



Part 2: Trees Outside Forests Assessments



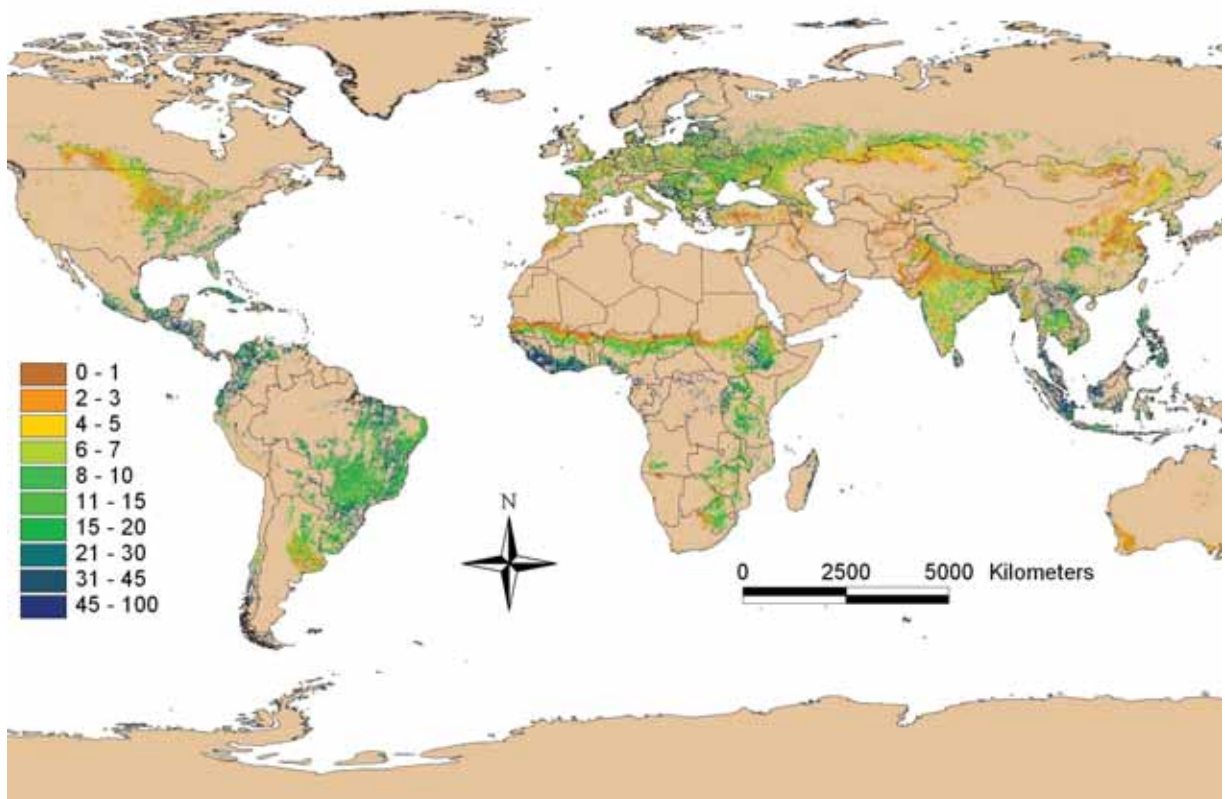
Introduction

This part consists of the synthetic profile sheets that were made for each assessment and for each supporting programme. Most national assessments have been organized by country, because in most countries, complementary data on TOF may be gathered from different national inventories, due either to the land-use dispersal of TOF or to differences in the targeted variables. The profile sheets were used as a basis for the comparative analysis of the assessments (Part 1,

Chapter 3). All points that were unclear in the available documents were clarified by experts working in the supporting programmes for the global and regional assessments, and by national experts for the countries. Once completed, profile sheets were as much as possible sent for checking and validation to programme experts or to the relevant contact-persons in the countries. Any error still remaining is to be attributed to the authors of this report.

Figures in the Assessment Profiles usually follow the International System of Units («metric system»). In some profiles however, figures do not follow the metric system because they have been kept in accordance with the sources used for the profile .

Tree Cover on Agricultural Land - Global



Source: Zomer, R. J., A. Trabucco, et al. 2009. *Trees on Farm: Analysis of Global Extent and Geographical Patterns of Agroforestry*. ICRAF Working Paper 89. Nairobi, World Agroforestry Centre: 72.

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1. Large area TOF Assessments



Global Trees Outside Forests Assessment



..... Trees on Farm

The study “Trees on Farm, analysis of global extent and geographical patterns of agroforestry” represents the first attempt of a TOF assessment at global scale. Focused on trees on land used for agriculture, this assessment highlights the quantitative importance of this kind of TOF worldwide.

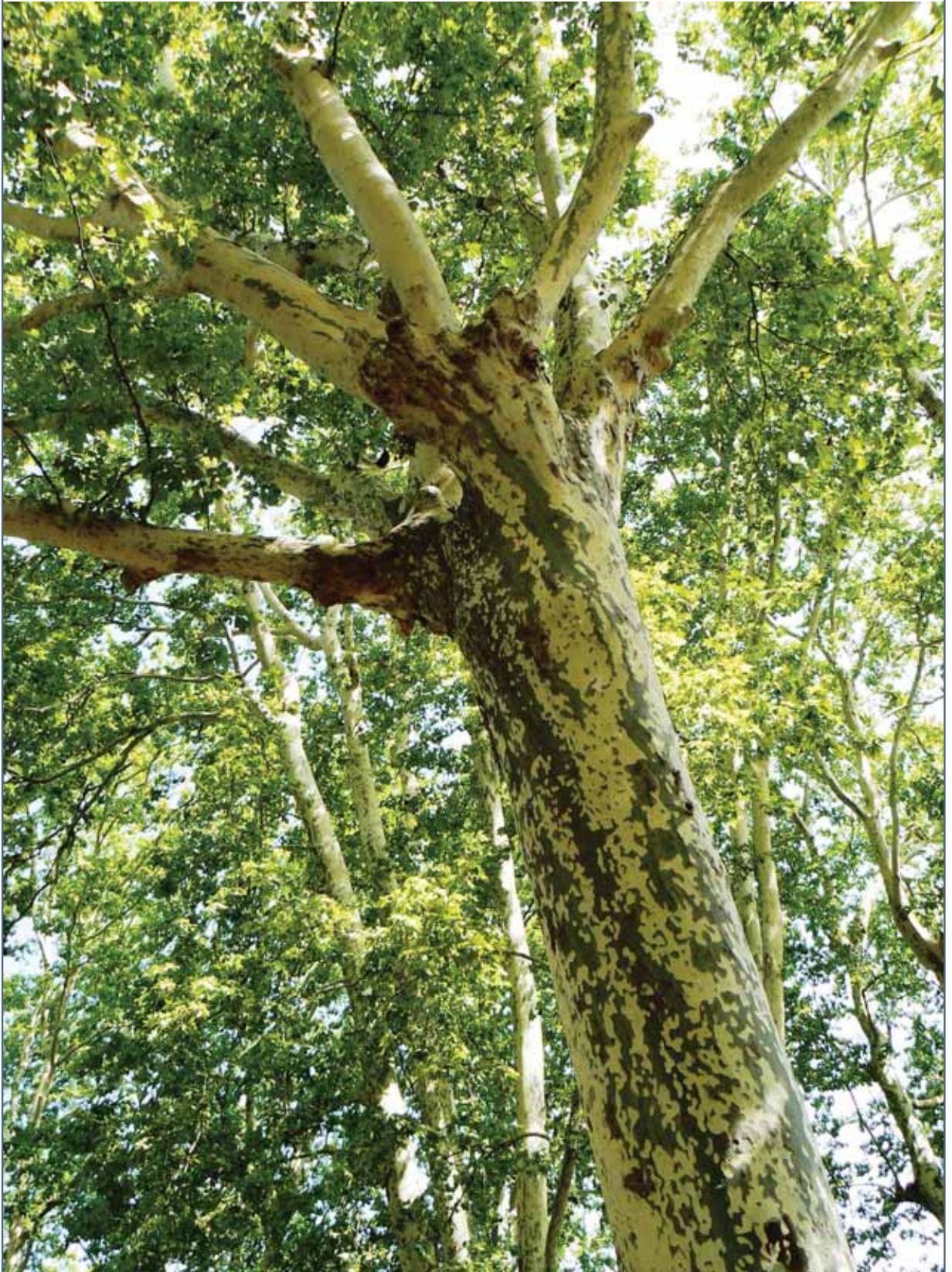
Trees on farm: analysis of global extent and geographical patterns of agroforestry	
Objective	To quantify and map the extent of agroforestry at the global level through a remote sensing approach, and to examine the relationships among tree cover, population density and climatic conditions within agricultural land.
Institution in charge	World Agroforestry Center (ICRAF).
Scale, duration, periodicity	Worldwide (Global) Results published in 2009
Data used	Geo-datasets: - VMAP 0 - Country Boundaries - MOD44B MODIS Vegetation Continuous Field Coll. 3– TC - Global Land Cover 2000 database - Global Rural-Urban Mapping Population (GRUMP v. 1) - Aridity Index
Methodology	<p>The geospatial analysis of remote-sensing derived global datasets allowed the production of maps visualizing the relationships among tree cover, population density and climatic conditions within land used for agriculture, at a 1 km resolution.</p> <p>Three data sources were used to obtain cross-sectional information:</p> <ol style="list-style-type: none"> 1. Global land use. Spatial data layers exist that classify any pixel as agricultural or some other land use. 2. Global tree cover. Remote sensing data has been interpreted to give an estimate of the percentage tree cover in a pixel. 3. Global population. Spatially disaggregated population layers are available, which give an estimate of population in any pixel and can be used to measure the relation between agroforestry and population density. <p>Only the portion of land used for agricultural has been considered. This area was then stratified for each tree canopy cover value (0 to 100) into 20 population density classes, 20 aridity index classes and 13 subcontinents. Within each stratum, or within specific aggregation of strata, zonal statistical values (e.g. mean, sum, total area, percentiles, areal distribution) were summarized to describe: tree canopy cover (percent), total population and population density.</p>
Variables related to TOF	Spatial: location, area covered by each feature Biophysical: Tree cover Background information: Aridity index and population density
Categories that may include TOF	All categories in this assessment are TOF categories (trees on land used for agriculture)

TOF sets and subsets covered	Trees in an agricultural land-use context: Set 1 (TOF-AGRI)
Results	<p>- Agroforestry is a significant feature of agriculture in all regions, with approx 10 million km² of agriculture area (or 46 percent of the total “agriculture land” in the survey) having more than 10 percent tree cover.</p> <p>- Its extent varies significantly across regions (e.g. for agriculture area with a canopy cover above 10 percent, it varies from 9 percent of total agriculture land in North Africa and Western Asia, to 98 percent in Central America).</p> <p>The resulting information of this assessment is presented in a number of maps (global and regional) and figures, among others :</p> <ul style="list-style-type: none"> • Tree canopy cover on agricultural land. • Agricultural area with tree cover at different thresholds (10, 20 and 30 percent) by major regions. • Population in agricultural areas with tree cover at different thresholds (10, 20 and 30 percent) by major regions. • Average tree density on agricultural land by population density for each region. • Actual and potential tree cover and their difference in Africa.
Comments	<p>- Even though resolution of images is low, the study allows a good overview of agroforestry resources at global scale. Regional comparison is then available, keeping in mind all the restrictions described in the report document.</p> <p>- It identifies the actual gaps of agroforestry evaluations and opens the way to other studies on tree cover patterns.</p> <p>- Due to the low resolution of the images used, the results are rough estimates.</p> <p>- This assessment is restricted to agricultural lands, and does not thus include all TOF categories. The low resolution allowed only large areas of agroforestry systems and tree crops to be taken into account.</p> <p>- As it is based on remote sensing only, the usual gaps are implied (e.g. clouds, no data area)</p>
References	Zomer, R. J., A. Trabucco, et al. 2009. <i>Trees on Farm: Analysis of Global Extent and Geographical Patterns of Agroforestry</i> . ICRAF Working Paper 89. Nairobi, World Agroforestry Centre: 72.

This assessment profile was validated by Mr Robert Zomer (Deputy Programme Manager, Ecosystem Services Program, ICIMOD, Nepal).



Regional Trees Outside Forests Assessment



..... Corine Land-Cover

The Corine land cover programme represents the first regional scale assessment that provides information on the area and location of some TOF subsets.

Corine Land-Cover (Co-Ordination of Information on the Environment)	
Objective	To provide information on land cover and land cover changes in Europe, based on the photo-interpretation of satellite images carried out by the national teams of participating countries, the National Reference Centres (NRCs) on land cover of the European Environment Information and Observation NETwork (Eionet).
Institution in charge	Developed by the European Commission and carried out by the European Environment Agency (EEA) and Eionet.
Scale, duration, periodicity	Region-wide: Europe First Corine Land-Cover (CLC) in 1990, Second in 2000, latest in 2006
Data used	Earth observation satellite images
Methodology background	<p>Since 2000, Corine Land-Cover projects (I & CLC2000 and I & CLC2006) are based on 2 components: Image acquisition and interpretation of land cover change.</p> <ul style="list-style-type: none"> - In 2000: <ul style="list-style-type: none"> • IMAGE2000: Covering all activities related to satellite image acquisition, ortho-rectification and production of the European and the national mosaics; • CLC2000: covering all activities related to the update of CLC1990 by detection and interpretation of land cover changes (CLC-Changes). It used CLC1990, IMAGE1990 and IMAGE2000 data. Additionally, in order to prevent the propagation of errors into the new update, geometric and thematic mistakes in CLC1990 were corrected. - In 2006, a similar update was done with IMAGE2006 and CLC2006, mapping land cover changes between 2000 and 2006. <p>In order to improve resolution and enlarge environmental monitoring and assessment programs, collaboration was launched between the European Commission, the European Space Agency (ESA) and the European Environment Agency. Now, CLC is part of the land monitoring services of the GMES Initial Operations (GIO) , and the European Topic Centre on Spatial Information and Analysis (ETC-SIA) is supporting the EEA in quality assurance and quality control of the land use/land cover changes.</p>



Methodology

Satellite images interpretation and national land cover inventories are carried out by the national teams, and are further integrated into a seamless land-cover map of Europe by the European Environment Agency (EEA). EEA is also in charge of the updates.

