New Mexico EPSCoR Innovative Working Group Report

Title: Connections Linking Hydrology, Biogeochemistry, and Biological Responses in Headwater Montane Streams

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Co-Investigators: Jesus Gomez, New Mexico Tech**;** Edward Martinez, New Mexico Highlands University

Date and location of meeting: Sagebrush Inn, Taos, NM, 16-18 June 2013

IWG Summary

The IWG convened hydrologists, biogeochemists, and biologists from the water quality and hydrology groups of the current NM EPSCoR grant, as well as members from the co-located Critical Zone Observatory in the Valles Caldera National Preserve for a three day working session to share data, results, and generate hypotheses based on complimentary datasets collected from the East Fork of the Jemez River and the surrounding upland catchment over the last 4+ years. The group, as a whole, was at a point when this focused working session was essential for the dissemination of results and generation of new research ideas for future exploration.

Questions with particular need and interest included 1) linking the hillslope areas with the valley stream reaches and 2) spatial and temporal relationships between hydrological and biogeochemical parameters and the resulting biological responses. Specific emphasis was placed on responses to snowmelt and summer monsoonal precipitation, interactions of nutrients and organic carbon with biological compartments in the soil, sediment, and stream and impacts of the Las Conchas and Thompson Ridge fires on ecosystems within the caldera.

The IWG assisted in the development of collaborative research that link EPSCoR and CZO datasets to make broader interpretation of the system's function and structure as well as the watershed's response to perturbations from climate variability and catastrophic forest fire. This working group also facilitated the generation of proposal ideas for future research and assisted in data compilation and management for the EPSCoR working group to fulfill data availability obligations within the NM EPSCoR Program.

Participants (Figure 1)

This IWG is an opportunity for hypothesis generation and discussion from multiple datasets that have been collected in the EFJR, a third-order stream, and its upland catchment. Invited participants had with critical and complementary expertise in hydrology [New Mexico Tech (NMT)], biogeochemistry [NMT, University of New Mexico (UNM), New Mexico Highlands University (NMHU)] and biology (UNM) in the EFJR; these participants are members of the current NM EPSCoR RII 3 (Track 1) grant to study the effects of climate change on montane stream ecosystems. Members of the Critical Zone Observatory (CZO) program based at the University of Arizona were also invited to participate in this IWG; the CZO group works in the zero-order basins of the same watershed and focus on carbon-water modeling, ecohydrology, and landscape evolution. This pairing of programs created synergy and overlap in expertise in headwater and middle reaches of the EFJR, including hydrologic flows, dissolved organic carbon dynamics, nutrient biogeochemistry, and ground water/surface water interactions.

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Becky Bixby, Department of Biology, University of New Mexico (bbixby@unm.edu), biological response to geochemistry and hydrology

Laura Crossey, Department of Earth and Planetary Sciences, University of New Mexico (lcrossey@unm.edu), biogeochemistry, mantle/surface interactions

Cliff Dahm, Department of Biology, University of New Mexico (cdahm@sevilleta.unm.edu), geochemistry and hydrology, surface/groundwater interactions

Jesus Gomez, Department of Hydrology, New Mexico Tech (jdgomez@nmt.edu), hydrology, groundwater/surface interactions

Edward Martinez, Department of Natural Resources, New Mexico Highlands University (eamartinez@nmhu.edu), geochemistry

Dave Van Horn, Department of Biology, University of New Mexico (vanhorn@unm.edu), nutrient cycling, sondes

Critical Zone Observatory, Jemez Mountains

Paul Brooks, Department of Hydrology and Water Resources, University of Arizona (pdbrooks@email.arizona.edu), "opportunistic catchment scientist", water balance between hillslope/catchment

Jon Chorover, Department of Hydrology and Water Resources, University of Arizona (chorover@cals.arizona.edu), soil geochemistry, hydrology

Tom Meixner, Department of Hydrology and Water Resources, University of Arizona (tmeixner@hwr.arizona.edu), catchment biogeochemistry, mineral weathering

Figure 1: Innovative Working Group, Valles Caldera National Preserve, 18 June 2013

(L to R) Jesus Gomez, Becky Bixby, Tom Meixner, Jon Chorover, Dave Van Horn, Paul Brooks, Cliff Dahm and Edward Martinez (missing: Laura Crossey, photographer)

Problem statement

For the past 4+ years, the East Fork of the Jemez River (EFJR), Valles Caldera National Preserve (VCNP) has been studied extensively, measuring hydrological, biogeochemical, and biological patterns in the context of snowmelt, monsoonal flows, and disturbance events. In addition to discrete water sampling (i.e. monthly), advanced real-time sensors have measured continuous solute responses in the stream and groundwater wells for nutrients, water quality parameters, stream metabolism, and hydrologic flowpaths. Additionally, discrete biological sampling has included autotrophic and heterotrophic components of the biofilm, macrophytes, and macroinvertebrates. Linking the hydrology, biogeochemistry, and aquatic ecology of this ecosystem with climate variability and catastrophic forest fire over multiple years were the main goals for the workshop.

