

# Land use inventory as framework for environmental accounting: an application in Italy

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Land use inventories are sound measures to provide information on the area occupied by different land use or land cover types and their changes, although less widespread than traditional mapping; as such, they are distinctively well-established tools for generating statistics on the state and the dynamics of land use in the European Union. Italy has recently set up a land use inventory system (IUTI) as a key instrument for accounting removals and emissions of greenhouse gases (GHG) associated to land use, land use change and forestry (LULUCF) activities elected by Italy under the Kyoto Protocol. IUTI adopts a statistical sampling procedure to estimate the area covered by LULUCF land use categories in Italy, and associated uncertainty estimates. Estimates of land use have been so far processed for the period 1990-2008 and highlight three inter-linked land use change patterns in Italy: (i) increase in forest land for a total uptake of 1.7% of the Italian territory; forest cover estimates, with a standard error of 0.1%, indicate an annual increase of forestland higher over the period 1990-2000 (32 901 ha year<sup>-1</sup>) than in 2000-2008 (22 857 ha year<sup>-1</sup>); surprisingly, also a significant deforestation rate is observed (-7000 ha year<sup>-1</sup>), due to forest land conversion mainly into artificial areas; (ii) consumption of arable land (-4.2% of the Italian territory) primarily due to land uptake by urban areas and to conversions to permanent crops (mainly orchards and vineyards); (iii) urban sprawl uptakes 1.6% of the Italian territory in this period, with a total coverage of settlements reaching 7.1% of total land surface in Italy in 2008. Overall, land use dynamic results in land uptake by forest land is of the same magnitude of land uptake by urban areas, but the effects of these processes on GHG removals (by forest sinks) and emissions (by urban areas) is expected to be significantly different. In a broader perspective, IUTI methodology, by providing reliable estimates and well-defined levels of statistical uncertainty for assessing stocks and flows of land use at national level, can be further implemented to frame other key questions for sustainable development policies, like the set up of environmental-economic accounting systems.

**Keywords:** Land Use Survey, Land Use Change, Statistical Sampling, Forest, Environmental Accounting

## Introduction

Land use inventories are sound measures to provide information on the area occupied by different land use or land cover types and their changes, although less widespread than traditional mapping. The use of formal statistical procedures allows land use inventory to straightforwardly provide area figures along with uncertainty estimates: this is an important advantage in comparison to other land-use area assessment methods, as the reliability of such figures can be quantitatively evaluated (Corona et al. 2007, Corona 2010).

Distinctively, land use inventories are well-established tools for generating statistics on the state and the dynamics of land use in the European Union: for instance, the Program

Land Use/Cover Area frame statistical Survey (LUCAS, Decision N°1445/2000/EC of the European Parliament and the Council) provides harmonized data on land use/cover and their changes over time in the 27 EU countries based on direct observations gathered through ground survey in the framework of area-frame sampling scheme.

Italy is one of the first European countries that have adopted statistical systems to monitor land use changes earlier than the proliferation of mapping initiatives, thanks to the AGRIT project (<http://www.itacon.it>). More recently, the Italian Ministry of Environment, Land and Sea has implemented the land use inventory (Inventario dell'Uso delle Terre - IUTI) as a key instrument of the National Registry for forest carbon sinks. The

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Registry is part of the national system for the Italian greenhouse gas inventory, which includes all institutional, legal and procedural arrangements for accounting anthropogenic emissions by sources and removals by sinks of greenhouse gases (GHG) under the United Nation Framework Convention on Climate Change and its Kyoto Protocol (ISPRA 2011). Italy has elected forest management (Article 3.4) as activities eligible for the first commitment period, thus assigning to forest sector a leading role in the fulfilment of the Italian target under the Kyoto Protocol. Accordingly, the latest Italian National Forest Inventory (NFI) has been conceived as main data source for accounting removals/emissions of GHG in forest land (see <http://www.infce.it>), e.g., by adopting the FAO FRA 2000 forest definition (FAO 2001) selected by Italy under the Kyoto Protocol (MATTM 2006, UNFCCC 2007).

The National Registry for carbon sinks integrates the NFI sample set within a bundle of integrated tools aimed at estimating greenhouse gases removals/emissions associated to activities under articles 3.3 (afforestation, reforestation and deforestation) and 3.4 (forest management) of the Kyoto Protocol, in accordance with the relevant decisions of the Meeting of Parties of the Kyoto Protocol and with the Good Practices Guidance for Land Use, Land Use Change and Forestry (GPG-LULUCF) of the Intergovernmental Panel on climate change (Panman et al. 2003). Notably, IUTI adopts statistical sampling procedures to estimate the