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Editorial

Plant Adaptation to Global Climate Change

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The problem of climate change is unavoidably accompanied by climate variabilities, such as high temperature, varying patterns of rainfall, and other environmental factors (including biotic factors), and causes an adverse impact on plant development and global food security. The effect of climate change on vegetation may be from cellular to the molecular level. Consequently, the existing literature on the plant's response to different environmental factors is varied. In view of the future impacts of climate change, understanding the response of plants becomes critical in developing strategies to cope with the threats to plant growth and development. To advance our current knowledge on the impact of climate change on vegetation, articles focusing on the urban, regional, and global levels as well as modeling studies were collected in this Special Issue. The *Atmosphere* Special Issue entitled "Plant Adaptation to Global Climate Change" comprises 13 original papers.

The impact of climate change on the harvested area, yield, and production of sugarcane has been studied in Thailand [1]. The study concluded a projected decrease in future sugarcane yield, harvested area, and production by 23.9–33.2%, 1.3–2.5%, and 24.9–34.9%, respectively, using the spatial regression using the instrumental variable. Highlighting the well-being of the sugarcane growers and instability of the sugar price under future global climate change is the important feature of the study.

Bakku et al. [2] demonstrated differentially expressed genes in rice (*Oryza sativa* cv. Koshihikari) seeds under high-temperature stress using the transcriptomics approach in Japan. The study showed up- and downregulation of more than 100 genes in grade 2 rice (Y2) and grade 3 rice (Y3) seeds, respectively. This study is among the first that suggests that high temperature during the seed filling and maturation in rice damages yield as well as kernel quality.

Analysis of tree rings provided a comprehensive understanding of growth dynamics and their adaptation to climate change using Chinese Torreya (*Torreya grandis* cv Merrillii) as a model system [3]. The analysis was performed using six stem sections from trees having ages between 60–90 years and local climate data. The results revealed that the accumulated radial growth enhanced linearly with time. The study suggested that the gradual growth, drought resistance, and several stems in a single tree could help the trees acclimate to different climate conditions.

Quantification of the isoprenoids between soil with litter and atmosphere in a Mediterranean *Pinus pinea* was performed in order to study the ground level isoprenoid exchanges [4]. The study showed that isoprenoid emissions were high, variable, and can be assessed by the dry weight of litter around the trunk. The findings recommend pervasive spatio-temporal analysis of ground-level isoprenoids' exchanges in different types of ecosystem. Gandia et al. [5] highlighted recognizing the response to environmental change of weed species by analyzing their distribution. The analysis of species led to the categorization of weeds as generalist, regional, or local species, corresponding to latitude and related temperature ranges. Three weed species, *Linaria micrantha* (Cav) Hoffmanns & Link, *Sonchus oleraceus* L., and *Sysimbrium irium* L., were categorized as generalist and *Stellaria media* (L.) Vill. was identified as a local species. The approach in the study can be used to designate weed distribution as a marker of changing climatic conditions.

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To study the effects of temperature on the physiological and ecological characteristics of plants, two high-resolution thermal cameras were used to monitor the canopy leaf temperature distribution in a primary tropical rain forest in southwest China [6]. The study included 28 different tree species and the results suggest that both stomatal conductance and size of the leaves determined the difference in the mean leaf-to-air temperature. The findings indicate species-specific functional traits required to investigate and model the interactions of entities for developing the knowledge and prediction of impacts of climate change on vegetation.

The following seven papers in this Special Issue conducted studies using different models or approaches under the future climate change scenario. Simulation of differential impact on winter wheat (*Triticum aestivum* L.) by future projections of climate change (2025 and 2050), especially under increasing temperature was done using CSM-CERES-Wheat model coupled with different Representative Concentration Pathways (RCPs) and two Global Circulation Models (GCMs) in China [7]. The study indicated that the production of wheat in Guanzhong plain will increase (positive) under future climate change using crop simulation modeling. However, the negative impact will depend upon the climate change projections as GCMs showed both increase and decrease in the grain yield. The study also emphasized proper use of irrigation management as rainfed wheat is very sensitive to climate change. In a study, a scaling approach was used to measure the variation of scaling factors and their correlation at large scales in the estimation of actual transpiration of three boreal species in a forest [8]. The authors demonstrated that the scaled canopy transpiration signified a considerable fraction of forest evapotranspiration (>70%) and recommend the approach for the proper estimation of actual transpiration in the areas having low tree diversity. Mendoza et al. [9] emphasized the use of the Climate Data Science (CDS) Toolbox Species Distribution Model (SDM) in evaluating the appropriate areas of grapevine (*Vitis vinifera* L.) under the present and future climate conditions in France. The study proved different possible effects of future climate change on the spatial distribution of proper areas for grapevine crops. The maximum entropy modeling approach was utilized to foresee future habitat distribution of the susceptible *Prunus Africana* under the effect of climate change in Tanzania [10]. The results showed reductions in appropriate habitats for *P. Africana* under all imminent representative concentration pathways' scenarios as compared to present distributions. Various statistical methods were used to study the variations in the seasonality of Ethiopian highlands' climate, consequences for crop development, assessment of variations in the annual cycle, and long-term trends. [11]. Coupled Model Intercomparison Project (CMIP5) Hadley2 data assimilated by the Inter-Sectoral Impact Model Intercomparison Project (ISIMIP) hydrological models used in the study provided understandings on the unimodal annual cycle of soil moisture in past and future eras. The study concluded that evaporation is increasing and might put stress on different land and water resources due to seasonal variations. An empirical hazard model was used to get the pattern of the global spread of Black Sigatoka Leaf Disease (*Mycosphaerella fijiensis*), an important pathogen on banana [12]. The results showed that agricultural trade might play a significant role in spreading the disease across countries and highlights the threat and prospective cost of relying on just a few varieties with genetic similarity to produce a particular crop globally. Climate change is negatively affecting the health of populations around the world, especially in low-income countries like East Africa. A Wet Bulb Globe Temperature (WBGT) approach, a common index, was used to evaluate the heat stress in occupational health in East Africa [13]. The results showed that heat stress is already influencing the areas of East Africa. The analysis of two terms of the agricultural calendar suggests that Kenya and Tanzania face substantial portions of their national landmass influenced by high WBGT values; a neighboring country (Uganda) is comparatively less affected.