The European database thus created is based on standard methodology and nomenclature (see CLC classes).

Maps are at a 1:100 000 scale, with a minimum mapping unit (MMU) of 25 ha and a minimum width of linear elements of 100 m for the baseline mapping. Land cover changes are mapped with a MMU of 5 ha and a minimum width of linear elements of 100 m.

Evolution of Corine land cover projects (EEA 2007)			
	CLC1990 Specifications	CLC2000 Specifications	CLC2006 Specifications
Satellite data	Landsat -4/5 TM single date (in a few cases Landsat MSS, as well)	Landsat -7 ETM single data	SPOT -4 and/or IRS LISS III two dates
Time consistency	1986-1998	2000 +/- 1 year	2006 +/- 1 year
Geometric accuracy satellite images	≤ 50 m	≤ 25 m	≤ 25 m
CLC minimum mapping unit	25 ha	25 ha	25 ha
Geometric accuracy of CLC data	100 m	better than 100 m	better than 100 m
Thematic accuracy	≥ 85 % (not validated)	≥ 85 % (validated, see Büttner, G., Maucha, G., 2006)	≥ 85 %
Change mapping	N.A.	boundary displacement min. 100m; change area for existing polygons ≥ 5 ha; isolated changes ≥ 25 ha	boundary displacement min. 100 m; all changes > 5 ha have to be mapped
Production time	10 years	4 years	1.5 years
Documentation	incomplete metadata	standard metadata	standard metadata
Access to the data	unclear dissemination policy	free access	free access
Number of European countries involved	26	32	38

Source : European Environment Agency, 2007

The standard CLC nomenclature includes 44 land-cover classes. These are grouped in a three-level hierarchy. The five main categories of level-one are: 1) artificial surfaces, 2) agricultural areas, 3) forests and semi-natural areas, 4) wetlands, and 5) water bodies.

Variables related to TOF

Spatial: location, area covered by each feature
 Biophysical: Land cover
 Background information: Land Use (to a certain extent)

Categories that may include TOF

The following table shows the various Corinne categories (level 3 classes) that include or may include TOF :

Corinne Land-Cover Classes			Description and examples of TOF apprehended
Level 1	Level 2	Level 3	
1. Artificial surfaces	1.1. Urban fabric	1.1.2 Discontinuous Urban fabric	Includes private housing estates, residential suburbs made of individual houses with privative gardens and small squares, scattered blocks of residential flats, hamlets, small villages where numerous un-mineralized interstitial spaces (gardens, lawns can be distinguished)
	1.4 Artificial, non-agricultural vegetated areas	1.4.1 Green urban areas	Includes parks, mansions and their grounds, vegetated areas, Green urban areas, Greenery with strips of lanes.
		1.4.2 Sport and leisure facilities	Camping ground, sport ground, leisure parks, golf courses, zoological gardens, botanical gardens outside urban fabric, forest parks outside built-up areas.
2. Agricultural areas	2.2 Permanent crops	2.2.2 Fruit trees and berry plantations	Parcels planted with fruit trees or shrubs: single or mixed fruit species, fruit trees associated with permanently grassed surfaces. Includes groves, Ligneous crops: fruit, orchards.
		2.2.3 Olive groves	Areas planted with olive trees, including mixed occurrence of olives trees and vines on the same parcel.
	2.3 Pastures	2.3.1 Pastures	Pastures can be described as extensively used grasslands with presence of farm structure. Include areas with hedges.
		2.4.2 Complex cultivation patterns	Juxtaposition of small parcels of diverse annual crops, pasture and permanent crops.
		2.4.3 Land principally occupied by agriculture, with significant areas of natural vegetation	Areas principally occupied by agriculture, interspersed with significant natural areas, such as linear structures of trees organized for truffle producing.
		2.4.4 Agroforestry areas	Annual crops or grazing land under the wooded cover of forestry species.

Source: http://etc-lusi.eionet.europa.eu/CLC2000/classes/index_html

TOF sets and subsets covered

- Trees in agricultural land-use context (set 1: TOF-AGRI, partly covered)
- Trees in urban land-use context (set 2: TOF-URB, partly covered)

<p>Results</p>	<p>No data on TOF have been published, but data related to the categories including TOF can be extracted and allow an estimate of the minimum extent of TOF covered land in the various countries of Europe as well as in Europe as a whole.</p> <p>CLC2006 is implemented in the following countries (EIONET 2010):</p> <ul style="list-style-type: none"> - Completed: Albania, Austria, Belgium, Bosnia and Herzegovina, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Hungary, Iceland, Ireland, Italy, Kosovo, Latvia, Liechtenstein, Lithuania, Luxembourg, Macedonia, the former Yugoslavian Republic, Malta, Montenegro, the Netherlands, Norway, Poland, Portugal, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland and Turkey. - Still in progress: the United Kingdom. - Not initiated yet: Greece.
<p>Comments</p>	<ul style="list-style-type: none"> - CLC database can be used to give a good overall estimation of the area covered with TOF, in a standardized way across Europe. - CLC database is, in general, compatible with national Land Use / Land Cover assessments that can help to provide more accurate information. For example, some European countries use LUCAS (Land Use / Cover Area frame statistical Survey) or LUCAS derived surveys, as an additional information dataset to implement Corine database. LUCAS, organized by Eurostat, is a European-wide national survey based on photo-interpretation and different types of ground surveys (EUROSTAT 2010). - Different projects use CLC database, among others: <ul style="list-style-type: none"> • The Land and Ecosystem Accounting (LEAC) project by the European Environment Agency (EEA), which deals with data on changes in land cover and land use and aims to trace the wider environmental, social and economic implications of these transformations; • Land Cover and Forest Indicator Service of the GSE Forest Monitoring, which is a European Space Agency (ESA) funded project. It is part of the Global Monitoring for Environment and Security Services Element (GMSE-GSE), a joint initiative of the European Commission and ESA. - Corine Land-Cover can be to a certain extent compatible with LCCS (see LCCS Profile sheet): “automatic translation from CLC to LCCS doesn’t seem feasible at the most detailed level but CLC has potential of interoperability with global land cover activities, (e.g. using the 2nd-level classes, aggregating several classes into a single one or also splitting specific single classes). When coming to concrete mapping, CLC can however be considered as a LCCS version for Europe” (Weber 2009). - Methodology only based on Remote Sensing, no direct field sampling is done, thus no qualitative data on vegetation is provided. - The scale used is quite large as the minimum mapping unit is 25 ha, which is by far too imprecise as it comes to a certain category of TOF (subset N).
<p>References</p>	<p>EIONET. 2010. Corine Land Cover 2006. from http://etc-lusi.eionet.europa.eu/CLC2006.</p> <p>European Environment Agency. 2007. CLC2006 technical guidelines. EEA Technical report 17/2007. Copenhagen, Denmark, EEA: 70 pp.</p> <p>EUROSTAT. 2010. LUCAS — a multi-purpose land use survey. Retrieved November 2010, from http://epp.eurostat.ec.europa.eu/statistics_explained/index.php/LUCAS_%E2%80%94_a_multi-purpose_land_use_survey.</p> <p>Weber. 2009. Land cover classification for land cover accounting. 14th Meeting of the London Group on Environmental accounting, Canberra, Australia. http://www.eea.europa.eu/data-and-maps/data/corine-land-cover-2006-raster http://www.eea.europa.eu/data-and-maps/data/land-cover-accounts-leac-based-on-corine-land-cover-changes-database-1990-2000.</p>

This profile was validated by Mr Chris Steenmans (Head of Programme Shared Environmental Information System, EEA, Denmark).

National Trees Outside Forests Assessments



Bangladesh

The first National Forest and Tree Resources Assessment 2005-2007 (NFA) of Bangladesh was implemented in both forests and TOF areas whereby earlier management inventories were confined within the designated forest reserves.

First National Forest and Tree Resources Assessment (NFA) 2005-2007	
Objective	To lay out sound foundations for the development of forest policies, forestry programmes, forest management, sustainable development, conservation of the resources, and integrated national policies. (Bangladesh Forest Department, Bangladesh Space Research and Remote Sensing Organization et al., 2007).
Institutions in charge	Bangladesh Forest Department (BFD) of the Ministry of Environment and Forest (MOEF): with assistance from the Bangladesh Space Research and Remote Sensing Organization (SPARRSO) for the remote sensing survey.
Scale, duration, periodicity	Countrywide The NFA was implemented from June 2005 to August 2007
Data used:	- Landsat TM imageries 30 x 30 m (Band 3,4 and 5) - 267 Topo-Sheets at the scale of 1:50 000
Methodology	NFA Bangladesh is based on the NFMA methodology (see NFMA description sheet) Methodology design was issued after the Inception Workshop organized by the Forest Department (FD) in April 2005. Attended and participated by different ministries and divisions of Government of Bangladesh, institutes, herbarium, universities, forest and agriculture departments and FAO. A National Forest Assessment Unit (NFAU) was set within the FD for project implementation (coordination and monitoring of the NFA at national level) under the overall guidance of a National Project Coordinator (NPC). Specific adaptations of the NFMA Bangladesh general methodology: - Systematic sampling grid 15' x 10': 296 sampling points on land (FAO's standard layout for Tracts, Plots and Subplots was adopted but Subplots were not used in non-forest plots) - Development of a national Land Use classification system that corroborates with the Global Land Use classes (GLU) identified by FAO - Socio-economic interviews in sampled areas to assess information related to forest and tree resources management, uses and users: <ul style="list-style-type: none"> • With external key informants (local forest services, local administrations) • With forest and tree users: individuals or focus groups met during focus group discussions (FGDs) (owners, women, hunters)
Variables related to TOF	Spatial: Plot and tree location, plot orientation, sketch map with property limits, land use/cover sections, watercourses, hedges, proximity to infrastructure Biophysical: Trees assessment if DBH > 10 cm. Tree cover class (<5 percent; 5-10 percent; 10-30 percent; 30-70 percent; >70 percent), shrub coverage, tree species, stem quality, health, number of stumps, tree regeneration, dendrometric characteristics (DBH, total tree height, commercial tree height, year since cut, branch diameter and length), environmental problems (e.g. drought, erosion, burning) Socioeconomic: Land tenure status, Density of population on tract, Tree uses and products (including Non Timber Forest Products (NTFP)) Other background information: Class of protection level, Land use.

Categories that include TOF:	<ul style="list-style-type: none"> - Other land/ Cultivated Land/ Annual Crops/with trees 0.1-0.5 ha (CA1) - Other land/ Cultivated Land/ Annual Crops/with trees >0.5 ha (CA2) - Other land/ Cultivated Land/ Perennial Crops/ with trees 0.1-0.5 ha (CP1) - Other land/ Cultivated Land/ Perennial Crops/ with trees >0.5 ha (CP2) - Other land/ Cultivated Land/ Wooded Land with shifting cultivation, Fallow (Fa): It includes woody vegetation deriving from the clearing of natural forest for shifting agriculture. - Other land/ Villages/ Rural settlement with trees 0.1-0.5 ha (SR1) - Other land/ Villages/ Rural settlement with trees >0.5 ha (SR2) - Other land/ Cultivated Land/ Range Land, Pasture (RL): Land under permanent meadows and pastures
Categories that may partly include TOF:	<ul style="list-style-type: none"> - Other land/ Built-up Areas/ Urban settlements (SU) - Other land/ Built-up Areas/ Highways and other artificial areas (HA) - Other land/ Barren Land, Grasslands (BG) - Inland water (W): it appeared in results that 5 percent of this LUC has tree cover of > 5 percent.
TOF sets and subsets covered	All TOF sets and subsets are covered (no exclusion); they are taken into account either in specific TOF categories (see above) or in categories that may include TOF (e.g. trees in urban settlements, trees in pastures, grasslands with less than 5 percent tree cover).
Results	<ul style="list-style-type: none"> - Data from 296 tracts were collected ultimately all over the country within 10 regions - 27 land use types are distinguished in the maps produced by SPARRSO - 30 percent of the Cultivated land area has tree cover - The area covered with categories that include TOF is 4 091 000 ha (27.72 percent of the total country area, while Forest stands for 9.77 percent and OWL for 1.95 percent). - Total TOF above-ground biomass is estimated to 569 million tons (Forest: 278 million tons). Cultivated lands account for 142 million tons (density: 17 tons/ha), Village lands account for 413 million tons (density: 144 tons/ha), Urban lands account for 10 million tons (density: 93 tons/ha) and Inland water account for 4 million tons (density: 2 tons/ha).
Comments	<ul style="list-style-type: none"> - In the different LUCs, all woodlots areas measured are more than 0.1 ha: woodlots smaller than 0.1 ha cannot be distinguished from their surrounding land-cover category. - Basic data for categories that may include TOF are accessible in the original NFA sampling forms, and may thus be extractable. - Sampling error is relatively high due to disproportion between the main classes. It is 17 percent for the “Other land” category (FAO, 2008). - There were 10 field teams of 3 members each, and field sampling lasted 5 months (FAO, 2008). The whole project was 33-month long and its cost was US\$520 000 (of which 115 000 for fieldwork) (FAO, 2008). - For an unknown reason, the level 2 “Shrub” category, which is fully under the “Other Wooded Land” International Land Use category had been included into the Cultivated Land category for the estimation of all variables except for area.
References	<p>Bangladesh Forest Department, Bangladesh Space Research & Remote Sensing Organization, et al. 2007. <i>National Forest and Tree Resources Assessment 2005-2007 Bangladesh</i>. 286.</p> <p>FAO. 2008. NFMA approach and process: an analysis of Cost and Time. <i>Background Paper prepared for the National Forest Monitoring and Assessment [NFMA] Expert Consultation “Meeting Evolving Needs”</i>. Rome - 26-28 November. Working Paper NFMA 39: 20.</p> <p>FAO. 2010. <i>Forest Resources Assessment 2010 (FRA 2010)</i> - country reporting process. Retrieved October 14, 2010, from http://www.fao.org/forestry/62318/en/.</p>

..... Cameroon

In order to update the information on forest resource and obtain information on wood resources in non forest areas, the Cameroon government implemented a new comprehensive inventory. This assessment provides information on TOF.

