

CZO NO Major activities 2015-16

In Year 2 of the NO project we focused on building the structures necessary to promote communication and collaboration across the CZO network. There have been some excellent examples of collaboration across the network, but the systems for promoting and communicating these collaborations had previously been largely *ad hoc* in nature. As the CZO network has grown, and CZO scientists and staff increasingly focus on issues that involve significant parts or all of the network, there is a growing need for structures that can facilitate efficient and focused communication and collaborative work.

During the first part of Year 2 we found ourselves spending substantial time dealing with the fallout from what we consider to have been a deeply flawed Panel review. In the wake of that process it was not clear that we wanted to or even could continue to operate the NO. Fortunately we and the new NSF PO saw a way forward, and we were able to get back to focusing on what we consider to be the important issues for the NO and the CZO network.

Summary of organizational efforts in Year 2

Expanded role for the NEC

The CZO PIs continue virtual meetings on a monthly basis, but the size of the group (there may be 10 to 15 persons on line for these meetings) implies that this is not the forum for quick decisions on organizational matters. Toward the end of Year 1 we established a Network Executive Committee (NEC), consisting of the current PI Chair (Brantley) and chair-elect (McDowell), the Chair of the Steering Committee (Grant), the CZO-NO Director (Derry) and the CZO-NO Program Coordinator (White). This group has regular meetings and has been able to streamline communication with NSF, the Steering Committee, and the large PI group, as well as efficiently make decisions on a range of issues (for example; meeting scheduling, follow up on Strategic Plan, data management steps). For example, during Spring 2015 the NEC quickly commented on and revised the agenda for the IML meeting, based in part on protracted discussions during PI teleconferences. In Summer 2015 the NEC was able to efficiently advance the notion of a strategic planning meeting, and advanced a new strategy and schedule for annual meetings. NEC conversations and decisions during Spring 2016 have focused on how to resolve data management issues, and advancing and implementing actions from the strategic plan. The NEC has played an increasingly important role in acting as a clearing house and decision making body. This has increased the efficiency of our PI meetings as they are less cluttered and we can focus the larger group on a smaller set of issues.

Integration of Education and Outreach efforts across the CZOs

In Year 2 we recognized at least two areas where there were significant ongoing efforts at individual CZOs but low levels of communication between the CZOs. Each CZO has an education and outreach program (E&O), as does the NO. We established an E&O working group, led by the NO and with representation from all nine CZOs. This group has several goals. First, is to improve communication and sharing of ideas, methods and resources among the

E&O teams across the CZO network. Second, is to develop a catalog of CZO-related education and outreach activities to be made available to anyone, inside the CZO program or elsewhere. Third, is to build a CZO E&O community that can support network-wide activities and possibly seek additional external funding to that end.

Integration of data managers and data management strategies across the CZOs

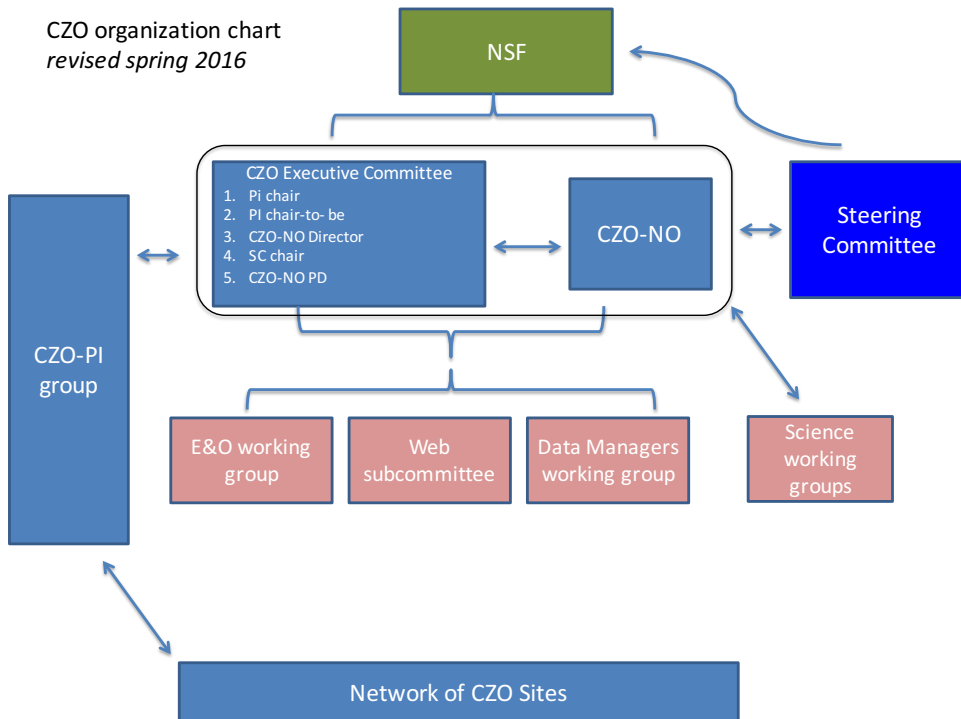
An ongoing challenge to the CZO program and to CZ science more broadly is the need to establish a functioning data system that can handle the diverse and complex data sets currently being produced by the CZOs. While CZO data management is not one of the charges to the NO, we felt strongly that effective communication from the NSF-funded CZOData project to the CZO PIs and their on-site data managers and potential users had partly broken down. We have spent a lot of time trying to address this issue, as we see it as very important for the long-term goals of the CZO program. As can be the case in these situations there was somewhat of a disconnect between the goals of the software developers and the needs and aspirations of the user community, i.e. the CZO data managers and scientists. We arranged some additional meetings and a webinar in fall 2015. Beyond that, we established a working group of the CZO data managers, who are now holding regular virtual meetings. The goals for this group include:

