Simulating climate change in drylands: Amount and variability of precipitation

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Drylands account for more than 40% of the terrestrial surface and play a key role in the global carbon cycle accounting for most of its interannual variability. In addition, drylands are home for 30% of the human population and support 50% of livestock in the world. The major impacts of climate change in drylands occur through changes in precipitation. Global scenarios predict two impactful changes for drylands: a decrease in precipitation amount and an increase in interannual variability with more severe and prolonged droughts followed by periods of high precipitation. Increased variability is a dimension of climate change that has received less attention than changes in amount of precipitation.

Experiments are the only way to address cause-effect relationships and they complement observations. Field experiments manipulate precipitation amount or variability while isolating the effects of other variables such as previous conditions, temperature and seasonality. Observations although cannot determine cause-effect relationships, they determine patterns broadly distributed in space and time that can reject or support hypotheses.

Climate change impacts on ecosystems depend on the change in climate and the ecosystem sensitivity to those changes. Future precipitation conditions depend on the scenario chosen and the time target, usually 2050 or 2100. Sensitivity, on the contrary, is a property of each ecosystem. Precipitation manipulative experiments aim at assessing sensitivity to changes in precipitation and unraveling mechanisms behind those changes.

Rainout shelters became popular experimentation tools because of their low cost, reliability, no-electricity requirements and minimal impact on other environmental variables. Rainout shelters are sometimes combined with passive irrigation plots to enhance the range of precipitation conditions and explore the full response surface. Enhanced precipitation variability can be simulated by using drought plots combined with irrigated plots. The irrigated and drought plots are swapped every year. So, throughout an 8-year period, treatments will have received the same amount of precipitation but the coefficient of variation of precipitation variability has changed according to proportion of precipitation that is intercepted and re-routed.

Inexpensive and easily to deploy drought experiments have been distributed all over the world. This program named Drought-Net, International Drought Experiment, coordinates drought experiments. Analysis of the global distribution of several climate and soil variables justifies the need to have distributed experiments in most continents. Distributed experiments create novel insights difficult to obtain with other methods.

Climate change simulation and specifically field experiments that manipulate amount and variability have a great potential as a tool to enhance predictions about the impact of climate change on the functioning of ecosystems.