To date, these linkages have been discussed informally among the collaborative group from UNM, NMT and NMHU, including a session titled "The interface of hydrology, biogeochemistry, and ecology in riverine systems" held at the 4th Tri-State EPSCoR meeting in April 2012. From a practical standpoint, the current EPSCoR program will end in August 2013, and it was critical to enhance our current scientific interactions to develop manuscripts and proposals to disseminate results and fund future collaborative work at this site beyond August 2013. Drought and forest fire portend the climate of the future in the southern Rocky Mountains, and the research from recent years sheds considerable light on how hydrology, biogeochemistry, and aquatic ecology responds to these stressors.

After this proposal was funded, the Thompson Ridge fire (May-June 2013) started in the western region of the VCNP. The CZO project had considerable damage to towers and areas burned while the NM EPSCoR project in the EFJR did not sustain any direct damage. This new disturbance was discussed at great length in terms of how to coordinate efforts to capture the effects of the fire and monsoonal rains post-fire.

The working group discussed three broad science questions:

1) How can we merge inferences from high temporal resolution and limited spatial extent continuous samplers with high spatial resolution but discontinuous grab samples?

2) How does spatial and temporal variability in water source, flowpath, and residence time influence biological and biogeochemical processes in stream and near-stream environments?

3) How do we predict and measure the effects of the Las Conchas and Thompson Ridge fires on the hillslope and valley?

Schedule

Before the IWG meeting, emails were exchanged about hypotheses and ideas that needed to be discussed among the group. Spreadsheets were also compiled to gather publications and datasets from both NM EPSCoR and CZO research.

Day One (16 June 2013):

The day was organized around synthetic project talks by most participants. After introductions, overview talks were given to inform the group of each research group's activities.

Cliff Dahm: Water quality instrumentation, deployment, and nutrient results from the EFJR; stream metabolism and organismal response to hydrology and fire in the EFJR

Edward Martinez: Seasonal and diurnal solute variation in the Rio Jaramillo and EFJR; fate and distribution of geothermal solutes in Jemez River watershed streams and biota; utilizing Las Conchas fire to determine nutrient concentrations in surface water runoff in wildfire severity classes

Jesus Gomez: Flow dynamics and connectivity of meandering streams and shallow aquifers

Jon Chorover: Probing how water, carbon, and energy drive critical zone evolution in the VCNP

Paul Brooks: Hydrologic partitioning and stream flow generation in the VCNP

Tom Meixner: How water, carbon and energy drive chemical composition of soils and waters in the Valles Caldera

The rest of the afternoon and evening were spent working on initial thoughts of joint research projects between NM EPSCoR and CZO. There were frequent updates of the Thompson Ridge status throughout the meeting in regards to CZO equipment and access to the preserve.

Day Two (17 June 2013) (Figure 2):

The morning was devoted to compiling a list of data by year from NM EPSCoR and CZO projects, with many questions regarding details about timing, extent, and location. The group spent the majority of the afternoon planning a joint campaign to assess the effects of Thompson Ridge fire and further developing the additional projects related to longitudinal patterns, silica cycling, and hillslope/valley relationships for hydrology and biogeochemistry.

In the late afternoon, Soren Scott from the Earth Data Analysis Center (EDAC) gave a talk about the EPSCoR data portal and connecting future publications to existing datasets, embargo dates, and linking EPSCoR and CZO databases.

Day Three (18 June 2013):

In the morning, the group drove from Taos to the VCNP, meet with Bob Parmenter (Science Director, VCNP) and Betsy Shafer (Hydrologist, VCNP) to talk about the effects of Thompson Ridge fire. We also spoke with one of the fire bosses from Prescott Arizona about the damage and behavior of the fire. After getting permission, the group walked out to the EFJR site where the EPSCoR group works to look at the wells, in-stream instrumentation, and trailer where the additional instrumentation is housed (Figures 3-4).