- Sharing information on how to implement some of the new data tools that have been made available.
- Supporting the development of common data structures that will enable integration of data across the CZO network.
- Providing guidance and feedback to future efforts to develop a CZO-wide data system.

Establish standing committee for website oversight and feedback

The growing importance and complexity of tasks associated with criticalzone.org and its interactions with other sites (the individual CZO sites, czen.org, other networks and resources) led us to establish a web committee.

New organizational chart for CZO program



Development of a Strategic Plan for the CZO Network

The CZO program was initially developed as a set of sites each funded with specific scientific goals and hypotheses to test. As the program became established and grew, there has been increasing emphasis on the potential for scientific advances by combining data, observations, ideas, models and hypotheses across the CZO network. There is considerable interest among members of the CZO community in pursuing the power of the CZO network to develop and test new science questions, as evidenced by the cross-site science working groups that were first established in Year 1 of the NO. However, since the CZO program was first established in 2007 there has not been an organized attempt at developing an overall vision for how the CZOs can work together to produce new science that takes advantage of the network of people, ideas, tools and sites.

In order to address this issue, the NO initiated a CZO Strategic Planning process in fall 2015 that culminated in a three day workshop in Boulder, CO in February 2016. The meeting was attended by representatives from all the CZOs as well as the NO, and produced a Strategic Plan that has two components. The first is a Vision for Critical Zone Science in 2026, a set of aspirational goals that the CZO leaders believe are scientifically exciting and challenging but also achievable within a decade. It is also intended in part as a first step in discussions of how CZ science in the U.S. should develop after the current round of funding for the CZO program ends in 2018.

The second component is a more detailed Strategic Implementation Plan for network activities that the CZOs will undertake between now and 2018. This is the first time in its nine years of existence that the CZO program has formally engaged the CZO PIs and senior scientists

to develop a clearly articulated plan for the CZO network. It lays out goals, desired results, and strategies for reaching those goals. Among the strategies is a plan to hold a community wide CZ science meeting in 2017 with broad participation from U.S. and international scientists working on the Critical Zone. A major goal of that meeting will be to produce a white paper that lays out a vision and strategy for the next phase of CZ science in the U.S. We have begun planning for that meeting.

Standing goals of the CZO-NO

Maintaining and enhancing communication

An important set of tasks for the CZO-NO is to promote communication between the diverse members and groups of the CZO community. One way the NO addresses that is to organize virtual and face-to-face meetings within the CZO network and with broader CZ community. To this end we have organized over 60 formal interactions across the CZO program in the last year (listed below).

Virtual meetings – held via teleconference or using Zoom meeting software

CZO PI committee: 11
CZO-NO planning: 21
CZO website: 4
CZOData: 6
InTeGrate: 2
Education and Outreach: 3
Network Executive Committee: 7
Steering Committee: 1
Graduate Research Group (GRG): 3

Physical meetings

AGU Town Hall	12/15/2015
AGU GRG	12/14/2015
AGU Annual Breakfast meeting	12/16/2015
CZO Strategic Planning meeting	2/3 to 2/5/2016
CZO-NO team meeting	3/20/2016
REU/RET coordination	2 meetings
CZO Annual PI meeting	scheduled for 9/17/2016
AGUSoils/CZ technical committee breakfast	
AGU Soil Organic Matter meeting	12/15/2016

Network level science activities

The cross site science working groups that were initiated in Year 1 of the NO award continue to be active. For example, papers are currently being submitted to a special issue of Water Resources Research from the Concentration-Discharge (C-Q) group, with a deadline of June 1 2016.

Two different CZO groups submitted proposal to the USGS Powell Center. One of those, titled "*Interconnections Between Hydrologic and Ecologic Resilience*" was successful, and is now receiving USGS Powell Center support (Harpold - UNLV and Sullivan - Kansas are proponents from the CZO program. Burns and Clow are proponents from the USGS). This effort grew directly out of a Cross Site Science Working Group on "Critical Zone Resiliency" funded by the NO SAVI project in 2015.