National forest resource assessment 2003-2004	
Objective	To assess national forest resources (timber and non-timber), taking into account woody perennials and trees outside forests, and to implement a monitoring system for forest resources.
Institution in charge	Ministry of Forests and Fauna, with FAO collaboration.
Scale, duration, periodicity	Countrywide Preparation and implementation phase (1) 2002-2003, Implementation phase (2) 2004-2005
Data used	Topographic maps (usually 1:200 000)
Methodology	NFRA Cameroon is based on the NFMA methodology (<i>see NFMA description sheet</i>) Specificity within the NFMA general methodology: <ul style="list-style-type: none"> - Two areas have been distinguished, based on vegetation type and ecological features: 2 strata, northern open area and closed southern area - Systematic sampling grid: for northern area 30' x 30', for southern area 30' x 15'; a total of 207 sampling points have been inventoried - Sampling units: 1 km x 1 km², following the general methodology - Socio-economic interviews with key informants and forest users (individuals or groups) in sampled areas
Variables related to TOF	Spatial: Plot location, tree location, plot orientation and sketch Biophysical: tree number and species, tree measurement if DBH ≥ 10 cm for TOF (DBH, height, health, quality, damages, conservation status, etc.) Socioeconomic: land tenure, land management, products and services (including NWFP) and income generating activity Background information: Land use (LU/LC Sections)
Categories that may include TOF	The categories assessed are the FAO FRA categories. So, as expected, TOF can be found within some of the subcategories of Other Land: <ul style="list-style-type: none"> - Natural: <ul style="list-style-type: none"> • Grassland • Wetland - Cultivated: <ul style="list-style-type: none"> • Perennial Crop • Pasture land - Built-up area

TOF sets and subsets covered	All TOF sets and subsets are covered
Results	<p>- Other land (OL) represents 11 230 928 ha (23.6 percent of the country area) with a total wood volume of 350.5 million m³ (average density of 31.2 m³/ha):</p> <ul style="list-style-type: none"> • Perennial crops cover 1 238 249 ha (11 percent of OL) with a total wood volume of 114.7 million m³ (92.7 m³/ha). • Annual crops cover 5 105 665 ha (45.5 percent of OL), and also represent an important wood resource, with 109.7 million m³ (21.5 m³/ha). • Wetland: 1 158 866 ha (10.3 percent of OL), with 64.6 million m³ (55.77 m³/ha). • Grassland: 1 944 742 ha (17.3 percent of OL), with 40.3 million m³ (20.7 m³/ha). • Pastures: 1 308 204 ha (11.6 percent of OL), with 18.6 million m³ (14.2 m³/ha). • Built-up areas: 382 402 ha (3.4 percent of OL), with 2.6 million m³ (4.4 m³/ha). <p>- Even though almost all categories of OL have wood, very little can be considered as harvestable for timber (5.2 percent of the total)</p> <p>- Other Land had 317 species of trees out of 573 encountered in the whole inventory</p> <p>- “Fallows” represent 2 088 803 ha, with a total wood volume estimated to 110 360 740 m³ (52.8 m³/ha)</p> <p>TOF represent a minimum area of 13 319 731 ha (28 percent of the country area), with a total wood volume estimated to 451 million m³ (6.3 percent of the country estimated total wood volume). Harvestable volume (trees belonging to the “Top 50” species list with a DBH > the minimum legal DBH for cutting) is estimated to 88 million m³, or 7 percent of the total harvestable volume.</p>
Comments	<p>- No minimal area for Other Land and Other Wooded Land.</p> <p>- Forest fallows (with trees less than 5 m high) in shifting cultivation system with a short cycle (less than 5 years) made-up a sub-class “fallow”, integrated into OWL. This whole sub-class is to be considered TOF (part of OL) because land is used predominantly for agriculture.</p> <p>- Data on small woods (< 0.5 ha) cannot be extracted.</p>
References	<p>Branthomme, A. 2002. <i>Inventaire forestier national du Cameroun - Manuel de terrain</i>. Altrell, Saket and Vuorinen. Rome, FAO: 60 pp.</p> <p>Ministère des Forêts et de la Faune. 2007. <i>Évaluation des Ressources Forestières Nationales du Cameroun 2003 - 2004</i>. FAO. Yaoundé, Cameroun, République du Cameroun, FAO: 93 pp.</p>

..... Canada

The National Forest Inventory (NFI) is currently the only available source of information on TOF at country scale. It was established between 2000 and 2006, replacing the CanFI (which was a periodic national compilation of existing provincial and territorial forest inventory information). This new National Forest Inventory takes into account the FAO-FRA categories as a basis (although ignoring the size threshold), including “Other Land with Tree Cover”, a subcategory of Other Land with TOF.

Although Canada has no countrywide assessment of its trees and forests in urban environments, many municipalities have their own urban forestry management systems, and some even quantify the economic benefits of maintaining Urban Forests (personal communication: Mike Rosen). Most countries are in the same situation, having city assessments but no countrywide integration of these assessments. The Toronto Urban Tree Canopy Assessment is included here as an example of city assessment.

First National Forest Inventory (NFI), 2000-2006	
Objective	The purpose of the NFI is to assess and monitor the extent, state and sustainable development of Canada’s forests in a timely and accurate manner.
Institution in charge	Natural Resources Canada – Canadian Forest Service coordinates the NFI, manages and analyzes the data, and provides the final reports. Provincial and territorial collaborators collect and provide data using jointly developed standards and procedures.
Scale, duration, periodicity	Countrywide NFI follows a 5-year measurement (continuous) and reporting cycle.
Methodology	<p>There are 6 phases in the NFI:</p> <ol style="list-style-type: none"> 1. A network (grid) of sampling points across the population (Canada); 2. Stratification of the sampling points, with varying sampling intensity among the strata; 3. Estimation of some attributes from remote sensing sources on a primary (large) sample; 4. Estimation of other detailed data from a (small) ground-based sub-sample; 5. Estimation of changes in (3) and (4) from repeated measurements; 6. Compilation of NFI attributes. <p>General sampling design</p> <p>The objective is to survey 1 percent of Canada Land mass. The base for the national network is a 4 km x 4 km grid. Each territory/province can select to a certain extent the sampling intensity according to its own inventory process, but the sampling grid most of the time is 20 x 20 km, nested on the national 4 km x 4 km grid. Sampling intensity varies also with the type of ecozone. All NFI plots are permanent.</p> <p>The stratification is done by terrestrial ecozones (15 ecozones) and territory/province. Data are then aggregated at national level.</p> <p>The NFI Design Document lists a set of 25 key attributes designed to satisfy national reporting requirements for criteria and indicators of sustainable forest management. Individual provinces and territories may decide to include additional attributes.</p>

	<p>Photo-plots</p> <p>They are located generally at the nodes of a 20 km x 20 km sample point grid. Photo-plots have a square shape and a size of 2 km x 2 km. 18 850 Photo-plots (equivalent to 1 plot per 39 000 ha, none in the arctic ecozone) provide information on area coverage and some attributes estimable (e.g. wood volume and tree species) by Remote Sensing (aerial photography, with a minimal scale of 1:20 000 for vegetated areas (forested and non forested) and satellite images for unvegetated areas or with little vegetation).</p> <p>Each Photo-plot contains 4 data layers: Land cover, Land Use, Ownership, Protection Status. Interpretation is done according NFI Land Cover Classification System (LCCS) and the NFI Land Use Classification System (LUCS):</p> <ul style="list-style-type: none"> - NFI LCCS has 5 levels: land base meaning vegetated or not (5 percent vegetation), land cover type (treed, non treed/water, land) landscape position (Wetland, Upland, Alpine), vegetation type and density class. - NFI LUCS: Industrial, Forestry, Agriculture, Conservation, Infrastructure, Settlement, Recreation, National Defence, Unknown. <p>Each polygon is recommended to have a minimal size of 0.5 ha and a minimal width of 1 mm at photo scale, but they can be smaller.</p> <p>Ground plots</p> <p>They are a subsample of the photo-plots (10 percent, with a minimum of 50 forested plots/ecozone), on which measurements, like diversity and biomass are taken. These ground plots are only established on forested locations, and for this reason, they will not be described further here.</p>
Variables related to TOF	<p>Photo-plots</p> <p>Spatial: landscape location (relative to the drainage and elevation), area</p> <p>Biophysical: Land cover, vegetation type, density class, stands structure. For vegetated polygons: stand origin, stand disturbance, stand attributes (species and percent, height, age, crown closure, volume)</p> <p>Background information: Land use, Ownership, Protection status</p>
Categories that may include TOF	<p>OLwTC which is a sub-category of Other Land <i>with TOF</i> (S>0,5ha and CC >10 percent), including urban trees and tree crops;</p> <p>Forest may also include TOF (small woods) because of the absence of a size threshold;</p> <p>Other Wooded Land may also include TOF for the same reason.</p>
TOF sets and subsets covered	All TOF sets and subsets are included in the coverage of the assessment
Results	Other Land With Tree Cover spans over 7 773 240 ha.
Comments	<ul style="list-style-type: none"> - Definitions for forest and other wooded land are the FAO-FRA definitions except for the size threshold (no size threshold). - The NFI covers all lands, but ground sample plots are made only in forested areas. - The NFI provides data on the area of OLwTC but it will be more difficult to enlarge data collection on other TOF, because of the lack of size threshold.
References	NFI Canada. <i>Canada National inventory/ Inventaire Forestier Canadien</i> . from https://nfi.nfis.org/index.php .

Toronto Urban Tree Canopy (UTC) assessment 2010

Objective	<ul style="list-style-type: none"> - Describe the current composition, structure and distribution of Toronto's Urban forest. - Quantify the ecological services and benefits provided by the urban forest. - Identify opportunities for increasing sustainable tree cover. - Define a baseline forest condition for further monitoring.
Institutions in charge	<p>Project Coordination by City of Toronto, with project advisors from Toronto and Region Conservation Authority (TRCA) Assessment done by Syracuse USDA Forest Service Northern Research Station (NRS) and City of Toronto Urban Forestry staff, Mapping by City Planning and The University of Vermont Spatial Analysis Laboratory.</p>
Scale, duration, periodicity	<p>Municipal boundaries of the City of Toronto (66 140 ha). Field data collection (4 months) and mapping (8 months) in 2008. Periodical re-measurements planned (3-4 years).</p>
Methodology	<p>The project was divided in 5 steps:</p> <ol style="list-style-type: none"> 1. Study design phase and field data collection based on a two phase sampling: <ul style="list-style-type: none"> • A grid of 407 squares was laid over the city map and one circular 0.04 ha permanent sample plot (PSP) was randomly selected within each square for field assessment. All trees within each PSP were measured. • A stratification was then realised based on 9 Land Use types 2. Data analysis using the i-Tree Eco model, including Hydro modeling (An urban forest hydrologic model was used to simulate the effects of tree and impervious cover on water flow in the Don watershed). Collected data were sent to Syracuse USDA Forest Service NRS with other data (hourly weather data, air pollution data) for further treatment. 3. Integration of existing City street tree data and City mapping data from the Toronto Maintenance and Management System (TMMS): street tree species composition, size class distribution, tree conditions as well as trends in the rate of planting and tree removals over time. 4. Manual assessment of Land Cover change between 1999 and 2005 based on digital leaf-off aerial orthophotos (1999 and 2005). A total of 9 998 random geo-referenced points sampled on each set. Results post-stratified by land use and change in area assessed for 7 land-cover types (Tree/shrub cover, Grass, Soil, Water, Building, Road, Impervious – other). 5. Automated land cover mapping and Urban Tree Canopy (UTC) assessment based on City land cover mapping using high resolution (0.6 m) QuickBird satellite imagery (leaf-on) acquired in 2007 combined with planimetric data (ownership information, road infrastructure and building footprint data). The UTC assessment provides information describing the amount of current tree canopy currently (Existing UTC) along with the amount of potential tree canopy (Possible UTC).
Variables related to TOF	<p>Spatial: location, distance and direction to space-conditioned buildings</p> <p>Biophysical: Ground and tree cover, individual tree attributes (species, quantity, DBH, tree height, height to base of live crown, crown width, percentage crown canopy missing, crown dieback)</p> <p>Socioeconomic: Ownership</p> <p>Background information: Land use</p>
Categories that may include TOF	<p>All land-use categories of the assessment include trees and are TOF categories as they are all in a urban area</p>

TOF sets and subsets covered	Trees on land that is predominantly urban use: set 1: TOF-URB
Results	<ul style="list-style-type: none"> - The project is based on the I-tree method. This method has been used in many cities in the USA and elsewhere: http://www.itreetools.org/international-users.html - There is no extra cost for the i-Tree Software Suite, so the global cost is the same as a normal inventory task. - This method requires an existing urban forest staff and city data (city mapping, land tenure, weather and pollution data).
Comments	<ul style="list-style-type: none"> - Toronto covers 66 140 ha and has approximately 20 percent tree cover representing 10.2 million trees. - Of the total tree population, 0.6 million (6 percent) are street trees, 3.5 million (34 percent) are trees in City parks/natural areas and 6.1 million (60 percent) are growing on private property. - The urban tree canopy has an estimated structural value of CND \$7 billion. - Toronto's urban forest provides the equivalent of at least CND \$30 million in ecological services each year. - Gross carbon sequestration by trees in Toronto is estimated at 46 700 metric tons of carbon per year with an associated value of CND \$1.3 million.
References	<p>This assessment profile is based on personal communications from Mrs. Ruthanne Henry, Urban Forestry Planner (City of Toronto, Canada), and on the following document:</p> <p>City of Toronto - Urban Forestry. 2010. <i>Every Tree Counts - A Portrait of Toronto's Urban Forest</i>. Toronto: 106 pp.</p>

China

Various forest assessments are conducted at different levels in China to meet different information needs. We focus on the national forest inventory (NFI) as some data on TOF could be extracted from this countrywide assessment.