IWG Outcomes

This meeting was extremely productive in terms of understanding the two groups' data sets and research questions. From these initial discussions, there have been a number of developing hypotheses and questions that have stem from the two projects' many commonalities.

- Joint field campaign to examine the catchment contributions to the valley and the EFJR to examine annual patterns of snowmelt to monsoon rains documenting the water year. We also planned extensively about monitoring the effects of the Thompson Ridge fire on transfer from the uplands to the caldera. Instrumentation, such as sondes and ISCOs, would be installed at key locations along the La Jara, Jaramillo, and the EFJR to monitor discharge and nutrient flows through the catchments during the post-fires monsoon season.

  We plan to contact NSF to investigate funding options for a RAPID (Rapid Response Research) proposal. Cliff is going to contact the NM EPSCoR office to determine mechanisms that might be available through the EPSCoR program.
- Role of biological uptake of silica in groundwater modeling. In hydrology models, silica concentrations are used as an indicator of deep ground water contribution (versus shallow groundwater) but these models do not account for any biological uptake by diatoms and aquatic plants. Becky and Paul will head up this project.
- Cliff et al. at UNM is currently examining longitudinal patterns of metabolism along the EFJR to the Rio Grande reach to I-25 with noted decreases as the parameter is monitored downstream. Including sondes in the upper CZO reaches of the EFJR to examine upland contributions to metabolism along the longitudinal gradient with increasing stream order.
- Adrian Harpold (CZO post-doc) has developed a geochemical mixing model to separate flow paths of specific geochemical 'signatures.' Most of the water chemistries that were inputted into that model were from within the caldera itself. Laura has outflow geochemical measurements from the caldera (i.e., Rio San Antonio, East Fork Jemez and Jemez rivers). Tom and Laura will incorporate those "out of basin" measurements into this geochemical mixing model developed with the CZO research.
- Long-term plan to write a synthesis paper combining EPSCoR and CZO data seemed premature at this time. Follow-up conversations and plans to synthesize data will likely occur after these short-term projects listed above are developed.

Figure 2: Innovative Working Group at the Sagebrush Inn, Taos, June 16-18, 2013

Figure 3: Jesus Gomez explaining groundwater dynamics at the East Fork of the Jemez River, Edward Martinez in background

Figure 4: Tom Meixner fording the East Fork

Timetable of activities

Because the Thompson fire was ongoing during the IWG and there were concerns for using the Science and Education Center in Jemez Springs related to emergency housing and smoky conditions, the meeting was moved to Taos at the Sagebrush Inn. The initial plan for a field trip to the VCNP was moved in the end to the end of the meeting.

Saturday, June 15: Arrive in Taos in evening (meals on own)

Sunday, June 16

7:30-8:30:	Breakfast at the Sagebrush Breakfast Room
8:30-8:45:	Welcome, introductions, agenda review (Bixby) (Piñon)
8:45-10:15:	Short synthesis talks (Dahm, Gomez) (Piñon)
10:15-10:30:	Break
10:30-12:00:	Continued short synthesis talks (Martinez, Chornover, Brooks, Meixner) (Piñon)
12:00-1:00:	Lunch (Piñon)
1:00-3:00:	Initial of research questions and hypotheses (Piñon)
3:00-3:30:	Break
3:30-5:00:	Continue discussion (Piñon)
6:00-?:	Dinner at Sagebrush Inn

Monday, June 17

7:30-8:30:	Breakfast at the Sagebrush Breakfast Room
8:30-10:15:	Hypothesis generation (Piñon)
10:15-10:30:	Break
10:30-12:00:	Synthesis paper development (objectives, data inclusion, broader impacts) (Piñon)
12:00-1:00:	Lunch (Piñon)
1:00- 3:00:	Post-fire instrument coordination and discussion of collaborative manuscripts and future proposal ideas (Piñon)
3:00-3:30:	Break
3:30-4:00:	Participant demographics and wrap up (Piñon)
4:00-5:00:	Use of EDAC and data portal to link present and future work (Soren Scott) (Piñon)
6:00-?:	Dinner at Sagebrush Inn

Tuesday, June 18

6:30-7:00:	Breakfast at the Sagebrush Breakfast Room
7:00-8:30:	Drive to Valles Caldera National Preserve
8:30-11:30:	Talk with Valles employees re: fire impacts and visit EPSCoR East Fork site
11:30:	Lunch