Editorial

Application of Innovative Silvicultural Treatments in Pine Forests

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Pine forests—as natural stands and artificial plantations—are one of the most extended and common forest types in the world. *Pinus* is an ancient conifer genus, comprising approximately 110 species covering a wide range of ecological environments and able to characterise early and late successional stages. *Pinus* trees are pioneer species able to grow well in severe environmental conditions (i.e., drought, heat waves). Therefore, they have been extensively used in many afforestation programmes.

Considering the current extension of natural and artificial pine forests, an important challenge is to manage these forests to maintain or improve timber production, while enhancing other ecosystem services and promoting the long-term sustainability of forest resources. Certainly, forest management should maintain a synergistic and complementary relationship between various ecosystem services while avoiding the generation of trade-offs. Among the forest management choices that can affect the provision of ecosystem services, an important role is played by silvicultural treatments and their spatiotemporal application. Silvicultural treatments influence forest species composition, horizontal and vertical stand structure, stand density and age. They also affect the provision of services in terms of wood assortment production, the natural cycle of elements, water cycle components, and recreational opportunities. In this view, the goal of this Special Issue is to provide a compendium of documents that scientifically evaluates the effects of the application of different silvicultural treatments on the various ecosystem services expected from pine forests.

The Special Issue comprises four articles from the Mediterranean area of Europe, two focusing on artificial plantations of *Pinus nigra* in Italy, one on *Pinus brutia* in Greece and one on natural *Pinus nigra* forest in Spain. Moving to Eurasia, one contribution explores *Pinus taeda* L. plantations located in northern Iran. In addition, *Pinus massoniana* and *Pinus tabuliformis* plantations are investigated in two researches from China. Another paper from Asia is a review of *Pinus merkusii* plantations in Indonesia. Additionally, the North American continent contributes one research, focusing on *Pinus contorta* var. *latifolia* natural forest in British Columbia, Canada.

Concerning pine forests and provisioning services, Zhao et al. [1] in China used 57 plots in a *Pinus tabuliformis* plantation to investigate the direct and indirect influences of site conditions, population structure, and population stability on the productivity of the plantation. The effect of silvicultural treatments and fertilization on provisioning and regulating services are investigated by Sullivan et al. [2] in *Pinus contorta* var. *latifolia* natural forest in Canada. At 25 years after the onset of pre-commercial thinning with different intensities and repeated fertilization, the effect on forest's productivity, structural features, and carbon sequestration of overstorey and understorey are assessed. This report of the 25-year responses of tree growth metrics, stand development and carbon storage could be an important support for forest managers in developing forest strategies capable of ensuring the functionality of diverse ecosystem services provided by forests.

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Determining the contribution of thinning intervention on stands' resistance against natural hazards is important. Thinning practices play a key role in increasing stands stability in the long term. The influence of thinning on snow and wind damages is investigated in the study of Picchio et al. [3] developed in *Pinus taeda* L. plantations located in northern Iran. The research provides suggestions and best practices in choosing thinning strategies, recommending the precise planning of thinning operations finalized at reducing the risk of snow and wind in the different stages of the cultural cycle.

In the Mediterranean area, temperature and water availability are important factors limiting some key supporting services such as plant germination, tree growth and plant health. Petrou and Milios [4] highlight the role of the sowing season in the successful germination of seeds in the field with the lack of water during the dry season as the most relevant driver for a reduction in the survival of seedlings in *Pinus Brutia* plantations in Cyprus. Other negative impacts on seedling emergence are due to skidding operations, which increase soil compaction and reduce vegetation cover and soil's organic matter content, as evidenced by Lucas-Borja et al. [5] in natural stands of *Pinus nigra* Arn. Spp. *Salzmannii* in Spain). The study suggests the short-term impact of skidding operations, realized after tree harvesting, on seedling emergence.

Appropriate forest management practices and silvicultural treatments play a fundamental role in decomposition efficiency, favouring the abundance and the biodiversity of soil organisms. Landi et al. [6] show how the choice of adequate thinning systems affects soil nematode and microarthropod biodiversity in artificial *Pinus nigra* stands in Italy. The effect of different thinning techniques on underground fine root biomass and productivity and water/nutrient absorption is investigated by Li et al. [7] in a *Pinus massoniana* plantation in China, confirming that forest management choices affect the provision of supporting services.

With a focus on the effect of forest interventions on cultural services, De Meo et al. [8] consider the impact of thinning on forest scenic beauty, namely the aesthetic characteristics of forest which can be visually appreciated by visitors in a research in a *Pinus nigra* stand in central Italy.

Rinaldi et al. [9] offer an overview of the current condition of *Pinus merkusii* in Indonesia, describing the innovative silvicultural practices and their effects on the provision of multiple ecosystem services.

In this Special Issue, innovative silvicultural treatments for natural and artificial pine forests have been investigated across different sites representing a part of the world's range of pine conditions. Although pine forests with different geographic contexts, ecological characteristics and management histories have been considered, the accepted articles are connected by a common effort: to increase the various ecosystem services provided by the pine forests, through innovative and adequate silvicultural practices favouring multifunctional and sustainable forest management.

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