Planning an International CZO Programme

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International Call to Action

Earth's Critical Zone (CZ), the thin planetary veneer extending from the top of vegetation to the bottom of aquifers that supports almost all human activity, is under intensive pressure from growth in human population and wealth. Critical Zone Observatories (CZOs), established during the past 5 years, intensively study the complex interactions of rock, soil, water, air and organisms that regulate CZ properties and their ability to provide life-sustaining resources. CZOs are providing transformative advances in basic natural sciences with far greater, holistic understanding of how geophysical, geochemical, and biological processes integrate from the vegetation canopy, across the land surface through soil, to aquifers and the deeper biosphere. CZOs have established scientific focal points that define major research questions, raise awareness of Critical Zone vulnerability, and interface with environmental policy. They have fostered the interdisciplinary research necessary to rapidly deliver solutions to the major societal challenges of land degradation, climate change, food security, biofuel production and a clean and plentiful water supply. International networks of CZOs offer enormous potential to globally integrate basic science with innovation in human adaptation to rapid and intensive environmental change.

Achieving this vision requires a transformation in the ambition and integration of CZO science agendas worldwide. Our goal in forming an International CZO Programme is to facilitate the integration and broad communication of knowledge gained from new and existing CZOs, with an aim towards understanding of the resilience and vulnerabilities of Earth's CZ and its inhabitants and to formulate interdisciplinary solutions to sustaining Earth's CZ for future generations.

Project Plan

An international workshop was convened 9th-11th November, 2011 at U. Delaware, USA to develop an international Critical Zone science agenda for the next 10 years. Eighty-nine scientists from 25 countries representing around 60 CZOs and associated field sites around the world attended the meeting.

The workshop participants debated and refined six key science questions, listed below, and developed these into research hypotheses and framework experimental designs, in order to drive this 10-year agenda forward. The science areas spanned basic science enquiry and challenge-driven research that delivers solutions.

Long-Term Processes and Impacts

1. How has the geological evolution and paleobiology of the CZ established ecosystem functions and the foundations for CZ sustainability?
2. How do molecular-scale interactions between CZ processes dictate the linkages in flows and transformations of energy, material and genetic information across the vertical extent of above ground vegetation, soils, aquatic systems and regolith - and influence the development of watersheds and aquifers as integrated ecological-geophysical units?
3. How can theory and data be combined from molecular- to global- scales in order to interpret past transformations of Earth's surface and forecast CZ evolution and its planetary impact?

Short-Term Processes and Impacts

4. What controls the resilience, response and recovery of the CZ and its integrated geophysical-geochemical-ecological functions to perturbations such as climate and land use changes, and how can this be quantified by observations and predicted by mathematical modelling of the interconnected physical, chemical and biological processes and their interactions?
5. How can sensing technology, e-infrastructure and modelling be integrated for simulation and forecasting of essential terrestrial variables for water supplies, food production, biodiversity and other major benefits?
6. How can theory, data and mathematical models from the natural- and social- sciences, engineering, and technology, be integrated to simulate, value, and manage Critical Zone goods and services and their benefits to people?

A common feature of the experimental designs is the establishment of networks of CZOs located along planetary-scale gradients of environmental change, e.g. gradients of climate and intensity of land use.

The workshop prepared a 3-year plan to establish a coordinated international CZO programme. The report proposed to review progress and agree on next steps 10 months later, during the CZO Geobiology conference, convened 5th-8th September, 2012 at the China University of Geosciences in Wuhan. An outcome of discussions with the participating scientists and national funders at the Wuhan meeting was the concept to develop an international steering committee in order to further develop and drive forward this project plan. This group, named above, is committed to the hard work and necessary consultation and preparatory work with partners around the world, to enable this vision to be realised.

Initial Steps

To advance this global project requires a series of steps through 2013 and continuing into 2014:

1. Establishment of an international forum of CZO leaders to integrate with additional observatory networks, to broaden the disciplinary mix, and to debate, test and strengthen the programme of research,
2. Creation of a Critical Zone Science Joint Working Group of The International Union of Soil Science (IUSS), American Geophysical Union (AGU), and the Ecological Society of America (ESA);
3. Preparation and presentation of a proposal to develop and implement this CZ Science agenda within the interdisciplinary activities of the International Council for Science (ICSU);
4. Preparation of a bid with national funders for multilateral international funding with the Belmont Forum;
5. Coordinated advocacy and strategy development with national funders and research foundations; and
6. Continued development and implementation of this plan for a coordinated international programme of CZO research.