As discussed above, one of our major initiatives this year was the effort to develop a Strategic Plan for the CZO program. The PI group had a number of discussions leading up to the meeting, but these were mostly focused on process. The final meeting was held in Boulder, CO Feb 2-5 2016, with eighteen CZO participants. Unfortunately, two members of our CZO team had to cancel at the last minute due to illness. We engaged a professional consultant and facilitator, Cindy Zook & Associates. Cindy Zook and her assistant were uniformly described as very effective by the meeting participants, and there was general consensus that we could not have achieved what we did without them. The meeting began with an extended session gathering ideas from around the room. We then winnowed these, and found areas of substantial agreement. Zook prepared a draft plan for the next morning, at which point there was extended discussion of priorities and specific steps necessary to reach the identified goals. By Friday morning (Day 3) we had a solid draft, and we began to strategize about specific cross CZO projects that could be completed within the next 2.5 years. The meeting was hard work but in our view it was highly productive. The completed document, "A Strategy for Advancing Critical Zone Science", is attached to this report.

The Strategic Plan is not intended to be a detailed guide for CZO activities. Rather, it is intended to prioritize and outline steps for the CZO program that can achieve a greater level of integration among the CZOs and focus the resources of the CZOs on network level science, education and outreach. Essentially we address the questions "How can the whole of the CZO program be greater than the sum of its parts?"

CZO-NO staffing changes

In October 2015 we added *Dr. Justin Richardson* as the CZO-NO postdoc. Justin received a Ph.D. from Dartmouth College in summer 2015. He has been working on network-level science questions, in particular developing new tracers for aluminum in the Critical Zone. He will be using multiple CZO sites to test the use of gallium-aluminum ratios as a tracer for aluminum mass balances and transport mechanisms. Justin is also heavily engaged in Education and Outreach activities for the CZO-NO, described in more detail below.

Sarah Sharkey is a staff member supporting both the CZO-NO and SAVI projects, and is working on social media as well as general administrative support.

Education and outreach

In year 2 the National Office has focused upon development of a cohesive CZO E&O network, to facilitate communication among CZO E&O personnel and to increase our collective impact. This has included compiling a list of individuals, contact information, and information about E&O representatives at each site. The National Office E&O staff, including Duggan-Haas and Ross, Richardson, Lubinski, and Sharkey, have worked together to facilitate communication among CZO E&O members. We have hosted several virtual meetings and on CZO E&O at which E&O individuals have met each other and expressed common needs and interests. This is the foundation for creating new activities that CZO E&O staff create together, such as hosting workshops, compiling information across CZOs, and writing about CZO science and E&O resources.

The NO led the development of a new Education and Outreach (E&O) working group involving E&O coordinators from all nine CZOs and the NO. We initiated development of a CZO E&O database of activities and products that will be hosted on criticalzone.org to improve accessibility and dissemination. This effort is loosely modeled after the [Digital Library for Earth Science Education](http://www.dlese.gov) (DLESE) database of Earth Science educational activities and resources. The CZO database is now linked to DLESE. One of the first steps was to tabulate a list of available resources across the CZOs, something that was not previously available. A pdf version of that list is attached to this report. We are working on expanding this list, while continuing to make all materials available on criticazone.org and via DLESE. The E&O group has been meeting regularly and communicating using Basecamp Project management software, set up by the NO webmaster.

Compiling and analyzing activities at individual CZOs

We have begun compiling data on the amount and types of activities occurring in the individual CZOs (see attached Table). Taken together, CZOs reach nearly all standard education demographic groups, for example, K-12, college, general public, and teachers, and reach a wide variety of sociocultural groups depending on location. The foci of outreach each site varies substantially. Particular strengths of the group appear to be working with teachers and creating resources for them. Attached is a table of resources thus far self-reported by the CZO sites, which includes 19 resources appropriate to secondary school students, some of which can be used at lower or higher grade levels. Many of the sites are doing some form of teacher professional development. For example, among the four sites that reported teacher outreach data (not including the National Office), the number of teachers reached in the past year was over 200 (150 of which were at Southern Sierra CZO). The impact of reaching teachers is high because in principle each teacher reaches between about 20 and 100 students per year, depending on their position, thus conservatively these programs influenced several thousand students in the past year. The Southern Sierra programming reached a variety of teachers, for example an AP Biology class and an Engineering-in-the-Classroom Summer Institute. Like all educational outreach, some of this teacher professional development is designed to reach a large number of individuals briefly and some is designed to reach a relatively small number much more intensively; in the future the National Office will introduce the idea of recording

contact hours (number of individuals x duration of contact) as means to compare across these different strategies.

From the data currently available, the amount of direct interaction of CZO outreach providers and K-12 students is somewhat less, but all varies widely, e.g., about 60 at Susquehanna Shale Hills CZO to 600 at Southern Sierra CZO, to much larger numbers if one takes into account Boulder's relationship to CU Science Discovery. An especially strong component of CZO outreach to K-12 to help students participate in authentic research, for example, Luquillo CZO's "Data Jam" activity that prepares teachers to support students in using long-term CZO data to conduct their own inquiry investigations and the SSCZO semester-long mentorship program with high school students from The Center for Advanced Research & Technology (CART), in which students complete a research project with specialists serving as project mentors/advisors.

Education of undergraduate students is a natural strength for CZOs. Though undergraduates are not always considered a part of "educational outreach," there is often a fuzzy boundary between what constitutes public outreach and what is considered college preparation of the next generation of scientists, especially with respect to resources that can be adapted to a variety of audiences. Thus far those CZOs reporting on quantity of college students have reported a total of 263 in the past year, in contexts ranging from a CZO course to individual guest lectures on critical zone science.

