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Assessing the attributes of scattered trees outside the forest by a multi-phase sampling strategy

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Summary

A sampling strategy to be used with multi-phase forest inventories is proposed for assessing scattered trees outside the forest on large territories. The first phase is carried out by means of a systematic search over the area to be inventoried. The area is partitioned into regular polygons of the same size and points are randomly located, one per polygon. Subsequently, in the second phase, the land cover class of the first-phase points is determined by very high-resolution remotely sensed imagery and a sample of points are selected from each land cover stratum. Then, the number of trees outside the forest lying within plots at the sampled points is recorded on the imagery. Finally, in the third phase, a subsample is selected from the second-phase samples of each stratum and the biophysical attributes of trees within plots are measured in the field. Approximately unbiased estimators of abundance and of totals and averages of biophysical attributes are achieved in the second and third phase, respectively, together with the estimators of the corresponding variances. A simulation study is performed in order to assess the accuracy of the strategy under random and aggregated distributions of trees. The sampling errors achieved in the second phase using sampling fractions of ~0.3 per cent of trees vary from 6 to 13 per cent, whereas the errors achieved in the third phase using sampling fractions of ~0.15 per cent vary from 15 to 31 per cent. The results obtained from three case studies carried out in Italy confirm the accuracy levels achieved in the simulation.

Introduction

Scattered trees outside the forest (STOF) are prominent features in many landscapes worldwide, including natural, cultural and recently modified landscapes, and their ecological, social and economic importance is widely acknowledged (Manning *et al.*, 2006). STOF are usually associated with annual/permanent crops and pastures, and secondarily with non-cultivated/non-managed lands (e.g. parts of savannah land, mountainous regions, peatlands).

Research has turned its attention to STOF because of the growing importance of agroforestry and the key role played by trees in carbon sequestration, nitrogen fixation, biodiversity conservation and the supply of fodder and browse. The significance of STOF can be observed in several other contexts as well, considering their multiple aesthetic, environmental and social roles. Moreover, in countries with low forest cover, they constitute the main source of wood products and energy for rural populations. For these reasons, STOF are considered as a distinct item in the preparation of the Global Forest Resource Assessment 2015 (FAO, 2010). A number of international agreements and commitments (e.g. the Forest Principles of Agenda 21, the Convention on Biological Diversity and the Framework Convention on Climate Change) emphasize that an appropriate database is a prerequisite for sound management of the world's natural resources: whereas these agreements and commitments generally refer to forest, the idea of sustainable management of natural resources applies to STOF as well (Kleinn, 2000). The general objective is to enable the provision of information on STOF status and evolution in time and quality in order to take informed decisions related to the optimization of tree resources for sustainable development and food security (FAO, 2010).