Seventh National Forest inventory, 2004-2008	
Objective	To periodically identify the status and functions of forest resources, and provide basic information support for national forestry policies making, planning and management at provincial, regional and national levels.
Institution in charge	State Forestry Administration (SFA), P. R. China. 4 regional inventory institutes are responsible for technical guidance, quality check and data analysis. The field survey is organized by provincial forestry agencies, and undertaken by provincial monitoring institutes.
Scale, duration, periodicity	Countrywide 1/5 of the provinces is inventoried annually 5-year cycle
Methodology	<p>The NFI includes 4 main activities:</p> <ul style="list-style-type: none"> - Field inventory for all attributes related to forest area and volume estimation (160 factors); - Dynamic analysis based on remote-sensing plots; - Socio-economic investigation; - Mapping of forest distribution using satellite data. <p>Field inventory is based on a two-stage sampling, where the Chinese provinces are the first stage sampling unit. The sampling scheme is then systematic and covers all land cover classes (including deserts and wetlands).</p> <p>Permanent Sample Plots (PSPs) are systematically laid out on the grid dots of x, y coordinates on topographic maps (scale 1:50 000). A total of 415 000 PSP have been established, but the distance between plots, their shape, area and size are flexible, depending on the required estimate precision of variables (forest land area, growing stock, plantation area, amount of growth and consumption, and net timber volume increase), which differs from one province to another.</p> <p>Sampling plots are squares (in general) or rectangles. Distance between plots is 2 km to 8 km, and size is 0.06 ha or 0.1 ha (generally 0.0667 ha, namely 1 mu).</p> <p>PSP data is first set at provincial levels, and then aggregated to be analyzed at national level.</p> <p>Dynamic analysis based on RS-plots.</p> <p>The RS-based plots (RSPs) are set using satellite images with 10 to 30 m resolution (mainly Landsat). Equal-distance systematic sampling is used to set RSPs, but the sampling intensity varies proportionally with the field sampling intensity. The number of RSPs is 4 to 8 times greater than field plots. In total, 2.84 million RS-plots are set at national level. This sampling is used for sampling precision control of main inventory indicators, for the identification of forest distribution in the unreached area, and for the spatial distribution of forest dynamics.</p> <p>Socio-economic investigation</p> <p>This is carried out during field inventory, consisting of a social investigation and a questionnaire to farmers. Its purpose is to collect information on forestry development at provincial and county levels, on tree planting and on forest cultivation, management and utilization in local communities.</p>

	<p>Mapping of forest distribution.</p> <p>The map of forest distribution is drawn using the same satellite data as that of dynamic analysis based on RS-plots. The mapping method is polygon division. The division attributes are forest types including: “coniferous forest”, “broadleaves forest”, “mixed forest”, “bamboo forest” and “national especially designated shrub trees”. The map of forest distribution is updated every five years (through NFIs) at national level.</p>
Variables related to TOF	<p>About 160 variables are collected during field inventory.</p> <p>Spatial: plot location , all trees with DBH > 5 cm are individually localized/mapped on the plot.</p> <p>Biophysical: plot land cover, tree-growing environment (including soil and landform), stand characteristic (including average DBH, average height, average age, etc.), health, quality, disturbances, biodiversity, ecological benefits, forest management and disturbance, and individual dendrometrics if DBH > 5 cm (tree species, DBH). Stand features are not recorded in non-standing tree plots.</p> <p>Socio-economic (more than 20 variables, not plot based): statistics on population, forestry employment & GDP, management rights, ownership of trees and land. Tree stand designated functions</p> <p>Background information: plot land use, plantation, afforestation area, wood and products consumption, natural reserve at provincial and county levels</p>
Categories that may include TOF	<p>The results of the NFI are given at different successive levels (forest land type, forest type and characteristics).</p> <p>There are two special subcategories that are made up of TOF:</p> <ul style="list-style-type: none"> - “Four-side” trees, most of which come from planting. “Four sides” include the areas around houses, roads, rivers and crop lands. The trees are distributed by linear structure and are mainly established for windbreaks, soil conservation and scene purposes. Cover cannot reach the threshold cover and width of stands and open forest, width threshold varying among provinces but generally set around 4 m (Personal communication). - “Scattered trees growing on other non-forestry land (excluding arbour, mangrove stands and open forest) and other land”.
TOF sets and subsets covered	<ul style="list-style-type: none"> - All TOF sets and subsets are included into the coverage of this assessment.
Comments	<ul style="list-style-type: none"> - The classification scheme seems pretty complex and data on TOF may be difficult to extract even though some categories are completely TOF categories. - The category “scattered trees” has no tree cover limit.
References	<p>FAO.2007. Brief on National Forest Inventory NFI – China. MAR-SFM Working Paper 16/2007. Rome.</p> <p>Lei, X., M. Tang, et al. 2010. China. In <i>National forest Inventories - Pathways for Common Reporting</i>, eds. E. G. Tomppo, T. Gschwantner, M. Lawrence, R.E. McRoberts. Springer: 113-129 (16).</p> <p>State Forestry Administration, P.R. China. 2004. <i>Technical Regulation of National Forest Resources Continuous Inventory</i>. Beijing. (in Chinese)</p> <p>State Forestry Administration, P.R. China. 2009. <i>Supplementary Technical Regulation of National Forest Resources Continuous Inventory</i>. Beijing. (in Chinese)</p>

This Profile was completed in collaboration with Mr. Xia Chaozong, Senior Engineer at the Academy of Forest Inventory and Planning, State Forestry Administration, Beijing, P.R. China.

India

Forest Survey of India (FSI), is a national organization under the Ministry of Environment & Forests. Among the main tasks carried out by the FSI, two are directly related to Trees Outside Forests:

- The National Forest Inventory
- The Forest Cover / Tree Cover Assessment

National Forest Inventory	
Objective	To make the national inventory of forest and tree resources and assess their tree cover, growing stock, biomass, and carbon stock.
Institution in charge	Forest Survey of India.
Scale, duration, periodicity	Countrywide 2 years duration 2 years periodicity
Methodology	<p>The country is first stratified by physiographic zones (14 zones based on tree species composition, physiographic and ecological parameters). Then 10percent (60) districts are randomly selected from the entire country, representing each physiographic zone for a detailed inventory of forest and TOF during a cycle of two years. The inventory of forest is carried out in the recorded forest area, which is mainly owned by the government. Since field boundaries of the recorded forest are not available, the green wash area in the topographic sheet of Survey Of India (SOI) is taken as a proxy to forest area. All area outside the recorded forest area is termed as TOF, which is again divided into rural and urban areas. Separate methodologies are followed for assessment of forest, TOF (rural) and TOF (urban):</p> <ul style="list-style-type: none"> - Forest Inventory: A number of 0.1 ha plots are selected for field sampling: Each Survey of India (SOI) toposheet map at 1:50 000 scale (15 minutes lat. x 15 minutes long.) is divided into 36 units (called “grids”) of 2 ½’ x 2 ½’. Each “grid” is then subdivided into 4 (1 ¼’ x 1 ¼’) “sub-grids”. Two “sub-grids” per “grid” are then randomly selected. All selected sub-grids falling in the recorded forest (or green wash) area or in any other area declared as forest area are systematically sampled. For each sampled “sub-grid”, data are collected on pre-designed forms in a 0.1 ha sampling plot, centred in the middle of the “sub-grid”. - TOF inventory: all areas outside the recorded forest area are classified either as water bodies or as TOF areas, and further sub-divided into “TOF Urban” and “TOF Rural”: <ul style="list-style-type: none"> • TOF Urban: Urban Frame Survey (UFS) blocks are used as sampling units. UFS blocks are defined by the National Sample Survey Organisation (NSSO) so that each block has well-defined boundaries and a population of 600-800 persons or 120-160 households. In each selected district, UFS blocks are randomly selected according to the following rules: <ul style="list-style-type: none"> ▪ If the number of UFS Blocks<500, 10 percent are selected for sampling, with a minimum of 20 sampled blocks. ▪ Between 500 and 1000 UFS Blocks, 5percent are selected for sampling; if the number of UFS Blocks>1000, 5percent are selected for sampling, with a minimum of 50 sampled blocks and a maximum of 60 sampled blocks. ▪ The selected UFS blocks are distributed according to town class (which is based on size of population) and data are collected from selected UFS blocks on pre-designed field forms. • TOF rural: High-resolution satellite data, now mainly LISS-IV Mx (Multispectral 5.8 m) are used for the stratification of rural TOF, based on geometrical shapes corresponding to: <ul style="list-style-type: none"> ▪ Block (compact group of trees > 0.1 ha) ▪ Linear formation ▪ Scattered trees

	<p>In each selected district, field sampling plots are randomly selected as follows:</p> <ul style="list-style-type: none"> • the “Block” stratum: 35 (0.1 ha) plots, • the “Linear formation” stratum : 50 (10 x 125 m) plots, • the “Scattered” stratum is further divided. <p>If non hilly areas: 50 (3 ha) plots, if hilly areas: 95 (0.5 ha) plots.</p>
Variables related to TOF	<p>For forest inventory areas:</p> <ul style="list-style-type: none"> - Spatial: plot - Biophysical: <ul style="list-style-type: none"> • size class, regeneration, damages (fire, wildlife) • trees assessment if DBH > 10 cm: number of trees sampled, tree species, dominance, dendrometric characteristics(DBH, crown-width, height) - Socioeconomic: legal status - Background information: land use <p>For TOF areas - Urban TOF :</p> <ul style="list-style-type: none"> - Spatial: plot location, category of trees (farm forestry, block plantation, railway line, etc.), area of UFS block - Biophysical: <ul style="list-style-type: none"> • size class • trees assessment if DBH > 10 cm : number of trees sampled, trees species, dendrometric characteristics(DBH, crown-width) <p>For TOF areas - Rural TOF:</p> <ul style="list-style-type: none"> - Spatial: plot location, category of plot (hilly, plain, irrigated, un-irrigated), category of trees (farm forestry, village woodlots, block plantation, railway, homestead). - Biophysical: trees assessment if DBH > 10 cm: number of trees sampled, trees species, dendrometric characteristics (DBH, crown-width) - Socioeconomic: legal status and ownership - Background information: land use
Categories that may include TOF	<ul style="list-style-type: none"> - “TOF rural”: all trees in this category are TOF sensu FAO - “TOF urban”: all trees in this category are TOF sensu FAO - “Green-washed” areas (mainly Recorded Forest) - Forest is not the only land use encountered in this category; some TOF sensu FAO are also included: <ul style="list-style-type: none"> • Agricultural tree lands, a distinct legal sub-category of Private Recorded Forests (owned by private individuals, communities or corporations), • Trees in line (trees planted along canal banks, along road sides, along railway lines, windbreaks and shelter belts planted under social forestry schemes) • Agricultural lands with trees in surround (all lands under cultivation including fallow lands which are covered with trees along bunds and in the surrounding 2 ha) • Non-forestry plantations (all lands with trees planted primarily for purposes other than forestry such as cashew, coffee, gardens, parks, zoos) <p>However, for the purpose of estimation, plots under such land-uses are excluded from the forest inventory and included in the TOF inventory when located on private forest land.</p>
TOF sets and subsets covered	All TOF sets and subsets are covered by the combination of these two assessments.
Comments	<ul style="list-style-type: none"> - Area, growing stock and canopy cover of almost all TOF sensu FAO categories are extractable. - The two tree categories assessed by FSI outside “green-washed” areas, TOF Urban and TOF Rural, are TOF sensu FAO, but these two FSI categories do not represent all TOF sensu FAO, as some TOF sensu FAO are also encountered in green-washed areas. However, the area of TOF in green-washed areas is extractable.
References	<p>Forest Survey of India. Forest Inventory. Retrieved November 2010, from http://www.fsi.nic.in/forest_inventory.htm.</p> <p>Lakhchaura, P. 2010. Assessment of TOF in India. Inception workshop on TOF for FRA 2010. Rome.</p>

Forest Cover / Tree Cover assessment

Objective	Have an accurate and complete view of the forest/tree cover in the country and its evolution.
Institution in charge	Forest Survey of India.
Scale, duration, periodicity	Countrywide 2 years duration 2 years periodicity
Data used	Satellite data used is IRSP6- LISS-III (Multispectral 23.5 m)
Methodology	<p>The country land cover is divided into 4 classes: “forest cover”, “tree cover”, “scrub cover” and “non-forest cover”.</p> <ul style="list-style-type: none"> - Forest Cover includes all lands located inside and outside Recorded Forests with a tree canopy cover > 10 percent and an area ≥ 1ha. This class is further subdivided into 3 sub-classes according to the density of their tree canopy cover. It is assessed only by wall-to-wall mapping and Digital Image Processing. - Scrub Cover includes all lands located mainly inside Recorded Forests with a tree canopy cover < 10 percent. It is assessed only by wall-to-wall mapping and Digital Image Processing. - Non Forest Cover includes all lands that are not included in the above classes. Its area is obtained by subtracting areas of forest cover and scrub cover from the total country area. <ul style="list-style-type: none"> • Tree Cover is a sub-category of “Non Forest Cover”. It includes all lands located outside Recorded Forests with tree patches < 1 ha. It is assessed by using TOF data from the NFI: <ul style="list-style-type: none"> ◇ for rural tree patches between 0.1 and 1 ha, cover of the block and linear strata is estimated through remote sensing only for the sampled districts; ◇ for rural scattered trees and urban (UFS) blocks, cover is estimated using field-recorded crown diameter, converted to correspond to a 70 percent canopy density. <p>Data for both components are aggregated at the district level, then at the physiographic level, and finally at the national level to give the total Tree Cover estimate for the country.</p>
Variables related to TOF	Spatial: location and area of each cover category
Categories that may include TOF	<ul style="list-style-type: none"> - Forest Cover <ul style="list-style-type: none"> • TOF systems, such as large orchards, non-forestry tree plantations and agroforestry systems, may be found in this category (if area > 1 ha and tree cover > 10 percent). - Scrub Cover <ul style="list-style-type: none"> • This category may include the following TOF sensu FAO category: scattered trees (less than 5 percent cover) on land that is not under agricultural nor under urban use. - Non-Forest Cover <ul style="list-style-type: none"> • This category includes Tree Cover and thus includes TOF. - Tree Cover <ul style="list-style-type: none"> • Tree Cover may include woodlands and woodlots with an area between 0.5 and 1 ha, which fall into the Forest sensu FAO category. Otherwise, Tree Cover is exclusively made up of TOF sensu FAO.
TOF sets and subsets covered	All TOF sets and subsets are covered in this assessment
Results	In 2009, estimation of Forest Cover area was 69.09 million ha, Scrub Cover was 4.15 million ha and Non-Forest Cover was 255.5 million ha. Tree Cover area was 9.3 million ha.