Public outreach varies especially widely among the CZO sites, depending partly on relationships with informal science education venues and parks and on effort expended on digital/social media. Direct interaction with the public among the CZOs, from existing data, is relatively small (hundreds to a few thousand), but some sites such as Southern Sierra report news interviews, social media, and news articles that potentially reach very large audiences (mostly unquantified). Sites such as Boulder and Calhoun have created short videos that have excellent potential as the foundation for a cross-CZO compilation that can be added to platforms such as PBS LearningMedia (described further below).

Cross CZO activities

Social media

Blogs: interested lay public, with broad K-16 application

A new series entitled "Adventures in the Critical Zone" has been created and is hosted on the CriticalZone.org website. The goal of the blog entries is to take complex questions and techniques and 'deconstruct' them to be understandable, entertaining, and informative for general readers. We utilize art from a professional cartoonist and journalist, Eleri Mai Harris M.F.A. (<https://elerimai.com/>), to be appealing visually for the lay audience.

Blog entries thus far are:

1. [Welcome to a New Adventure](#)

2. [Why do soils look different?](#)
3. [Salmonids in Northern California Rivers, to be or not to be?](#)
4. [How deep can water enter bedrock?](#)
5. [Where do trees get their water?](#)
6. [How does fire change a forest?](#)

Approaches to reaching young K-12 audiences

A series of illustrated infographics about each CZO are being developed for younger audiences. Each piece will be a full color illustrated history and introduction to the science investigated at each Critical Zone Observatory. These illustrated works will appear similar to a comic book but will convey the geologic, anthropogenic, and ecosystem present at each CZO. Justin Richardson is working with the Principal Investigators at each CZO to create the story line that is being illustrated by Alana McGillis from the Paleontological Research Institution's Cayuga Nature Center. The first issue of the series will focus on the Calhoun CZO and will be finished by May 13th, 2016. The story covers the history of Calhoun as a slave-owning cotton plantation, its massive erosion problems, its rebirth as a research site, and current research efforts and findings.

Reaching teachers and the public through collaboration with PBS

We are exploring a potential partnership with a local PBS station (WSKG in Binghamton, NY) to create CZO STEM content – videos, background content, and curricula -- that would be made available to PBS LearningMedia (<http://www.pbslearningmedia.org/>). PBS LearningMedia is a set of digital media used extensively by educators nationally (and internationally) and thus provides an existing network to reach tens of thousands of teachers. The videos are also posted to YouTube, where they may be seen by the general public, and may be used as short time filling segments by PBS stations. We have discussed creating several short videos (3-5 minutes) and associated written resources with Shale Hills CZO, created collaboratively by the National Office personnel and WSKG film producers, which would cost about \$12,000. We would use these examples to fundraise for additional videos at other CZOs, including a proposal to the NSF AISL program, due in November 2016. Other related opportunities may also transpire, such as a full length CZO documentary.

Virtual Fieldwork Experiences

Virtual Fieldwork Experiences (VFEs) are multimedia representations of field sites designed to promote meaningful, inquiry-based exploration; where learning is guided by asking the question, "Why does this place look the way it does?" Duggan-Haas and Ross, the E&O coordinators, are national leaders in the development of VFEs and of tools and strategies that facilitate their creation and use. VFEs may stand in the place of actual fieldwork, but the approach used here intentionally frames VFEs also as a catalyst for actual fieldwork. VFEs serve as models for framing and executing fieldwork and for sharing what is learned in fieldwork with others. VFEs have been developed for both Southern Sierra and Shale Hills. See: <http://virtualfieldwork.org/CZO-VFE-Intro.html>.

K-12 Teacher professional development: Critical Zone Observatory Network REU/RET Program

The Shale Hills CZO and Stroud Water Research Center jointly host a Research Experience for Teachers (RET)/Research Experience for Undergraduates (REU) supported by NSF. Tim White lead an orientation in June 2015 that with Don Duggan-Haas brought Virtual Fieldwork Experience (VFE) development to the program. The participating teachers developed a Virtual Fieldwork Experience VFEs for the site, incorporating their own research and research done by the REU students. The teachers also worked with Don and Tim to lead a half-day workshop for teachers from the region in early August 2015 at Penn State's Shaver's Creek Nature Center, which is adjacent to the Shale Hills CZO. The RET program, with its development of a VFE and the execution of RET participants leading workshops for other teachers is intended to serve as a model for the other eight CZOs around the country.

Integrating critical zone science into teacher preparation

One of the best ways to integrate CZO science into the consciousness of the next generation is to incorporate it into geoscience education and teacher education programs. Duggan-Haas and Ross submitted a proposal to the NSF "GEOPATHS" solicitation to give undergraduate geoscience majors and science education majors opportunities to experience participation in secondary school science education, focusing content on the study of the critical zone, and using the NSF-funded Shale Hills Critical Zone Observatory in Pennsylvania as a case study. The proposal included a partnership with the geoscience teacher education programs at SUNY Fredonia and James Madison University, and the New York Earth Science Teachers Association (NYESTA). The proposal was not funded, but we may revise and resubmit to a future similar solicitation. While the proposal was not funded, the collaboration on the proposal did lead to the inclusion of a workshop on CZ science to be led by Duggan-Haas at the July 2016 NYESTA Geologic Field Conference.

