for the traction that the Mountain Research Initiative's (MRI's) Concerted Effort on Mountain Observatories (Greenwood 2013) has gained over the past year. MRI's campaign to mobilize a network of mountain observatories is based on the premise that, while a more comprehensive international system of mountain observatories is needed, there is no single entity with the authority to organize it or the budget to fund it (Greenwood 2013). The best way to mobilize a global observation network is to piece one together from the many existing but disparate observation efforts. By linking environmental and socioeconomic observations across whole regions, we can start using data to make evidence-based comparisons, inform decisions, and shape policies. More data do not just let us see more, they allow us to see in a new, better, and different way (Cukier 2014).

In July 2014, more than 175 researchers working with existing observation sites met in Reno, NV, USA, for "Mountain Observatories: A Global Fair and Workshop on Socio-ecological Systems" to exchange ideas, identify priority topics and sites, and develop common programs. Experts identified a core set of indicators and the challenges of monitoring them. A key conclusion of the conference was that understanding the history of a system and its connections across spatial scales is extremely useful for understanding the operation of the system as shown by monitoring data. In addition, we need to find ways to juxtapose quantitative and qualitative data such that qualitative information (eg the history of a place) informs our interpretation of current quantitative data. Similarly, a more effective integration of remotely sensed data, ground measurements (Figure 1), and spatial models is needed to ensure that highly precise but spatially limited site data can be placed in a broader spatial context.

To read more about the outcomes of this conference, visit www.mountainobservatories.net/ or watch conference talks at https://cast.switch.ch/vod/channels/1lf4ova8qa.

Although the mountain research community is far from assembling the sort of big data sets NASA works with, we are nevertheless entering an era of at least medium-sized data. The mountain research community now needs to identify what has already been done, focus on and enumerate variables, and develop references and protocols or pool existing protocols (eg climate data standards from World Meteorological Organization) in one place. Over the next year, MRI will invite a set of mountain observing sites to constitute the core of a global observation network. These core sites will provide a real-world framework by which to establish protocols and standards for global observations, introduce novel data collection methods, and pioneer new ways to integrate qualitative and quantitative data from a wide range of disciplines.

Elevation-dependent warming

Although it is well known that global warming is more pronounced at high northern latitudes, there is some evidence that warming is also amplified by elevation. The question of where and why global warming is occurring at a faster rate at high elevations is at the heart of MRI's second Concerted Effort, Elevation-Dependent Warming (EDW). Considerable scientific theory exists about EDW, but mixed observational evidence makes it difficult to know if this is a global phenomenon. If it is, we may be strongly underestimating the magnitude of impacts, particularly with regard to the water cycle.

From 22 to 25 April 2014, a group of 16 MRI experts met in Payerbach, Austria, to review the evidence related to accelerated climate warming at high elevations and to design a campaign to assess if, where, to what extent, and why mountains and other high-elevation regions are warming more rapidly than other portions of the planet. A large part of the workshop was dedicated to identifying the mechanisms that could produce EDW, such as changes in albedo and condensation levels, as well as changes in the energy balance due to changes in water vapor, incoming and outgoing radiation, and aerosols. The group also spent a good deal of time discussing what needs to be done to increase our confidence in information about the location and magnitude of EDW. Improving existing data sets, bringing in new data sets, and linking station data with remote-sensing data

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FIGURE 1 One of four flux towers installed at different altitudes between 405 and 2700 m by the Southern Sierra Critical Zone Observatory, California, USA. Instruments collect information about climate and fluxes of carbon dioxide and water vapor with the objective of gaining new knowledge on how water, soils, and climate interact. (Photo by Claudia Drexler)

will be key to answering the EDW question. The next step of the EDW campaign will be to identify a project or projects that implement the lines of research outlined by experts at Payerbach.

EDW takes a very different approach to the subject of observations. In contrast to the bottom-up approach of Mountain Observatories, which integrates existing data and asks what insights the sum of these data supports, EDW takes an intellectually top-down approach centered on a single question: "What other sort of observational network do we need to be able to answer this question?" For more information about the campaign, visit http://mri.scnatweb.ch/en/projects/global-campaign-to-understanding-elevation-dependent-warming.

It's all about the data

The MRI's other two Concerted Efforts, Agency and Governance and Assessing Sustainable Mountain Development, are also strongly data-driven and closely linked with the concept of developing global observation data sets. The Agency and Governance campaign has focused on stimulating a conversation (without dictating the form or structure) between diverse social science disciplines about the interplay between human agency (an acting force) and governance (a constraining structure) in mountain regions.

During the 2014 "Global Fair and Workshop" in Reno, it was clear that while there are many different theoretical approaches to understanding socioecological systems, data are central to all of them. To address agency and governance, we need information about both the observable behavior and institutions and the unobservable but certainly reportable interior states that underlie behavior. Answering this question will require the collaboration of a diverse range of social science disciplines, from anthropologists and sociologists to political scientists and legal scholars. At the "Global Fair and Workshop," it was clear that data form the basis of a discourse linking all these disciplines.

MRI's fourth Concerted Effort, Assessing Sustainable Mountain Development, was conceived around the idea that good policy is based on evidence—which again means data. Sustainability encompasses measures of environmental, economic, and social capital. To assess sustainable mountain development, it is necessary to define the dimensions of each of these types of capital and the space that these dimensions create, as well as the surface that conceptually separates that space into sustainable and unsustainable domains. The definition of these spaces and the surface that bisects them depend on data and their trends over time, not rhetorical arguments. Thus, the assessment of sustainable mountain development will depend on yet

FIGURE 2 Photos can be an important source of knowledge about the dynamics of socioecological systems in mountains. A forest ecologist from Ecuador documents the scattered flora on Mount Rose (NV), USA, in July 2014. (Photo by Claudia Drexler)

more data, much of which will probably also be common to the other three Concerted Efforts.

Assembling and homogenizing existing, disparate data sets into a global set of observations will certainly provide new insights into how mountain socioecological systems function, how climate warming affects high-elevation environments, and how mountain communities exercise agency and via what forms of governance. However, none of these questions are just about what variables to measure. As the mountain community embraces the era of medium-sized data, it will be necessary to identify new ways to ensure data quality, manage global data sets, and create repositories that are accessible and that allow researchers to understand global change in mountains in new and better ways.

As a parting thought, consider that our world is now rich in data-collecting devices, from satellites to cell phones. The mountains are crawling with people armed with GPS-tracking, photo-taking, instant-uploading cell phones and digital cameras (Figure 2)—what sort of information might they provide that could really change our understanding of mountain systems?

MRI

The Mountain Research Initiative is an international networking project for global change research in mountain regions that has worked assiduously for more than 10 years to develop a community of researchers and to synthesize and publicize knowledge about global change in mountain regions. It is funded by the Swiss National Science Foundation and was founded under the auspices of the International Geosphere–Biosphere Project, the International Human Dimensions Projects, and the Global Terrestrial Observing System.

REFERENCES

Cukier K. 2014. Big data is better data [video]. www.ted.com/talks/kenneth_cukier_big_data_is_better_data?language=en; accessed in November 2014.

Greenwood G. 2013. Mountain Research Initiative seeks to break new ground in second decade. *Mountain Research and Development* 33(4):473–476. http://dx.doi.org/10.1659/MRD-JOURNAL-D-13-00094.1.

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