BOX: The Right Climate Data for the Right Task

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Although different analyses of climate impacts may have different national, regional, and sectoral focuses, most begin with the same premise: that future climate conditions under a set of consistent assumptions regarding human choices, as reflected in future greenhouse gas emissions, can be simulated by global climate models.

Modeling of climate processes, that is, the physics, chemistry, and biology defining the Earth's climate, are usually done at the global scale. There are now over 30 global climate models around the world that are used in the international comparisons of these models (called CMIP) that occur for each major international assessment of climate change. They also vary in quality and there is no perfect model. These models are extremely complex and computationally expensive, so the resolution of these models currently is roughly 1 degree or about 100 km in latitude and longitude. This resolution is generally far too coarse for most applications to study the potential impacts of climate change. As a result, downscaling techniques, both regional climate models and statistical techniques, have been developed to get to higher resolution, towards being able to better define local and regional impacts.

Which set of global models, what downscaling approach, what climate variables are needed, and what spatial resolution to use for climate impacts analyses, will depend on the specific sector of interest, and often on the specific location of concern. How can businesses, communities, or countries plan for adaptation in a changing climate? The answer isn't just a matter of spatial and/or temporal scale: often, climate model outputs must be translated into the variables or indicators already used as input for planning – return period, threshold exceedances, degree-days, streamflow, or more. This requires that a non-trivial amount of time and effort be invested in communication and collaboration between experts in climate information and experts in quantifying the impacts on a given system.

For some systems or sectors, only average changes in temperature and precipitation may be needed, but for many others, the changes in climate extremes are necessary to determining risk and vulnerabilities. In other words, for some applications statistical downscaling using a simple delta approach may be perfectly adequate, but in most cases, that technique is likely to be deficient because it does not adequately treat temperature and precipitation extremes. For this reason, much effort has gone into statistical techniques that can much more accurately consider extreme events. Also, if more parameters are required than temperature and precipitation changes, regional climate model results for that specific region at appropriate resolutions can provide many more climate variables (e.g., cloudiness, winds) for impacts and resiliency analyses.

In addition to climate datasets, other scientific tools may also be needed to fully understand the impacts of climate and other forms of global change on a landscape. For example, very high-resolution models developed by Earth Knowledge for Northern California and other parts of the western United States use statistical downscaled projections of temperature and precipitation as inputs to detailed energy and water balance models that account for the local landscape structure and surface and near-surface hydrology to determine risks resulting from extreme heat, droughts, floods, and other climate extremes and variability affecting local and regional utilities, manufacturing, real estate, agriculture, forestry, and other sectors.

Earth Knowledge's high-resolution models have successfully forecasted the likely location and extent of catastrophic wildfires in the 2017, 2018, and 2020 fires seasons in the North Bay area of California. The 270 m spatial and monthly temporal resolution of these models allows for a clearer representation of dramatic shifts in hydrologic conditions on the landscape and the high degree of water stress. Likewise, because of the monthly statistical downscaled climate data these models accurately show the dramatic change in very wet conditions to very dry conditions in a short period of time indicating the potential for a high volume of vegetative matter that has a high vulnerability for extreme wildfire conditions. In 2020, a brief period of high-intensity lightning storms ignited wildfires throughout Northern California contributing to the most destructive wildfire season in California State history.