Graduate Research Group

CZO Postdoc Justin Richardson has reinvigorated the Graduate Research Group (GRG) for graduate students working at CZOs beginning December 2015 at the American Geophysical Union meeting. The current membership consists of 23 graduate students from 17 different academic institutions. The purpose of the group is to develop partnerships beyond their home institution for collaborations with other young researchers. Thus far, we have held one formal meeting at the 2015 AGU meeting and three virtual meetings using Zoom. In our meetings, we have identified four ways for the graduate research group to increase collaboration and improve professional development. First, we have established a collection of materials focusing on pedagogy, résumé writing, preparing a job talk, and transitioning to being an independent researcher. Second, we have created an informal peer-review system for abstracts and manuscripts in preparation. Third, we are establishing graduate student representatives for each CZO to aid with cross-site visits and research. Moreover, this position is established to act as a point-person for distributing CZO opportunities for graduate students. Fourth, we are creating the framework for research enhancing activities, specifically a cross-site, graduate student led review study and a workshop on biogeochemical models at the landscape scale written in MATLAB or R. Fifth, a subgroup of graduate students from the GRG and Richardson

are preparing two review papers. The first an overview on the use of metals to understand critical zone processes and the second an overview of critical zone research to be published in a Spanish language ecosystem science journal. Richardson created a video to showcase the graduate student-led research at the 2015 AGU fall meeting:
<https://www.youtube.com/watch?v=zLVQt-fEZ1I>.

Reaching audiences underrepresented in the sciences

NSF-GOLD Ideas Laboratory: *Increasing underrepresented audiences in STEM fields.*

In March 2016, CZO-NO postdoc Justin Richardson attended the NSF GOLD (Geoscience Opportunity for Leadership in Diversity) to participate in an ideas laboratory. The overall process was to discuss the current state of underrepresented groups in the geosciences and generate ideas and plans to shift the culture of geosciences to be more inclusive. With input from social scientists, administrators, and geoscientists, plans were developed to enact change in the culture of geosciences. As an outcome of the GOLD meeting, Justin is working with Jason Chen [William and Mary], Andrea Motto [Yale], Carolyn Brinkworth [UCAR], Brian Teppen [Michigan State], Heather Houlton [AGI], and John Breier [University of Texas Rio Grande Valley] on a final proposal aiming to utilize interactions with digital scenarios for geoscience departments to learn about unconscious bias and gain behavioral tools to avoid bystander effect. This is a brand new effort and we hope to establish the CZO program as an active participant at an early stage, with potential for substantial impact.

A number CZOs are engaged in activities that relate to reaching traditionally underrepresented communities, which vary depending on the demographics of each of CZO. For example, Susquehanna Shale Hills CZO report seeking minority students during recruiting for REU and for graduate student participation, and are working on Marcellus Shale water quality issues in other parts of the state, including poor rural populations. The Southern Sierra CZO reports that a majority of their 7 students in their CART high school environmental lab (Clovis, CA) identify as non-white (Hispanic, African-American, multiple races/ethnicities, other). Their courses taught at UC Merced reach traditionally underrepresented communities in Earth and environmental sciences because of the school's minority majority demographics, and their partnerships with teachers in Merced County for TEAM-E also reach underrepresented communities when teachers bring activities back to their classrooms. At Luquillo CZO they have targeted Puerto Rican schools that have all underrepresented students. At Calhoun, they are developing educational materials addressing the needs of students and instructors at 4-year and 2-year institutions where both access to emerging research and representation of the Earth sciences are often low relative to research universities. Groups underrepresented in the sciences are often present in large numbers at these organizations. One goal for the CZO community moving forward will be whether there might exist useful synergy in creating a program that works across CZOs and underrepresented audiences.

Proposals to expand quantity of CZO E&O

In the coming months, the National Office E&O team will write or seek to facilitate several proposals that build on the strongest foundations of CZO E&O, have the strongest likelihood of success, and have the largest impact. These proposals fall broadly into four categories:

- One or more proposals that integrate critical zone science into secondary school education, taking advantage of the need for CZO-type science to meet the Next

Generation Science Standards and experience with use of virtual fieldwork experiences. This will build on strengths of both the CZOs and the National Office. We are working toward an NSF DR-K12 proposal.

- A proposal that introduces critical zone science to teachers in preparation (college students), taking advantage of both the existing strength of critical zone science college-level curricula. The NO submitted a proposal this past year for a similar project to NSF I-USE GEOPATHS, and we will work toward another I-USE proposal (no new solicitation currently exists for GEOPATHS).
- Given experience of several CZOs with video production, and the relationship of the NO to its local PBS station, we will work toward a proposal to develop short videos and associated curricula that can be disseminated through the national PBS Learning Media online network. Complementary materials for informal science education venues will allow data sharing. Proposals will be considered for the NSF AISL program and IMLS National Leadership Grants program.