Comments	<p>TOF sensu FAO are included in all the four FSI categories of this assessment.</p> <p>It is impossible, in the current state of this assessment, to estimate the part represented by TOF sensu FAO in the “Forest Cover” and “Scrub Cover” categories. However, an estimate of the TOF area can be generated from the experience of states which have already digitised their forest boundaries.</p> <p>The “Non-Forest Cover” category includes TOF sensu FAO only in the “Tree Cover” sub-category.</p> <p>The “Tree Cover” category is almost exclusively made up of TOF sensu FAO. It would be relatively easy to modify this category so that it would exclusively consist of TOF sensu FAO, by distinguishing, in units with an area between 0.5 and 1 ha, those in which the land is predominantly under agricultural or urban use, from those in which the land is not predominantly under agricultural or urban use (woodlands and woodlots) which are Forest under FAO definition.</p> <p>This assessment does not bring in new information on TOF except integrated information on the areas occupied by the “TOF Rural” and the “TOF Urban” categories. However, in association with the National Forest Inventory, this assessment is used for national reporting to international processes such as FRA and the UNFCCC.</p>
References	<p>Forest Survey of India. 2010. India State of Forest Report 2009. Retrieved from http://www.fsi.nic.in/sfr_2009.htm.</p>

This country profile was realized in collaboration with Mr. Prakash Lakhchaura, Deputy Director, Forest Inventory, Forest Survey of India, Ministry of Environment and Forests, Dehradun, India.

Morocco

Trees outside forests are an important resource for Morocco. Fruit tree crops such as Olive, Citrus, Almonds, and Date Palms are considered as an integral part of agriculture. Other TOF, such as the Argan trees in sylvopasture or sylvoarable areas are considered part of the forest lands. Three large area assessments are presented below that can provide information on TOF at national scale: the Land-use mapping under GlobCover 2008, the National Forest Inventory, and the Citrus Census 2006.

National Forest Inventory	
Objective	To provide information (maps and statistics) on wood resources per administrative unit To facilitate the design of forest policy and forest management
Institution in charge	National forest inventory (under the High Commission for Water, Forests and the Control of Desertification - Ministry in charge of Forests).
Scale, duration, periodicity	Countrywide 1990-2005 10- to 15-year cycle
Data used	- Satellites and aerial images - Topographic maps
Methodology	NFI includes two phases, both carried out in areas of forest covering more than 10 ha: Forest mapping: Forest maps (1:100 000 and 1:500 000) are issued after an interpretation of aerial photos at 1:20 000, and involves a stratification (124 strata) based on tree species, canopy cover, height and management type of the dominant species. Minimum mapping unit is 10 ha. Field survey: Based on a method called oriented random sampling, with clusters selected at random and plots (5-6 per cluster) systematically laid out in each cluster. A total of 3 635 sampling plots were established. Plots are temporary, have a circular shape and a variable size depending on the relative quantity of selected species (should contain at least 15 to 20 trees surveyed). Minimal and maximal radii are 10 m and 30 m, respectively. All trees with a DBH >7.6 cm were measured.
Variables related to TOF	Biophysical: dendrometrics (DBH, height), species
Categories that may include TOF	Argan tree formation
TOF sets and subsets covered	Trees in an agricultural context (sylvo-arable and sylvopasture systems): set 1: TOF-AGRI, Trees in low-tree cover areas: set 3: TOF-Non A/U, subsets 3 and 4.
Results	Argan tree formations cover 871 210 ha, representing 18.1 percent of the total forest area. Argan tree standing wood volume is estimated at 17 339 536 m ³ , representing close to 11 percent of the total standing wood volume in Morocco.
Comments	Argan tree can be considered TOF, this species being used for different purposes (fodder, nuts) and occurring mostly on land predominantly used for agriculture (cropping and pasture). Due to the lack of information on canopy cover (cc), other TOF areas may be included in the forest strata (areas with trees and a cc of less than 5 percent, and area with a combined cover of trees and shrubs of less than 10 percent).
References	IFN. 2000. Inventaire forestier national - Rapport de synthese. Rabat-Chellah, Morocco: 42.

Citrus Census 2006

Objective	To provide detailed information on Citrus in the framework of the Agriculture general census.
Institution in charge	Direction des programmations et des affaires économiques - Division des statistiques et de l'informatique.
Scale, duration, periodicity	Countrywide Assessment started in June 2006, lasted 6 months
Data used	- Topographical maps and aerial photos
Methodology	<ol style="list-style-type: none"> 1. Aerial photography and mapping <ol style="list-style-type: none"> a. First topographical maps (1:50 000) were used to delineate the main Citrus areas in order to identify where aerial photos were needed (679 487 ha). b. An aerial photography (1:17 500) campaign was carried out. c. Orthophoto-maps were made at the scale of 1:5 000 for approximately 500 000 ha in order to delineate precisely each orchard and its plots d. Identification of the owner, citrus variety and plantation date for each plot, for reporting on the orthophoto-maps. 2. Census questionnaire, conducted by specialized interviewers in each farm, based on 2 forms: <ol style="list-style-type: none"> a. The Farm survey b. Plot information 3. Data processing using the CPro (Census and survey program) and implementation of the GIS database on citrus called the SIGAG combining cadastral data, data from the survey and water resource data.
Variables related to TOF	<p>Spatial: localization of the farm and the plot, localization of the wells</p> <p>Biophysical: Species, Variety, production and yield</p> <p>Social: Ownership, cooperatives, social data</p> <p>Background: irrigation, sanitary aspects, grafting, plantation prospects for 2010 and destruction program, fertilization, investments. In the plot form, technical aspects and productivity</p>
Categories that may include TOF	All categories in this assessment include TOF (trees on land used for agriculture).
TOF sets and subsets covered	Part of set 1: TOF-AGRI
Results	A total of 12 820 citrus orchards, representing 81 550 ha.
Comments	This census was the first agricultural survey using aerial photographs as a support. Other surveys following the same methodology are expected for the other fruit crops.
References	Direction des programmations et des affaires économiques. 2007. Recensement général des Agrumes 2006. Rabat: 155 pp.

Land use mapping under Globcover 2008

Objective	To provide a land use map compatible with international standards.
Institution in charge	Global Land Cover Network.
Scale, duration, periodicity	Countrywide
Methodology	See LCCS template sheet Land cover of Morocco was derived from the GlobCover program for Africa, using the 46 regional classes.
Variables related to TOF	Spatial: localization and area Biophysical: Land cover in 2005 Background information: Land Use
Categories that may include TOF	<ul style="list-style-type: none"> - Categories that contain TOF (FAO 2009) <ul style="list-style-type: none"> • Irrigated shrub or tree crops (class 12) • Rainfed shrub or tree crops (class 16) - Many other categories might contain TOF at least in some areas, but information is not precise enough as far as TOF are concerned.
TOF sets and subsets covered	All TOF subsets are included into the coverage of this assessment (no exclusion)
Comments	<ul style="list-style-type: none"> - The resolution is 300 m and minimum mapping unit is 10 ha. - Only the tree crop category can be strictly attributed to TOF; TOF in the other categories is merely speculation. - The threshold for tree cover in many classes of Globcover Africa is 15 percent cover, above the current threshold of 5 percent for TOF in land used neither for agriculture nor for settlement.
References	<p>FAO. 2009. «Land cover of Morocco - Globcover Regional.» From http://www.fao.org/geonetwork/srv/fr/metadata.show?currTab=simple&id=37195.</p> <p>Mhirit, O. & Et-Tobi, M. 2002. Trees outside forests: Morocco. <i>In Trees outside forests - Towards a better awareness</i>, eds. R. Bellefontaine, S. Petit, M. Pain-Orcet, P. Deleporte and J.-G. Bertault. FAO: Rome. CAHIER FAO - CONSERVATION 35.</p> <p>Ministère de l'Agriculture et de la Pêche Maritime. Répartition de la superficie totale nationale. Retrieved 08/02/2011, from http://www.vulgarisation.net/sol.htm.</p>

New Zealand

The Land Cover Database (LCDB), the Land Use and Carbon Analysis System (Lucas) and the Agricultural Production Survey (APS) are available online and may be used for getting data on Trees Outside Forests.

Land Cover DataBase 2 (LCDB2)	
Objective	To establish and maintain a consistent land cover classification of known accuracy at national level in order to provide a basis for better resource management decisions, more effective use of natural resources and improved environmental management.
Institution in charge	New Zealand Climate Change Office (Ministry for the Environment). Consultants are involved in field checking (AgriQuality), image analysis and GIS processing (Terralink International Ltd).
Scale, duration, periodicity	Countrywide LCDB2 was completed in June 2004 and lasted approximately 2 years. Advised periodicity for the updates is 5 years (LCDB1 was completed in 2000). LCDB3 is proposed to provide a LC map for 2007/08.
Data used	Landsat 7 ETM+ (from 2001/02), aerial photography and ancillary data
Methodology	The LCDB classification is harmonized with international land cover mapping initiatives (FAO/UNEP Land Cover Classification System, see LCCS description sheet). Landsat 7 ETM+ sensor is used as the primary data source to define polygons for areas with similar land cover types. Minimum Mapping Unit (MMU) is 1 ha but resolution for LCDB2 is 15 m (1 pixel = 15 m). There are 43 classes in LCDB2. The classification is hierarchical: 7 classes at the 1st level based on physiognomy of the land cover, and more detailed classes at lower levels based on phenology, flora or other characteristics. For each polygon, data are edited and aerial photography and ancillary data are acquired to complete the work. For each class, a sampling intensity is decided and followed by field checking.
Variables related to TOF	Spatial: Location and area of each Land Cover class unit Biophysical: Field notes on the signatures of land cover Other Background information: Name of Territorial authorities, Name of Regional Councils
Categories that may include TOF	Categories that include TOF: <ul style="list-style-type: none"> - 2/ Urban Parkland / Open Space includes parks with scattered trees, playing fields, cemeteries, airports, golf courses, and river sides. - 32/ Orchards and Other Perennial Crops: Orchards and areas cultivated less than annually, and used for producing tree crops. - 60/ Minor Shelterbelts: Minor Shelterbelts are visible as linear features in the imagery. Shelterbelts longer than 150 m are mapped if 15 m (1 pixel) in width. If the signature of a shelterbelt exceeds 30 m (2 pixels) it is captured as a polygon and assigned to Class 61 – Major Shelterbelts (not TOF). Categories that may partly include TOF: <ul style="list-style-type: none"> - 1/ Built-up Area: includes horticultural sites dominated by structures and sealed surfaces. - 5/ Transport Infrastructure: includes artificial surfaces such as roads, railroads, airport runways where these features are discernable and exceed the 1 ha MMU. - 30/ Short-rotation Cropland: Due to MMU of 1 ha, this class may include TOF as scattered trees or small groups of trees. - 40/ High Producing Exotic Grassland: Due to MMU of 1 ha, this class may include TOF as scattered trees or small groups of trees. - 41 Low Producing Grassland: Due to MMU of 1 ha, this class may include TOF as scattered trees or small groups of trees.

	- 50 Fernland: This class includes areas of dominant ferns often associated with shrubs, such as manuka or kanuka (up to 6 m) and may thus include TOF.
TOF sets and subsets covered	All TOF sets and subsets are included in the coverage of this assessment.
Comments	<ul style="list-style-type: none"> - Although all TOF systems are taken into account, only three categories are fully TOF categories. Other categories that may partly include TOF are not detailed enough regarding TOF presence or absence. - Minimum mapping area is 1 ha, so all units that qualify as TOF areas but are less than 1 ha are not mapped.
References	<p>Grüner, I. & Gapare, N. 2004. «Fieldwork Procedures used for LCDB 2.» 8.</p> <p>Ministry for the Environment. 2009. «The New Zealand Land Cover Database.» Retrieved December 2010, from http://www.mfe.govt.nz/issues/land/land-cover-dbase/index.html.</p> <p>New Zealand Climate Change Office. 2004. «New Zealand Land Cover Database 2 - User Guide.» S. T. a. Partners; 24 pp.</p> <p>Thompson, S., Grüner, I., et al. 2003. «Illustrated Guide to Target Classes.» <i>New Zealand Land Cover Database Version 2</i>. Auckland, Ministry for the Environment, version 4: 62.</p>

