Editorial

Virtual Special Issue Preface: Forest Response to Environmental Stress: Impacts and Adaptation

The current distribution of forest types was largely established at the beginning of the Holocene epoch (approximately 12,000 BCE), but forests are constantly in flux. Many regional scale stresses (e.g., drought, heat, fire, and insect) and even a few multi-regional or global stresses (e.g., 8200 BCE cooling, or the medieval warming period) have occurred over the past 12 millennia. However, modern ecology is less than 200 years old, and large-scale anthropogenic impacts on climate are mainly confined to the latter half of the 20th century. Given the large number of potential climate, geographic, demographic combinations, and relatively short time of study, we should not be surprised that there are an increasing number of observed environmental stresses with no antecedent point of reference. Chronic anthropogenic stressors (e.g., elevated nitrogen, sulfur and heavy metal deposition, and tropospheric ozone) have mentality precondition human thought to accept these impacts as part of the environmental condition in the areas in which they occur. Therefore, the acceptance of non-antecedent variability is part of the challenge associated with climate change in which variability exceeds historic observation. This desensitizing of human reaction to disturbance impedes societies' ability to acknowledge unprecedented environmental change, and thereby delays measures to reduce or adapt to these non-antecedent stresses. A poor understanding of non-antecedent stress also contributes to the challenges of addressing these unprecedented disturbances.

Non-antecedent forest stressors can be divided into the three categories of 1) new individual stressors; 2) record stressors; or 3) integrated stressors. New stressors are those that have not been previously observed within an ecosystem or region. To better understand their potential negative impacts, researchers can exchange space for time. Examples include 21st Century ozone, and, heavy metal and acidic deposition in East Asia. In these instances, heavy metal disturbance impacts from Eastern Europe and ozone impacts from the United States southwest Pacific region during the 1960s–1980s provide some guidance. This STOTEN special issue contains several papers of local to regional scale new stress impacts that can provide guidance for both the study locations and potentially forest areas under similar, current or future stresses.

Record stressors pose a second challenge to understanding and developing ecosystem resilience adaptation measures. However, as with techniques to better understand new impacts, understanding locally non-antecedent record forest stress can again substitute space for time. For example, recent surface air warming is unprecedented in the Russian taiga, but similar record heat has occurred in both Canadian and United States taiga forests. Therefore, like non-antecedent new disturbances, non-antecedent record disturbance impacts can also ex-change temporal and spatial observations to help guide the understanding the impacts of non-antecedent record impacts on forest structure and function. This STOTEN special issue contains several papers that cite similar forest response as observed or experimental forest response to record stresses.

Thus far, all of the papers in this special issue have either examined new or record stress impacts on some aspect of forest structure or function. These are important questions that needed to be addressed. However, the most challenging and potentially most ecologically damaging impacts involve integrated (i.e., simultaneous), non-antecedent forest stresses. For the first time, humans are changing the very climate in which they and forests coexist. In addition to changing the climate, humans are also creating hereunto unprecedented combinations of ecosystem stresses (e.g., co-occurring combinations of ozone exposure, climate change induced drought, acid rain, nitrogen deposition, invasive disease, and increased atmospheric carbon dioxide, record heat driven wildfire and insect outbreaks).

These multi-factorial global "experiments" are challenging the limits of our scientific predictive capacity. No single study could replicate the complexity in size, scope, and interaction of these stressors, so forest managers are left to use incomplete knowledge for adapting to changing ecosystem structure and function. There will always be forest stresses, but the sooner and more fully integrated impacts are understood, the better forest managers will be able to adapt to these changes, both now and in the future. This special issue includes papers that attempt to predict multiple impacts interactions (e.g., ozone, nitrogen deposition, and climate change). We realize that this virtual special issue is just the beginning for considering these three important forms (i.e., new, record, and integrated stresses) of non-antecedent ecosystem stress, but this group of documents may provide some guidance for future research direction.

Steven McNulty
USDA Forest Service, Raleigh, NC, USA
Corresponding author.
E-mail address: smcnulty@fs.fed.us.

Enzai Du
State Key Laboratory of Earth Surface Processes and Resource Ecology,
Beijing Normal University, Beijing 100875, China
E-mail address: enzaidu@bnu.edu.cn.

Elena Paoletti
National Research Council of Italy, Italy
E-mail address: elena.paoletti@cnr.it.

22 June 2017
Available online xxxx