Conference CZO E&O presentations and booths

The National Office has made a number of presentations at national conferences within the past year to increase awareness of CZO activities and CZO E&O resources. These included presentations at the annual Geological Society of America annual meeting in Baltimore (October 2015) with a talk on using critical zone science examples to teach about systems in a manner consistent with the Next Generation Science Standards (Duggan-Haas et al, 2015) and at the Northeast GSA meet in Albany, NY (March 2016) on teacher professional development opportunities at CZOs.

Duggan-Haas led a workshop at the Science Teacher Association of New York State annual meeting on the progress of New York State's adoption of new science education standards and on the Critical Zone Observatory Network (Rochester, NY, November 2015). More high school students take Earth science in New York State than in any other state.

The National Office (Louis Derry, Tim White, Sarah Sharkey, Justin Richardson) as well as many of the CZO Principal Investigators operated a booth at the 2015 American Geophysical Union fall meeting. In addition to serving as a centralized meeting area for CZO personnel, we were able to provide hundreds of CZO information packets to non-CZO scientists and interested persons. National office personnel lead the initiative to answer questions and direct scientists to physical and electronic CZO materials. In addition, we hosted a Town Hall at AGU. Because of travel interruptions our original speaker from NSF could not attend but Division Director Carol Frost graciously stepped in on short notice.

In July 2016, Earth science educators from across the country will gather in Madison, Wisconsin for the Second Annual Earth Educators' Rendezvous. At the Rendezvous, Duggan-Haas will lead an invited workshop on educational resources from the Critical Zone Observatory Network. Immediately following his work at the Rendezvous, Duggan-Haas will attend the New York Earth

Science Teachers Association Geologic Field Conference at SUNY Oneonta, where he will lead a workshop on using Virtual Fieldwork Experiences to learn and teach about the Critical Zone.

We submitted a proposal for a workshop on CZO science for the March 2016 National Science Teacher Association (NSTA) meeting in Nashville (though we represented CZOs nonetheless at the Earth science share-a-thon), but it was not accepted and we have resubmitted for the meeting in Los Angeles in March 2017. The 2017 proposal is done in partnership with the National Earth Science Teachers Association (NESTA), and will be part of a series workshop coordinated by NESTA. We have begun to recruit CZO E&O personnel intending to participate together.

Web site and social media activities

Web Committee

The NO established a web committee and charged with overseeing the website and prioritizing tasks to improve it. The committee seeks to improve internal and external communication, help unify the CZO network, and expand Education/Outreach efforts. Current members include D. Lubinski, J. Richardson, K. Lohse, S. Gillmore, and D. Duggan-Haas (webmaster, National Office staff, Education/Outreach specialists, and a PI. The committee meets approximately monthly. Work so far has concentrated on assessment of audiences, looking at website problems, and prioritizing needed changes.

The group initially identified the following tasks as short-term priorities:

- establish email lists to make it easier to reach CZO personnel,
- add search tool capabilities to the website,
- redesign the homepage to reflect the network aspect and streamline for different audiences.
- Ensure quality and consistency of static website material.

Work is ongoing to address all four points, beginning with 1 and 2. In our E&O planning we are creating tools to track activity across CZOs in ways that are time efficient for E&O personnel reporting data. We've begun with a simple Google form and will refine the process as we move forward with a goal to create a long-term, sustainable reporting system. Metrics will include standard indices such as total number served, audience demographics, contact hours (number served x time spent per program or person), and educator use of resources developed (e.g., website hits).

Summary of website activities

The criticalzone.org website continues to have modest web traffic, totaling over 215,000 pageviews during Year 2. Site visitors remain highly engaged, spending over 3.4 minutes per session on average. Visits are mostly from the United States (71%), centered on the home cities of the CZOs (see attached map). Content continues to be regularly added to the Content Management System (CMS) by 18 active editors at all CZOs. The CMS now contains more than 4,440 entries, including over 1500 publications, 700 people, 500 News Articles, and much

more. The structured content has many inter-relationships which tie information together and promote cross-CZO compilations.

Highlights of Year 2 included setting up a number of new resources that promote communication within and outside of CZO. These resources include online collaboration tools for CZO committees and working groups (Basecamp), social media platforms like Twitter and Instagram to engage scientists and public audiences, a quarterly email newsletter for all those interested, and CZO blogs for public audiences. We also started a small, nimble CZO website committee to prioritize tasks to improve the website and nudge its' development Website traffic.