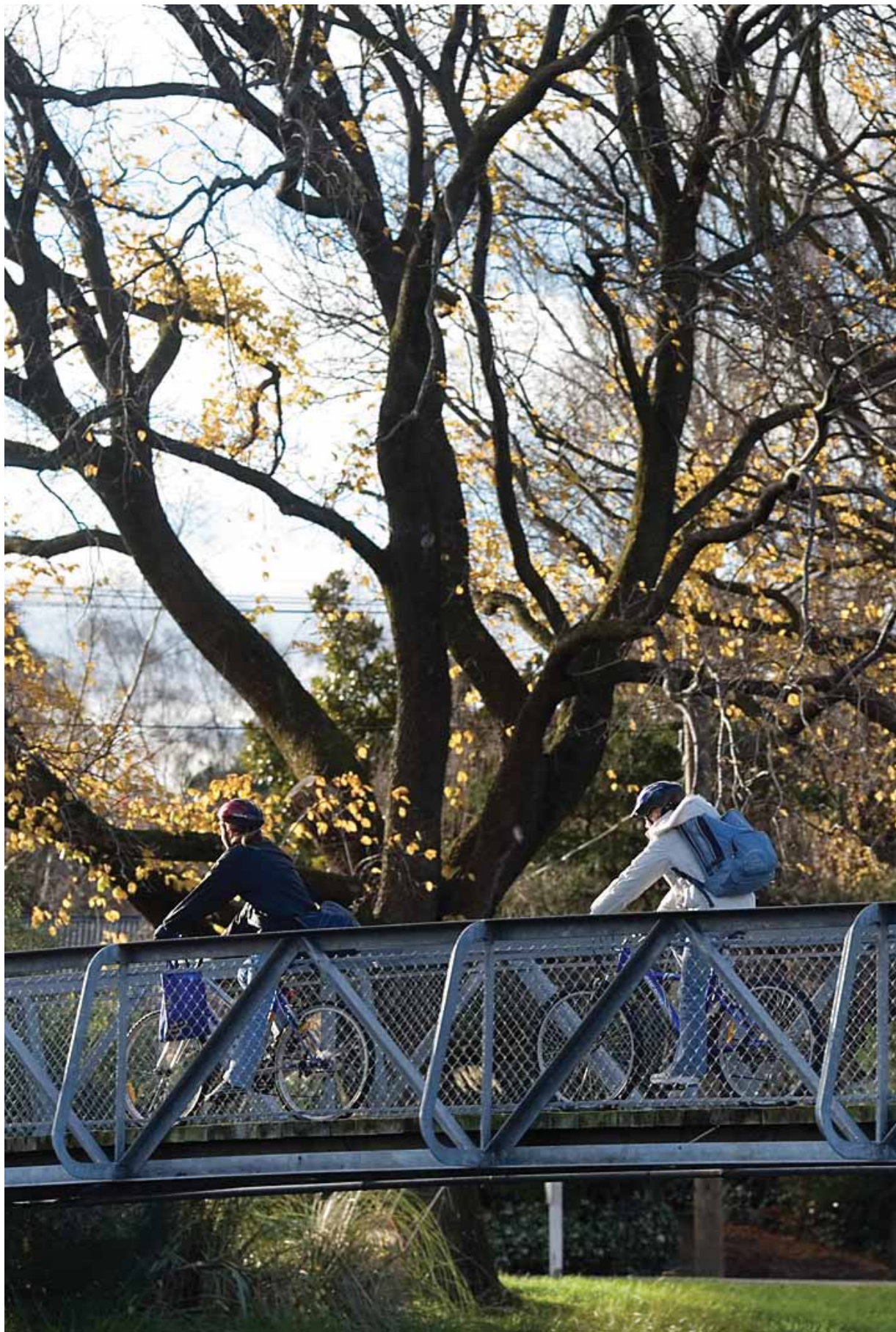
New Zealand's Land Use and Carbon Analysis System (Lucas)

Objective	To measure and monitor carbon stocks and stock change held in NZ's land categories and carbon pools (such as forestland, cropland, grassland and soils).
Institution in charge	Ministry for the Environment, in partnership with Ministry of Agriculture and Forestry and other government departments
Scale, duration, periodicity	Countrywide Land-use mapping for 1990, 2008 and 2012. Planned periodicity is 5 years.
Data used	161 SPOT 5 scenes acquired in 2006–2007 and 2007–2008 (resolution: 10 m)
Methodology	<p>LUCAS programme consists in 6 workstreams on:</p> <ul style="list-style-type: none"> - Database and reporting system (on Carbon and Land-use): data used in this workstream are stored and manipulated within 3 systems: <ul style="list-style-type: none"> • the geospatial system, using images and land-use maps; • the gateway, with forest plot data, soil data, parameters used to validate data from imagery; • the calculation and reporting application for LULUCF Analysis and reporting. - Method development to improve imagery techniques to inventory trees; - Land-use mapping: Minimum Mapping Unit (MMU) is 1 ha and Land-Use categories are IPCC categories; - Soils; - Natural forests; - And planted forests (pre-1990 planted and post-1989 forest). <p>Sampling design: used for forests and soils. A single grid (8 x 8 km) has been established across New Zealand to collect data on forests on permanent sample plots from NZ's National Forest Inventory. It is not detailed here because this field assessment provides no information on TOF.</p>
Variables related to TOF	Spatial: Area, location of each Land-Use unit
Categories that may include TOF	<p>Categories that include TOF:</p> <ul style="list-style-type: none"> - Cropland – perennial : all orchards and vineyards, and linear shelterbelts associated with cropland <p>Categories that may partly include TOF:</p> <ul style="list-style-type: none"> - Grassland – with woody biomass: may include scattered tall trees, riparian vegetation, linear shelterbelts > 30 m in width, and/or erosion control plantings, scattered areas of shrubland; - Grassland – high producing: grassland with high quality pasture species mostly in intensive dairying areas (may include linear shelterbelts with width < 30 m); - Grassland – low producing: low fertility grassland (may include linear shelterbelts with width < 30 m); - Cropland – annual : includes linear shelterbelts associated with cropland; - Settlements : include recreational areas within 'settlements', and urban parklands and open spaces which do not meet the forest definition; - Wetlands – vegetated non forest : includes Scattered patches of tall tree-like vegetation to be included as wetlands and estuarine/tidal areas including mangroves.
TOF sets and subsets covered	All TOF sets and subsets are included into the coverage of this assessment.
Comments	<ul style="list-style-type: none"> - Although all TOF systems are taken into account, one category only is a fully TOF category. Other categories that may partly include TOF are not detailed enough as regards TOF presence or absence. - Minimum mapping area is 1 ha, so all units that qualify as TOF areas but are less than 1 ha are not mapped.

References	<p>Ministry for the Environment. 2010a. Land Use and Carbon Analysis System (LUCAS). Retrieved December 2010.</p> <p>Ministry for the Environment 2008. Looking at Lucas - Data description. 1.-v. nz-data-description. Wellington, New Zealand..</p> <p>Ministry for the Environment 2010b. Land Use and Carbon Analysis System: Satellite Imagery Interpretation Guide for Land-use Classes. ME1024: 28.</p> <p>Beets, P. N., Brandon, A., et al. 2010. New Zealand. <i>National Forest Inventories</i>: 391-410.</p>
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Agricultural Production Survey 2009 (APS)

Objective	To produce up-to-date, robust statistics on livestock and arable farming (including Livestock, Horticulture) and forestry activity in New Zealand.
Institution in charge	Statistics NZ, in partnership with the Ministry of Agriculture and Forestry (MAF).
Scale, duration, periodicity	Countrywide. Started in 2002. Annual postal survey.
Methodology	Agricultural Production Survey is a direct survey of all businesses engaged in 'agricultural production activity' (including livestock, cropping, horticulture, and forestry) or owned land that was intended for agricultural activity. The target population includes business engaged in agriculture or forestry production as a secondary activity. Since 2002, a national census is carried out every 5 years, which includes all units identified in the relevant categories (a total amount of 80 000 units). In the years between, specific surveys are carried out alternating between a 'livestock, arable, and forestry' survey and a 'horticulture-focused' survey. In 2005 and 2009 horticulture-focused surveys were held. All farms classified as horticulture and with a minimum income of NZ\$ 60 000 were included in the postal survey.
Variables related to TOF	Spatial: Farm location, area of planted fruit trees, area of other horticulture crops Biophysical: Trees species and variety, age and number of trees planted, yield Background data: Farm practices and detailed land-uses on the farm
Categories that may include TOF	Horticulture: Orchards and tree crops
TOF sets and subsets covered	Part of set 1: TOF-AGRI
Results	APS 2009 on horticulture provides updated results on the area covered by the areas of main fruit tree species: Apples (9,280 ha), Avocados (4,120 ha) and Cherries (600 ha). The general Agriculture Production Survey 2007 includes Olives (2,173 ha).
Comments	<ul style="list-style-type: none"> - The estimated proportion of eligible businesses that responded to the 2009 Agricultural Production Survey on horticulture was 84 percent. - The survey focuses on only one category of TOF: tree crops. - People with income <NZ\$60,000 (hobby farms) are not sampled.
References	<p>Millar, R. 2009. «Environmental certification and the small forest grower.» F. E. L. New Zealand Farm Forestry Association, MAF; 75 pp.</p> <p>Ministry of Agriculture and Forestry. 2010. «National Exotic Forest Description.» Retrieved December 2010, from http://www.maf.govt.nz/mafnet/publications/nefd/.</p> <p>Statistics New Zealand. 2007. Area planted in outdoor fruit as at 30 June, from 1982. O. Fruit. Wellington, New Zealand, Ministry of Agriculture and Forestry.</p> <p>Statistics New Zealand. 2009a. «Agriculture, Horticulture, and Forestry Domain Plan 2009.» 151 pp.</p> <p>Statistics New Zealand. 2009b. Area planted in outdoor fruit by region. agprod-finaljun09-tables.xls. Wellington, New Zealand, Ministry of Agriculture and Forestry.</p>



Nicaragua

Nicaragua designed, with FAO assistance, a new National Forest Inventory based on the National Forest Monitoring and Assessment methodology.

National Forest Inventory 2007-2008	
Objective	To realize a National Forest Inventory that contributes to the sustainable management and use of natural resources, improvement of uses and costs of forest activities, and improvement of the rural population's standards of living.
Institution in charge	Instituto Nacional Forestal (INAFOR).
Scale, duration, periodicity	Countrywide The NFI was implemented from October 2007 to October 2008, with a first follow-up monitoring planned for 2010-2014.
Data used	- Topographic maps at 1:50 000 and 1:5 000 scale - Cobertura forestal/Forest Cover Maps for 1981-83, 1992, and 2000
Methodology	NFI Nicaragua is based on the NFMA methodology (see NFMA description sheet) Methodology design was issued after a multi-sectoral consultation (forestry services, agricultural services, regional governments, universities, technical centers, NGO's, community leaders, etc.). A Technical Unit was then established with the following tasks: project planning and execution, inter-institutional collaboration and field implementation. Specific adaptations of the NFMA general methodology: (Instituto Nacional Forestal 2009) - Systematic sampling grid 10' x 10': 344 sampling points on land. - Sampling units : 500 m x 500 m ² . - Socio-economic interviews in sampled areas: <ul style="list-style-type: none"> • with government (mayors' offices) and indigenous territories authorities: on forest and non forest area local management capabilities; • with inhabitants: about land ownership, employment, reforestation, management capabilities, production activities, uses, and products derived from forests and trees.
Variables related to TOF	Spatial: plot and tree location, plot orientation, sketch map with property limits, land use/cover sections, watercourses, hedges. Biophysical: trees assessment if DBH > 10 cm. Tree species, bole quality, health and damages (fire, hurricane), seed source potential, dendrometric characteristics (DBH, total tree height, commercial tree height), canopy cover. Socioeconomics: Land use, Land tenure status, Tree uses and products (including NTFP).
Categories that may include TOF	Other lands/ Agroforestry (level 2 National class): area over 0.5 ha, classified as other lands, with tree cover over 10 percent, with potential height of mature trees above 7 m. Level 3 classes: <ul style="list-style-type: none"> - Coffee under tree shadow - Cacao - Fruit crops - Silvopasture - Non-traditional crops with trees - Annual crops with trees - Orchards - Extensive pasture land with trees Other lands/ Without trees (level 2 National class): area over 0.5 ha, classified as other lands, with tree cover under: <ul style="list-style-type: none"> - 10 percent in agricultural or urban areas, - 5 percent in natural ecosystems. (Instituto Nacional Forestal 2008)

TOF sets and subsets covered	All TOF sets and subsets are covered.
Results	<ul style="list-style-type: none"> - Agroforestry land represents 2 099 127 ha, a gross wood volume of 68 444 829 m³ (32.61 m³/ha), a commercial volume of 25 580 445 m³ (3.76 m³/ha). - The dry biomass is 44 224 637 tons (21.07 T/ha) and carbon biomass is 20 788 021 tons (9.9T/ha). - Other lands Without trees represent 4 264 548 ha, a gross wood volume of 50 584 006 m³ (11.86 m³/ha), a commercial volume of 10 617 870 m³ (2.42 m³/ha). - The dry biomass is 13 821 522 tons (3.24 T/ha) and carbon biomass is 6 496 106 tons (1.52T/ha).
Comments	<ul style="list-style-type: none"> - No direct data on trees in: <ul style="list-style-type: none"> - Urban areas, - Linear structures, - Basic data for trees in urban areas and linear structures are however accessible in the original sampling forms (linear structure length and width, tree species, dendrometric data). - Small areas (<0.5 ha) with trees (TOF) can not be distinguished as the Minimum Mapping Unit was 0.5 ha.
References	<p>Instituto Nacional Forestal. 2008. <i>Manual de campo - Inventario Nacional Forestal de Nicaragua 2007-2008</i>. C. R. Zea. Managua, INAFOR, MARENA, FAO, GTZ, MAGFOR. 193 pp.</p> <p>Instituto Nacional Forestal. 2009. <i>Resultados del Inventario Nacional Forestal, Nicaragua, 2007-2008</i>. FAO. Managua, INAFOR, MARENA, FAO, GTZ, MAGFOR. 232 pp.</p>

Norway

Assessments focusing on TOF have never been carried out in Norway. Some raw data can however be extracted from the National Forest Inventory (NFI) database.