The goal of this Special Issue is to present research with a broad perspective to understand the effects of climate change on vegetation, involving applied research and studies with different types of modeling approaches, and the 13 papers in this Special

Issue achieve this goal. I thank the authors for their significant contributions and hope that this issue triggers some ideas and collaboration or serve as a resource to move ahead in a rapidly changing climate.

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References

1. Pipitpukdee, S.; Attavanich, W.; Bejranonda, S. Climate Change Impacts on Sugarcane Production in Thailand. *Atmosphere* **2020**, *11*, 408. [CrossRef]
2. Bakku, R.K.; Rakwal, R.; Shibato, J.; Cho, K.; Kikuchi, S.; Yonekura, M.; Sarkar, A.; Shioda, S.; Agrawal, G.K. Transcriptomics of Mature Rice (Oryza Sativa L. Koshihikari) Seed under Hot Conditions by DNA Microarray Analyses. *Atmosphere* **2020**, *11*, 528. [CrossRef]
3. Chen, X. Historical Radial Growth of Chinese Torreya Trees and Adaptation to Climate Change. *Atmosphere* **2020**, *11*, 691. [CrossRef]
4. Mu, Z.; Llusià, J.; Peñuelas, J. Ground Level Isoprenoid Exchanges Associated with Pinus pinea Trees in A Mediterranean Turf. *Atmosphere* **2020**, *11*, 809. [CrossRef]
5. Gandía, M.L.; Casanova, C.; Sánchez, F.J.; Tenorio, J.L.; Santín-Montanyá, M.I. Arable Weed Patterns According to Temperature and Latitude Gradient in Central and Southern Spain. *Atmosphere* **2020**, *11*, 853. [CrossRef]
6. Song, Q.; Sun, C.; Deng, Y.; Bai, H.; Zhang, Y.; Yu, H.; Zhang, J.; Sha, L.; Zhou, W.; Liu, Y. Tree Surface Temperature in a Primary Tropical Rain Forest. *Atmosphere* **2020**, *11*, 798. [CrossRef]
7. Zheng, Z.; Cai, H.; Wang, Z.; Wang, X. Simulation of Climate Change Impacts on Phenology and Production of Winter Wheat in Northwestern China Using CERES-Wheat Model. *Atmosphere* **2020**, *11*, 681. [CrossRef]
8. Quiñonez-Piñón, M.R.; Valeo, C. Modelling Canopy Actual Transpiration in the Boreal Forest with Reduced Error Propagation. *Atmosphere* **2020**, *11*, 1158. [CrossRef]
9. Hinojos Mendoza, G.; Gutierrez Ramos, C.A.; Heredia Corral, D.M.; Soto Cruz, R.; Garbolino, E. Assessing Suitable Areas of Common Grapevine (*Vitis vinifera* L.) for Current and Future Climate Situations: The CDS Toolbox SDM. *Atmosphere* **2020**, *11*, 1201. [CrossRef]
10. Giliba, R.A.; Yengoh, G.T. Predicting Suitable Habitats of the African Cherry (Prunus africana) under Climate Change in Tanzania. *Atmosphere* **2020**, *11*, 988. [CrossRef]
11. Tarkegn, G.B.; Jury, M.R. Changes in the Seasonality of Ethiopian Highlands Climate and Implications for Crop Growth. *Atmosphere* **2020**, *11*, 892. [CrossRef]
12. Strobl, E.; Mohan, P. Climate and the Global Spread and Impact of Bananas' Black Leaf Sigatoka Disease. *Atmosphere* **2020**, *11*, 947. [CrossRef]
13. Yengoh, G.T.; Ardö, J. Climate Change and the Future Heat Stress Challenges among Smallholder Farmers in East Africa. *Atmosphere* **2020**, *11*, 753. [CrossRef]