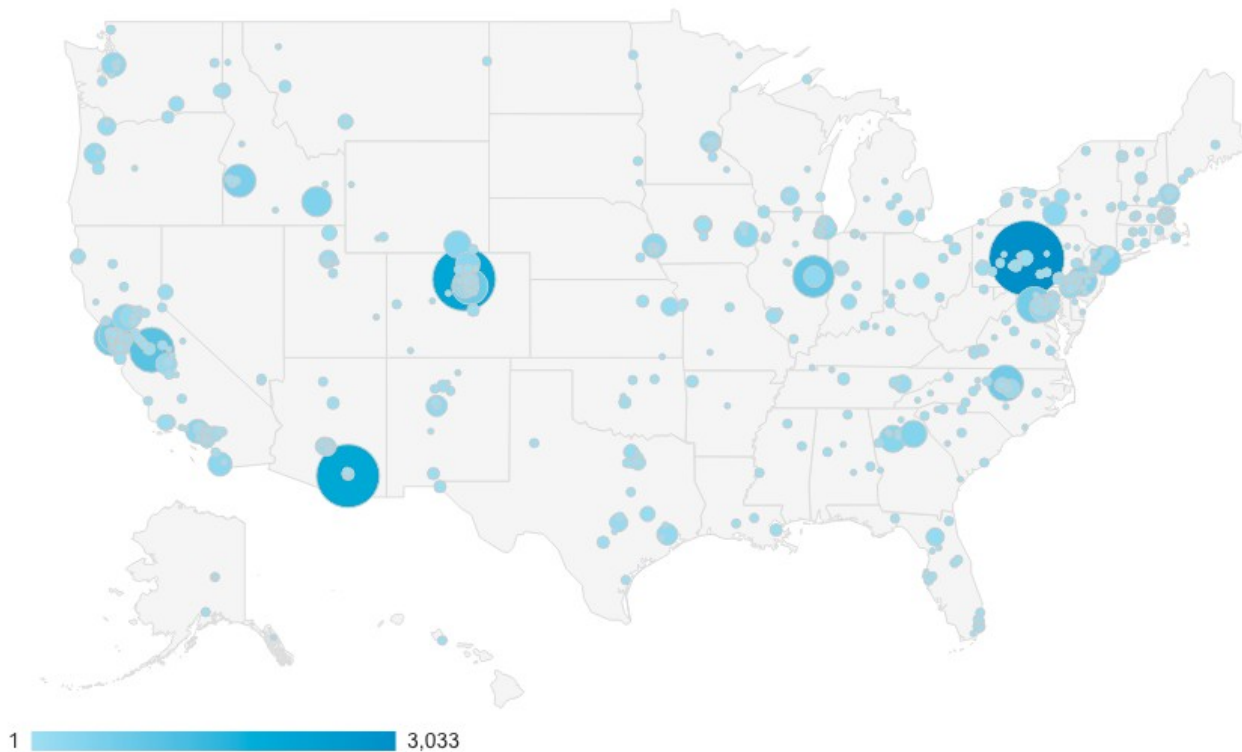
Summary of data on criticalzone.org traffic
(All traffic data via Google Analytics)

Modest Web Traffic, Slowly Increasing.
over 215,000 pageviews/yr
over 62,000 sessions/yr
over 40,000 users/yr

Users Remain Highly Engaged
3:40 avg session duration
3.4 pages/session

Visits From All Over The World, Mostly The U.S.
U.S. visitors comprised 71% of sessions

U.S. Traffic Comes from Many Cities, Centered On CZO Home Cities
Attached map shows scaled symbols for #sessions per city



Information in the Content Management System (CMS) Keeps Increasing (total entries as of 2016-04-21)

1500 main pieces of content worked on in Year 2 (i.e. publications, people, news articles etc.).
18 active website editors across the CZOs.

1517 Publications

522 People

176 alumni

533 News Articles

290 Datasets - Most datasets are composed of more than one component, so links are shown to more than 1,000 pieces of data. Some of those links are to complex datasets consisting of 10's to 100's of data files

Online Collaboration Tools

We set up online collaboration tools (Basecamp) in 2016 for multiple cross-CZO groups (Education/Outreach, Graduate Student Researchers, Data Managers). Those groups are currently assessing how well the tool works for them. CZO is likely to expand support to other committees and cross-CZO working groups.

Social Media

The National Office began using Twitter in July 2015 and has been quite successful so far. The

@CriticalZoneOrg feed is quite active, averaging about 45 tweets/month. CZ scientists and students have really begun to use Twitter in recent years. The National Office is re-broadcasting some of their best work... and to a growing audience. The National account has 333 followers as of April 2016. Lubinski set up the Twitter account and the TweetDeck app for managing and scheduling tweets. Lubinski and Sharkey worked together on a social media strategy. Sharkey has done the bulk of the subsequent work, almost all of the content posting and tracking. Sharkey is now extending the Twitter success (that has focused on scientists) to Instagram, which will reach more general audiences. The National Office also continues to improve the CriticalZoneOrg YouTube channel. Icons to all these social media resources were added to the footer on all website pages.

Newsletter

The National Office began the CZO quarterly newsletter in Spring 2015. The Newsletter is posted to the website by Sharkey (via a template set up by Lubinski) as well as emailed to subscribers. There are currently 130 subscribers, all of whom have explicitly signed up (see News page for the signup form). Newsletters are distributed via MailChimp and recipients can unsubscribe at any time.

Blogs

Lubinski and NO postdoc Richardson designed and developed a full blogging system in Year 2 to assist with education and outreach. The system is ready for multiple blogs by multiple authors, including cross-CZO blogs. The first blog, , "[Adventures in the Critical Zone](#)", is authored by Justin Richardson and guests. It will serve as an example blog as CZO expands to additional blogs and authors.