National Forest Inventory 9 (2005-2009)	
Objective	Provide data on natural resources, mainly timber resources and the environment for forest land in Norway.
Institution in charge	Norwegian Forest and Landscape Institute.
Scale, duration, periodicity	Countrywide, except the Finnmark county; however Finnmark will be surveyed during the present five-year cycle. 5-year cycle.
Data used	- Topographic maps at 1:50 000 and 1:5 000 scale. - Cobertura forestal/Forest Cover Maps for 1981-83, 1992, and 2000.
Methodology	Systematic sample plot field inventory based on a 3 km x 3 km grid, covering forest and non forest areas. NFI is based on circular permanent plots inventory (16 000 permanent sample plots, of which about 10 500 are located on productive forest and other wooded land. Re-sampling of permanent plots is based on a 5-year cycle: every year 20 percent of the permanent plots are randomly selected to be re-sampled. The survey forms the basis for forest statistics at regional and national scale. Sampling design (Eid, Brunner et al. 2010): 1. For forests (productive and non-productive), other wooded land, and other land-use classes where trees are assessed, the circular sample plot for tally trees has an area of 250 m ² . This plot type has been used since 1994 for measuring trees with DBH ≥ 50 mm. 2. For all permanent plots with tree assessments, data for trees with DBH < 50 mm are collected in four sub-plots of 1.3-m radius with centres located 5 m from the plot centre in directions north, east, south, and west. 3. Circular sample plots of 17.84 m radius (1 000 m ²) are used to assess area-related data such as land-use class, crown cover, development class, and site-quality class. Data on land cover, land use and land use change are provided.
Variables related to TOF	Spatial : Tree location Biophysical: Stand conditions, Development class, Site quality class, Crown cover, Operating conditions and biodiversity. Trees assessment if DBH > 5 cm: number of trees sampled, tree species, dendrometric characteristics (DBH, height) Socioeconomic: Land ownership, Land use
Categories that may include TOF	Categories are based on land cover, with sub-categories based on land use (see table below): Both productive and non-productive forest land (Land cover) in urban areas and along roads (Land use). Grazing land as it may partly be covered with trees, bushes. Arable land regularly cultivated (Agricultural land) as it may partly be covered with trees, bushes. Other areas as may partly be covered with trees, bushes.
TOF sets and subsets covered	All TOF sets and subsets are covered.
Results	No results on TOF are published.
Comments	- Assesses all timber resources (growing stock) on forest and non forest areas. - Land cover and land use criteria are taken into account, so some data on TOF could probably be extracted thanks to the land use subcategories. - Permanent plots enable change estimations.

References

Statistics Norway. 2008. Forestry Statistics 2008. Official Statistics of Norway Oslo–Kongsvinger, Statistics Norway: 53 pp.

Climate and Pollution agency. 2010. National Inventory Report 2010 - Norway. Greenhouse Gas Emissions 1990–2008. Oslo: 330 pp.

Eid, T., A. Brunner, et al. 2010. Estimation, availability and production of tree biomass resources for energy purposes – a review of research challenges in Norway. INA fagrappport 15 Ås, Norway, Department of Ecology and Natural Resource Management , Norwegian University of Life Sciences , Oslo.

National Forest and Tree Resources Assessment (NFA) 2003-2005	
Objective	To “enhance the social, economic and environmental functions of forest and trees resources through their sustainable management on the basis of better knowledge of their qualitative and quantitative importance. The project also aims at improving contribution of these resources in the national economy.”
Institution in charge	Project coordination by Forest Management Bureau (FMB) Field data collection by the Department of Environment and Natural Resources (DENR) Mapping by National Mapping and Resource Information Authority (NAMRIA)
Scale, duration, periodicity	Countrywide 3 years (2003-2005)
Data used	- Topographic map (usually 1:50 000) - Regional and provincial maps
Methodology	NFA Philippines is based on the NFMA methodology (see NFMA description sheet) Compliance with the NFMA general methodology: - Systematic sampling grid 15' x 15': 351 sampling points inventoried - Sampling units : 1 x 1 km squares - Socio-economic interviews in sampled areas to external key informants and forest users (individuals or groups)
Variables related to TOF	Spatial: plot and tree location, plot orientation, land use/cover sections Biophysical: TOF assessment if DBH > 10 cm. Tree species, timber quality, health and damages (fire), dendrometric characteristics (DBH, total tree height, commercial tree height), regeneration Socioeconomics: Land tenure status, user rights, Tree uses and products (including NTFP) Background information: Land use, Management system, Protection status, Ecological zones, silvicultural treatments & technology used
Categories that may include TOF	Other Lands (level 2 national class), Perennial crop (PCr) (level 3 national class) includes orchards, palm plantation and tree crops All the following level 3 subclasses of Other Land might also include TOF to a certain extent: - Grassland (Gl) - Marshland (Ml) - Annual crop (Ac) - Pastures (Pa) - Built-up area (BUA)
TOF sets and subsets covered	All TOF sets and subsets are covered
Results	- Other Land surface is 18,423,641 ha, being 61.4 percent of the total surface of the country. - Other Land wood Gross volume (DBH ≥10 cm) is 365 030 730.40 m ³ , (82.1 percent of the total volume) and Commercial volume (DBH≥ 50 cm) of 24 080 987.47m ³ (63.2 percent). - 77.1 percent of the 426 tree species recorded are found in Other Land. - Based on the perception of the respondents, grazing is the highest value service provided by TOF (in Other Land and Other Wooded land) at 12.6 percent and windbreaks (in Other Land and Other Wooded land) amount to 1 935 927 ha.

Comments	<ul style="list-style-type: none"> - TOF are fully taken into account as opposition to "Wooded Land", so that the whole category "Other Land" can provide information on TOF but it is not possible to make distinction between the different TOF categories. - Only very basic data is accessible in the original sampling forms (land use code and linear structures type) to suggest TOF subcategories. - No minimal size is given for the Other Land & Other Wooded Land category; so some TOF (S < 0.5 ha) might be included in Other Wooded land. - No tree cover indication is given for the Other Land category. - Small woodlots in Other Land (< 0.5 ha) can not be distinguished.
References	<p>Forest Management Bureau, Department of Environment and Natural Resources. 2005. <i>National Forest and Tree Resources Assessment 2003-2005, Philippines</i>. Department of Environment and Natural Resources, FAO. Quezon City, Philippines.</p>

Two projects have been reviewed that provide information on TOF at country scale in Senegal:

- PROGEDE: the Sustainable and Participatory Energy Management Project
- Senegal Land Cover Mapping, within the West Africa programme of GLCN with Land Cover Classification System (See LCCS description sheet)

Sustainable and Participatory Energy Management Project (PROGEDE)	
Objective	To contribute to the supply of households in traditional biomass fuels (fuelwood, charcoal) in a regular and sustainable way, by preserving environment and offering choice and comfort opportunities to consumers.
Institution in charge	Ministry of Environment and Ministry of Energy from the Government of Senegal Other organizations involved: Dutch Co-operation (DGIS) and the World Bank for financial support, "Direction des Eaux et Forêts, Chasse et Conservation des Sols" and the "Direction de l'Énergie" for fieldwork (Utria, Seck et al. N.D.).
Scale, duration, periodicity	Countrywide Implemented between 1997 and 2004 PROGEDE II is planned for June 2010 to November 2016.
Data used	1 100 aerial photos covering 1 500 000 ha, country-wide satellite data (Landsat 7 ETM)
Methodology	Methodology : 1. Photo-interpretation of aerial photos and satellite images 2. Field inventory (3 levels) : a. Intervention area : 1 284 forest plots and 570 pasture plots , on 840 000 ha of forest land, in order to acquire valid information on forest potential for the management plan ; b. National level : 1 788 forest plots, covering 5 out of the 6 existing eco-geographic zones in order to estimate the timber potential for the supply management plan of the main cities; c. Follow up of the permanent plots (PSP), carried out on 57 PSP clusters (a cluster being 4 PSP), that is a total of 228 PSP (Government of Senegal, 2009) to evaluate vegetation trend at country scale. Main steps of this inventory were (Dieng, 2005): 1 st : to distinguish agro-ecological units; 2 nd : to stratify those units in 2 or 3 homogenous sites; 3 rd : to determine for each site a number of sample units (at least 3) depending on its homogeneity and its forest cover importance; 4 th : to inventory trees above 3 cm DBH on circular plots (r = 16 m) in each sample unit. On each plot, circular subplots of r = 1 m are also inventoried for trees below 3 cm DBH.
Variables related to TOF	Spatial: plot location, plot orientation, altitude and slope, distance to nearest road. Biophysical: Number of trees for diameter >3 cm, tree species, threats (fire, grazing species), dendrometric characteristics (DBH, density cover, height), regeneration, average height of trees . Background information: Land use.
Categories that may include TOF	Agricultural land Forest with low potential.
TOF sets and subsets covered	All TOF sets and subsets were included into this assessment, except set 2: TOF-URB: (trees in urban environment).
Results	PROGEDE provides no data on TOF, although a re-analysis of raw data could probably provide some information on the two categories that include or may include TOF.

Comments	PROGEDE data are still used in 2010 (FAO, 2010). For instance, FRA 2010 data for Senegal are extrapolated from PROGEDE data. Data are not easily accessible.
References	<p>Dieng, C. 2005. «Suivi des impacts environnementaux de l'exploitation des ressources forestières dans les bassins d'approvisionnement en bois-énergie des villes sahéliennes.» <i>Choix d'un protocole régional de suivi écologique et environnemental sur le terrain RAPPORT DU SENEGAL</i>. Programme régional de promotion des énergies domestiques et alternatives au Sahel (PREDAS); 47.</p> <p>Dieng, C. 2008. «Le SIEF, Un Outil nouveau et une approche nouvelle pour la gestion des ressources naturelles au Sénégal.» 7.</p> <p>FAO. 2010. «FRA 2010 - country reporting process.» Retrieved October 14, 2010, from http://www.fao.org/forestry/62318/en/.</p> <p>Government of Senegal. 2009. «Pochette PROGEDE.» Ministère de l'Environnement de la Protection de la nature des Bassins de rétention et des Lacs artificiels; 12.</p> <p>Ministère de l'Environnement de la Protection de la nature des Bassins de rétention et des Lacs artificiels. 2009. «PROGEDE - Projet de gestion durable et participative des énergies traditionnelles et de substitution.» Retrieved 12 2010, from http://www.environnement.gouv.sn/article.php3?id_article=25.</p> <p>Utria, B. E., Seck, A., et al. N.D. «Senegal PROGEDE: Traditional Biomass Energy and Poverty Alleviation.» <i>Senegal: Sustainable and Participatory Energy Management Project (PROGEDE) - IDA/GEF/DGIS (\$20 Million)</i>. 4.</p>

Senegal Land Cover Mapping within West Africa programme of GLCN (with LCCS) (See LCCS description sheet)

Objective	To set-up an accurate Land-Cover data base for Senegal.
Institution in charge	GLCN and Centre de Suivi Écologique (CSE)
Scale, duration, periodicity	Countrywide
Data used	- Landsat ETM 2005 and 1999-2001 satellite images, - aerial photos, - high resolution images available in Google Earth
Methodology	A land cover database (2005) was created, with 55 LCCS classes (171 field verifications, and 706 extra observations with GPS coordinates, a photo and a short description) (Leonardi, 2008b). The spatial resolution is 30 m and the Minimal Mapping Area is 10 ha. Then, a selection of 477 polygons randomly extracted, and assessed through GLCN's Mapping Accuracy Program (MAP). A Land cover change analysis was then performed.
Variables related to TOF	Spatial: Location and area
Categories that may include TOF	Terrestrial agriculture: - Large to Medium Tree crops - Small Tree crops - Small Rainfed Herbaceous crops with a layer of Sparse Trees - Small Rainfed Herbaceous crops with a layer of Sparse Trees – Isolated - Large to Medium Rainfed Herbaceous crops with a layer of Sparse Trees Terrestrial natural vegetation: - Closed Gallery Forest - Open Gallery Forest - Very Open Trees in Mare Environment - Open Shrubs with emergent Trees - Very Open Shrubs with emergent Trees - Closed to Open Herbaceous vegetation with Sparse Trees and Shrubs Aquatic natural vegetation: - Open Trees temporarily flooded – Gonakie Artificial surfaces: - Urban areas - Rural settlement
TOF sets and subsets covered	All TOF sets and subsets are covered
Results	A map providing information on land cover for 21 238 polygons covering 19 659 000 ha.
Comments	- Scattered trees are in classes such as “Open shrubs with emergent trees” but tree cover in these classes can be >10 percent, so it would then be counted as OWL and not TOF. “Rural settlements” are non-linear, built-up areas. - The Mapping Accuracy Program is based on Google Earth high-resolution images that cover 1/3 of Senegal. This program confirmed the accuracy of the Land-Cover database.
References	Leonardi, U. 2008a. Senegal classes description. FAO, Dakar. Leonardi, U. 2008b. Senegal Land Cover Mapping. FAO Downloaded from: http://www.glcn.org/downs/prj/senegal/Sen_lc_report_dec08.pdf .

Two assessment projects can be used to extract TOF data in Slovenia: (i) the Forest & Forest Ecosystem Condition Survey (FECS) 2007, and (ii) the WISDOM Slovenia project.

Forest & Forest Ecosystem Condition Survey (FECS) 2007	
Objective	Ensuring essential and reliable data on forests and forest ecosystems conditions at national level, with data usable for national and international reports.
Institution in charge	Slovenia Forest Institute for the 16 km ² grid (test period) and Slovenia Forest Service for the 4 km ² grid
Scale, duration, periodicity	Countrywide Survey lasted from July to August 2007 Variable periodicity (1- to 10-year cycle), see below
Data used	Systematic sampling covering the whole country with a 4 x 4 km sampling grid. Satellite images, orthophotos and maps of the Actual Agriculture and Forest Land Use (MAFF 2002) are checked for dominance of forest. FECS field samples are implemented only on forest-dominated areas.
Methodology	<p>Different grid scales and periodicities, according to expected information:</p> <ul style="list-style-type: none"> - 4 km x 4 km (780 clusters): with a 5- to 10-year periodicity (last data from 2000 and actual in 2007) - 16 km x 16 km (44 clusters): every year to detect a changes - 8 km x 16 km, 8 km x 8 km: special surveys (soil, litter, forest functions) <p>Sampling unit is a sampling cluster with (see diagram below):</p> <ul style="list-style-type: none"> - 2 “M6 ” plots (4 x 4 km grid) or 4 “M6” plots (16 x 16 km grid) where only the 6 trees closest to the centre of each plot are taken into account (species, measurement); - 1 concentric permanent sampling plot (“CPSP”): tree identification and measurement only in the 3 inner circles: cpasp1 (30m²): if DBH > 0 cm and H ≥ 1.3 m, cpasp 2 (200m²) if DBH ≥ 10 cm, cpasp 3 (600 m²) if DBH ≥ 30 cm; in the outer circle (cpasp1 4: 2000 m²), site description and land use assessment.
	<p style="text-align: right; font-size: small;">G. Kolar et al.</p>
Variables related to TOF	<p>In the CPSP:</p> <ul style="list-style-type: none"> - Spatial: tree location. - Biophysical: site and stand spatial structure, health, tree species, status (living, dead), damages, dendrometrics (height, DBH), soils, canopy cover, regeneration. - Socioeconomic: forest functions and roles, ownership, management type. <p>In the M6 plots: tree species, social status and damages are measured for the 6 selected trees.</p>
Categories that may include TOF	“Forest”: according to the national definition, forests are forest tree stands > 0.25 ha and riverside forest corridors and windbreaks > 0.25 ha, if their widths are at least one tree-height (Forest Law: Official Journal of the Republic of Slovenia, nr. 30/1993 with amendments in 2007).

