"The Role of Ecosystem Science in Developing Adaptation and Mitigation Strategies to Climate Change"
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"Implications of Climate Change on Agricultural Ecosystems"

Agricultural production systems are sensitive to climate variation. The impacts range from shifting patterns of crop production, reduced productivity because of climate stress, and changes in production efficiency due to increased incidences of pests and diseases. If we consider a production system, climate determines where we grow the crop and the seasonal weather determines the amount we produce. The primary factors that affect crops are temperature and precipitation. Each crop species has a temperature range in which it can grow and an optimum temperature, beyond which productivity begins to decrease. One critical phase for all flowering plants is the pollen stage, which high temperatures can reduce the ability to produce seed. Exposure to extreme temperature events at critical times in the plant growth cycle can severely limit production. Precipitation is critical to supply the water for plant growth and either shortages or excesses can limit plant growth. Variation in temperature and precipitation for a given location can negatively impact plant growth and if this variation becomes too great then the plant will no longer produce sufficient quantities to be economically viable. The continued trend in climate variation may limit our ability to adapt management practices to withstand climate stresses; then shifts in distribution of crop production will occur. One example of this is perennial fruit trees, which require a certain number of chilling hours−hours below a given temperature during the winter−for the trees to bloom and set fruit. The warming climate may limit the ability of certain locations to provide adequate chilling hours, requiring a different fruit or crop to be grown. Excessive precipitation in amount and intensity can cause soil erosion. Protection of the soil with practices that reduce the rainfall energy may become necessary to reduce erosion. Exposure to extreme temperatures affects livestock and exposure to even short periods of high or low temperatures can cause reductions in milk, eggs, or meat production. To cope with climate change, agriculture will have to develop adaptation strategies that producers can use to offset the negative impacts of climate variation on production.

Dr. Jerry Hatfield has served as director of the National Laboratory for Agriculture and the Environment since 1989 and has worked for the U.S. Department of Agriculture since 1983. He is the lead author on the agriculture section of the U.S. Climate Change Science Program's *Synthesis and Assessment Product 4.3* and has served on Intergovernmental Panel on Climate Change working groups on climate impacts to agriculture and ecosystems. Dr. Hatfield is Past President of the American Society of Agronomy and a member of the Board of Directors of the Soil and Water Conservation Society. He received his Ph.D. from Iowa State University and a Master's degree from the University of Kentucky.

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"Rising Tides: Sustaining Coastal Wetlands in a Changing World"

While representing a small percentage of the total area on earth, coastal wetlands contribute a disproportionately large amount to the total value of global ecosystem services, making them among the most valuable ecosystems in the world. These low-lying coastal lands abate storm impacts, ameliorate flooding, stabilize shorelines, sequester carbon, and provide habitat for economically and ecologically important species. Yet, coastal wetlands are increasingly vulnerable to degradation or loss from sea-level rise, storm surges, and other environmental changes. Because loss of these coastal ecosystems results in the loss of the goods and services they provide, it is increasingly important to understand the factors contributing to their persistence in the landscape, as well as to identify the best strategies for climate change adaptation and mitigation. Sustaining coastal wetlands in a changing climate depends on the maintenance of land surface elevations relative to sea level. To avoid loss, coastal wetlands must accumulate sediment or organic matter at a rate that is equal to, or that exceeds, the rate of relative sea-level rise. Changing environmental conditions, such as rising temperatures, increased flooding, nutrient enrichment, or hydrologic modifications, can interact to alter rates of sedimentation or organic matter accumulation in coastal wetlands, and as a result, have the potential to influence the capacity of these ecosystems to keep pace with sea-level rise. Thus, it is important to improve our scientific understanding of the mechanisms governing elevation maintenance, and how these mechanisms respond to multiple, interacting global change factors. Such understanding improves conservation and restoration efforts aimed at minimizing coastal land loss and informs coastal adaptation and mitigation strategies, including the use of wetlands to sequester carbon or to protect coastal areas from storm damage.

Dr. Julia Cherry has served on the faculty of the University of Alabama since 2006. She received her Ph.D. from the University of Alabama and completed her postdoctoral research at the U.S. Geological Survey, where she also worked in the Water Resources Division from 1998 to 2002. Dr. Cherry's research focuses on understanding the ways in which wetland plants affect the structure and function of wetland ecosystems, especially in coastal wetlands in the northern Gulf of Mexico. She serves as Treasurer for the Society of Wetland Scientists and Associate Editor for the journals *Southern Naturalist* and *Wetlands*.

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"Cities, Agriculture, and Wildlands: Ensuring Continued Ecosystem Services from Our Rapidly Changing Landscapes"

American landscapes have a complex arrangement of many different elements – agriculture, cities, and natural habitats are juxtaposed against each other in ways that influence their functioning and sensitivity to global changes. Each of these landscape elements provides a wealth of ecosystem services–the benefits society obtains from functioning ecosystems such as provision of food and water, and regulation of air quality and climate. The arrangement of these landscape elements has a strong influence on the total benefits provided and the interactions between different components. For example the quality of drinking water in the urban center of Fresno, California is impacted by chemical inputs in adjacent agricultural areas. Similarly, air pollution and nonnative species from southern California urban areas are associated with invasions of exotic species and increasing fires in Joshua Tree National Park.

Currently, the functioning of many landscapes is changing rapidly in response to interacting global and regional changes. Rising temperature, more extensive droughts, and increases in background pollution are all providing strong external pressures on landscape functioning. Within landscapes, regional transformations including urban development, acute pollution sources, and species changes are reshaping the connections within landscapes, their functioning, and sensitivity to external pressures. Ecosystem science provides an essential source of knowledge for understanding these landscape changes and designing future landscapes to continue providing necessary ecosystem services. Tools of modern ecosystem science used to address landscape changes include networks of automated environmental sensors that measure whole ecosystems, plants, and belowground dynamics. A wealth of imaging tools allow for the viewing of ecosystems at global scales from satellites to viewing individual plants from low-flying airborne cameras. Coupling these rapidly increasing ecosystem databases with advanced computational modeling is allowing comprehensive tests of new theories and leading to improved prediction capabilities. Continued investments in ecosystem science will help us better understand our complex landscapes and how we can maintain or improve their production of ecosystem services in a rapidly changing world.

Dr. G. Darrel Jenerette has served on the faculty of the University of California, Riverside since 2008. His research emphasizes how biological systems work across multiple scales, especially the relationships among carbon and water cycles, energy partitioning, and biodiversity in dryland ecosystems across a diversity of land uses. Dr. Jenerette is a member of the Editorial Board for *Landscape Ecology* and led the group that developed terrestrial observation sampling designs for urban research sites for the National Ecological Observatory Network. He earned his Ph.D. from Arizona State University.