Content Updates

18 website editors across the CZOs are continuously updating the website. In year 2, they worked on 1500 main pieces of content (i.e. publications, people, news articles, datasets etc). The National Office is an active participant, working mostly on the National pages but assisting with individual observatory pages as well. Improvements include updates and new content for the "CZ profiles" series which provide non-technical introductions to individuals doing CZO science. The National office assisted with posting content across many other areas including student exercises, common measurements, job announcements, workshop announcements, and more.

Maintenance & Support

The website is an ongoing project that requires regular maintenance and attention. Lubinski keeps the Content Management System running and fixes bugs and other issues. He also supports the 18 active website editors across the CZOs. His support for them varies from providing instructions on updating certain content to analyzing Google Analytics traffic data.

Next steps

The web committee suggests the following top priorities for the first portion of Year 3:

1. Communication tools – support more groups with Basecamp, master email lists.
2. Search boxes – add universal search to all pages, targeted search for publications and people.

Collaboration within the CZO community, other US networks and internationally

Data managers group

Over the past 1.5 years the NO and PIs have been concerned about the extent of communication between the CZOData project and the greater CZO community including the NO, the CZO PIs, and the individual CZO site data managers. During Fall 2015, CZO data managers expressed a wide range of opinions about the data project. As the end of the CZOData project loomed, a general consensus emerged that the data project was probably not going to deliver a user-friendly end product designed specifically to respond to CZO needs. Further, it was increasingly clear to us that the data managers, each purportedly part of the CZOData project leadership team, were as concerned by a lack of communication as was the rest of the CZO community. With this knowledge, the NO engaged the data managers to begin a series of virtual meetings so that they could communicate and collaborate. This began prior to the 2015 AGU meeting, and the group prepared a short preliminary document of potential options that might deal with the eventual possibility that there might be no CZO data project in 2016. The document includes a list of potential strategies and actions along with potential budgets to enact those actions. The document was presented to all attendees of the annual NSF/CZO breakfast meeting at AGU including NSF representative Justin Lawrence and CZOData project PI Anthony Aufdenkampe.

The NO further engaged the CZO data managers in early 2016 to formalize their collaboration as a CZO working group that meets regularly, establishes some sort of sustainable governance structure, and most importantly, works to develop a network approach to data management that recognizes the diversity of data types and collection methodologies that exist in the network. During a March 31, 2016 PI teleconference, Dan Arthur, Shale Hills data manager, representing the CZO Data Management Working Group, was tasked by the PIs with helping to develop some consensus among the data managers, a task which he has enthusiastically embarked upon. We await the results of that effort and anticipate that this group, the “boots on the ground” working daily with the data and the system developed by the CZOData project, are best positioned to inform and advise this community on the most viable path forward.

Despite the importance of data management to the CZO program, until now there had not been an effort to get the site based data managers working with one another to share experiences, strategies, and solutions, and to formulate a bottom up set of requirements and needs that should be part of a broader CZ data management system. As a general statement, we are of the opinion that development of a national CZO data system should take place in close consultation with the scientists and data managers at the CZOs so that it can effectively address community-identified needs.

Collaboration with other US Observing networks

This is an area that has had somewhat less activity over the last year, as we have been somewhat focused in addressing internal CZO issues. Nevertheless, we have reached out to LTER and have had ongoing discussions with CUAHSI. NEON underwent a major management change this year and we did not have substantial interactions with them, although we hope to in the near future

CUAHSI

We used criticalzone.org to help publicize several CUAHSI workshops/short courses that were relevant to the CZO community. These included:

Virtual Short Course on Time Variable Transit Times:

<https://www.cuahsi.org/PastTrainingsandWorkshops#sthash.sgt3t4NO.dpuf>

The Role of Runoff and Erosion on Soil Carbon Stocks: From Soilscales to Landscapes:

<https://www.cuahsi.org/PastTrainingsandWorkshops#sthash.sgt3t4NO.dpuf>

We have also had significant off line discussions with CUAHSI personnel about data management. One option for addressing part of the CZO data needs is stream CZO data to the CUAHSI Water Data Center (WDC), a mature system. While the WDC cannot handle certain important types of CZ data it may be a useful part of a set of solutions for a larger data management system for CZ science.

LTER

We made a deliberate effort to reach out to the Long Term Ecological Research community this year. Several CZO scientists (W. McDowell, D. Richter, T. White, P. Groffman) led two working group sessions on [Critical Zone Observatories/Long Term Ecological Research Network Collaboration](#) at the Triennial LTER All Scientists Meeting (ASM), August 30 – September 2, 2015 in Estes Park Colorado. Two posters and several presentations were also made by these scientists.

International

A joint US-China meeting on Critical Zone Science was held in Guiyang China, October 6-10, 2015. Again, the CZO-NO did not play a major role in setting up this conference, but the NO did act to publicize the meeting and the results. CZO-NO Director Derry participated in the meeting, along with both senior and junior scientists from the US CZO program. He also contributed to the meeting report that was led by Henry Lin (Shale Hills CZO).