TOF sets and subsets covered	Part of the small woods category: set 3 TOF-Non A/U, subset 1
Comments	Data on small woodlands covering between 0.25 and 0.5 ha can probably be extracted from the raw data.
References	<p>This country profile is based on personal communications from Mr Janez ZAFRAN (Forestry division, Republic of Slovenia) and on the following documents:</p> <p>Kušar, G. & P. Simončič. 2010. Slovenian forest inventory data. <i>JRC technical workshop on LULUCF issues under the Kyoto Protocol</i>. Brussels, Belgium.</p> <p>Kušar, G., M. Kovac, et al. 2010. Slovenia. <i>National Forest Inventories</i>. E. Tomppo et al., eds.: 21 pp.</p>

Woodfuel Integrated Supply / Demand Overview Mapping methodology (WISDOM) in Slovenia

Objective	To acquire the knowledge base and the planning tools necessary for the formulation of a national bioenergy strategy and to contribute to the creation of the Slovenia Wood Energy Information System (SWEIS), applying the Woodfuel Integrated Supply / Demand Overview Mapping methodology (see WISDOM project sheet).																																		
Institution in charge	Slovenian Forest Service (SFS). Assessment led within the Project, "Supply and Utilization of Bioenergy to Promote Sustainable Forest Management", TCP/SVN/2901, 2003 /2004.																																		
Scale, duration, periodicity	Countrywide, based on a sample of 2696 Cadastral Communities (KO). July 2003 to June 2004.																																		
Data used	For wood-energy resource in forest-dominated areas, data are compiled from the SFS database aggregated to the KO level (see table above: Forest & Forest Ecosystem Condition Survey).																																		
Methodology	<p>For wood-energy resource in non-forest-dominated area, a specific survey was carried out:</p> <p>phase 1: on the 2002 LU Map, systematic sampling, using the same 4 km x 4 km grid as FECS, but covering only the non-forest-dominated areas (471 sampling points) to estimate the canopy cover of woody vegetation, using available orthophotos;</p> <p>phase 2: field measurement in randomly selected samples of the non forest dominated areas (227 sampling points), to relate canopy cover to woody biomass stocking and increment.</p> <p>During phase 1, 10 categories of cover type, including forest types, were identified. The sampling plot size in phase 2 varied with the cover type within each land use class (see below).</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 10%;">Code</th> <th style="width: 70%;">Cover type</th> <th style="width: 20%;">Variable sampling plot size</th> </tr> </thead> <tbody> <tr> <td style="text-align: center;">1</td> <td>Bushes and young trees (vegetation below 7 m height)</td> <td style="text-align: center;">20 m x 20 m</td> </tr> <tr> <td style="text-align: center;">2</td> <td>Intensive orchard</td> <td style="text-align: center;">30 m x 30 m</td> </tr> <tr> <td style="text-align: center;">3</td> <td>Extensive orchard</td> <td style="text-align: center;">30 m x 30 m</td> </tr> <tr> <td style="text-align: center;">4</td> <td>Young forest stand (up to the pole stand)</td> <td style="text-align: center;">20 m x 20 m</td> </tr> <tr> <td style="text-align: center;">5</td> <td>Middle-age forest stand (small to medium tree crown size)</td> <td style="text-align: center;">30 m x 30 m</td> </tr> <tr> <td style="text-align: center;">6</td> <td>Mature forest stand (medium to large tree crown size)</td> <td style="text-align: center;">40 m x 40 m</td> </tr> <tr> <td style="text-align: center;">7</td> <td>Individual (isolated) trees – crown area < 50 m² (diameter < 8 m)</td> <td style="text-align: center;">-</td> </tr> <tr> <td style="text-align: center;">8</td> <td>Individual (isolated) trees – crown area > 50 m² (diameter > 8 m)</td> <td style="text-align: center;">-</td> </tr> <tr> <td style="text-align: center;">9</td> <td>Lines of trees (e.g. roadside trees, hedges) with crown diameter < 8 m</td> <td style="text-align: center;">30 m</td> </tr> <tr> <td style="text-align: center;">10</td> <td>Lines of trees (e.g. roadside trees, hedges) with crown diameter > 8 m</td> <td style="text-align: center;">30 m</td> </tr> </tbody> </table> <p>In all woody cover types, trees and bushes with a diameter ≥ 5 cm were measured.</p>		Code	Cover type	Variable sampling plot size	1	Bushes and young trees (vegetation below 7 m height)	20 m x 20 m	2	Intensive orchard	30 m x 30 m	3	Extensive orchard	30 m x 30 m	4	Young forest stand (up to the pole stand)	20 m x 20 m	5	Middle-age forest stand (small to medium tree crown size)	30 m x 30 m	6	Mature forest stand (medium to large tree crown size)	40 m x 40 m	7	Individual (isolated) trees – crown area < 50 m ² (diameter < 8 m)	-	8	Individual (isolated) trees – crown area > 50 m ² (diameter > 8 m)	-	9	Lines of trees (e.g. roadside trees, hedges) with crown diameter < 8 m	30 m	10	Lines of trees (e.g. roadside trees, hedges) with crown diameter > 8 m	30 m
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Variables related to TOF	For the non-forest-dominated area assessment: Spatial: location, cover type category area Biophysical: Tree species, DBH, Height (for some individual trees)																																		
Categories that may include TOF	<p>Forest: tree stands between 0.25 ha and 0.5 ha</p> <p>Land Use Classes considered as Non-Forest areas:</p> <ul style="list-style-type: none"> - Fields and gardens - Orchard (Intensive , Extensive) - Meadow (Intensive , Extensive) - Re-growth on old farmland - Mixed use (Agric/Forestry) - Urban and built up areas, roads. 																																		

TOF sets and subsets covered	All TOF sets and subsets are covered.
Results	The standing volume in non-forest areas (including meadows, abandoned agriculture, agroforestry, urban areas, orchards, etc.) amounts to some 11.5 million m ³ , with an estimated annual increment of some 400 000 m ³ . From this resource, approximately 300 000 m ³ are believed to be used as fuel every year” (FAO, 2006). For comparison, the same report estimates the annual woodfuel extracted from forests at 1 million m ³ .
Comments	<ul style="list-style-type: none"> - Good overview of the total area, crown cover, stocking volume and increment in various TOF categories, but estimations are rough due to low sampling intensity. - Seems replicable in other countries, not only for fuelwood assessment purposes but for non-forest biomass in general. - Need for a preexisting data on land use and land cover. - The study could be realized in a short time (1 year) thanks to a relatively small country area, preexisting data on forests (representing approximately 60 percent of the country area) and preexisting good land use/land cover mapping system.
References	FAO. 2006. WISDOM – Slovenia. R. Drigo and Ž. Veseli. Rome: 69.

Sweden

The three following projects contribute information on Trees Outside Forests in Sweden:

- National inventory of Landscapes in Sweden (NILS)
- Swedish National Forest Inventory (NFI)
- A Survey of Urban Forestry in Sweden

National inventory of Landscapes in Sweden (NILS)	
Objective	To provide national-level data and perform analyses of landscape biodiversity conditions and changes in terrestrial environments in Sweden. To measure the occurrence of different landscape elements such as solitary trees.
Institution in charge	Swedish University of Agricultural Sciences (SLU)
Scale, duration, periodicity	Countrywide Planned periodicity: 5 years First cycle began in 2003 and ended in 2007. Second cycle began in 2008
Data used	infrared aerial photos
Methodology	<p>Various partner institutions were involved (Universities, Swedish Environmental Protection Agency, Swedish Board of Agriculture, National Heritage Board, etc.)</p> <p>The National Inventory of Landscape in Sweden (NILS) has been developed building upon the Corine Land Cover (CLC) Program, the Landscape inventory and monitoring (LIM), the Swedish National Forest Inventory and other approaches.</p> <p>the country was divided into 10 geographical strata, and 631 (5 x 5 km) sampling units were selected following a random-systematic pattern with stratum-dependent densities. NILS focuses on all terrestrial land cover types: alpine areas, forest, mires and peatlands, coastal areas, agriculture-dominated areas and populated areas.</p> <p>General aerial photo interpretation is conducted within all sampling units. The 1 x 1 km central square in each sampling unit is mapped by detailed colour infrared (CIR) aerial photo interpretation (resolution is 0.5 m and minimum mapping unit is 0.1 ha).</p> <p>If located in land with growing crops, in water, in built-up areas, or areas that are not physically or legally available, plots are not visited. Otherwise, field-inventories are carried out in the central square in 12 permanent sample plots at a distance of 250 m from each other, and along 12 lines (each 200 m long) with line-intercept sampling for linear structures. Each sample plot consists of several concentric circular plots of different radius (20 m, 10 m, 3.5 m and 0.28 m).</p> <p>About 120 (1 km x 1 km) squares all over Sweden's land base are assessed each year by field crews of 2 persons (from late May to September). The number of crews varies between years (8 to 13) depending on planning and logistics, and on the load of supplementary inventory on top of the original NILS-inventory.</p>
Variables related to TOF	<p>356 variables are assessed (269 in the field and 87 in aerial photo interpretation) and selected to be useful for a posteriori classifications such as the European Environment Agency EUNIS habitat type classification, the Biohab approach, and the LCCS classification.</p> <p>Spatial: plot location, site description</p> <p>Biophysical: Number of trees > 10 cm on plots with r=10 m and < 10 cm on plots with r=3.5 m, vertical structure of the Tree layer (no trees, scattered trees, one-layered tree stand, 2-layered tree stand), Shrub layer, Tree canopy cover, Tree species, Habitat type, dendrometric characteristics (DBH, tree height), tree aggregation pattern, grazing impact, Proportion of Dead trees, etc.</p>

Categories that may include TOF	<p>The extremely detailed land-use/land-cover classification allows the grouping of all TOF objects into more general TOF categories. For instance, the ‘trees on land predominantly used for agriculture’ category is made up of the following NILS classes:</p> <ul style="list-style-type: none"> - Fruit orchard cultivation - Grazing - Enclosure for reindeer - Berry bush cultivation - Other cultivation - Vegetation strips - Broadly crowned solitary tree - Biotope islets with trees and shrubs - Mound of stones/boulder/bedrock outcrop with trees and shrubs - Ponds with trees and shrubs - Wetlands in agricultural land with trees and shrubs
TOF sets and subsets covered	All TOF sets and subsets are covered
Results	<ul style="list-style-type: none"> - Provides national statistics for conditions and changes (natural or anthropogenic) on land cover, land use and landscapes for all terrestrial habitats. - Provides a detailed Land-use/land-cover map for the central 1 km x 1 km central square plot.
Comments	<ul style="list-style-type: none"> - Field inventory provided by NILS developed a specific classification that is compatible with other classifications such as LCCS. - Adjustments of the classification are continuously made to improve the data without compromising the variables and variable groups. - Aerial photo interpretation’s method is still under development. - Aerial photo interpretation phase is very accurate: even if results provided by NILS may not seem to focus on all TOF categories, information provided in NILS manual for photo interpretation shows that land cover and land use classifications used are detailed enough to extract information on areas for special TOF categories, such as: agricultural built-up areas, parks, golf courses, camping sites, fruit orchard cultivations, etc.. - Data is used by other surveys, including Swedish Bird Survey, a climate change monitoring project. - Other inventory is integrated with or supplemented with the NILS inventory, including a specific assessment of grasslands and pastures where also fauna are recorded, patch habitats in agricultural landscapes, and Natura 2000 habitats, according to the species and habitats directive.
References	<p>Allard, A., Nilsson, B., et al. 2003. «Manual for Aerial Photo Interpretation in the National Inventory of Landscapes in Sweden.» 81 pp.</p> <p>Esseen, P.-A., Glimskär, A., et al. 2007. «Field Instruction for the National Inventory of the Landscape in Sweden.» 239 pp.</p> <p>Ståhl, G., Allard, A., et al. 2010. National Inventory of Landscapes in Sweden (NILS)—scope, design, and experiences from <i>establishing a multiscale biodiversity monitoring system</i>. Environmental Monitoring Assessment: 17 pp.</p> <p>Swedish University of Agricultural Sciences. 2003. National Inventory of Landscapes in Sweden. NaturVårdsVerket Swedish Environmental Protection Agency. Wikströms, Sweden 4 pp.</p>

National Forest Inventory in Sweden (NFI)

Objective	To describe the state and changes in Sweden's forests.
Institution in charge	Swedish University of Agricultural Sciences (SLU)
Scale, duration, periodicity	Countrywide Annually (the Swedish NFI uses running 5-year mean values, where the interval of re-measurement of permanent plots is 5 years).
Methodology	There are both temporary and permanent tracts, laid out on both forest and non-forest lands. Permanent tracts are laid out on a systematic grid (with varying sizes of meshes and measurements depending on type of tract and region assessed: trees are callipered on all classes except Alpine areas, Urban land and water); temporary tracts are selected at random. Tracts are square or rectangular in shape. They are approximately 7,000 in Sweden (1/3 are temporary and 2/3 are permanent). Each tract is made up of 4 to 12 circular plots ($r=7$ to 10 m) spread around the cluster. There are 2 sorts of plots: plots ($r=7-10$ m) for which tree counts are conducted if $H > 1.3$ m, and plots for which only stump counts (if stump diameter is > 5 cm) are conducted.
Variables related to TOF	Spatial: Plot location, tree location. Biophysical: Tree species, type of forest, Number of trees, Mean diameter, dendrometric characteristics (DBH, tree height, stem volume), vegetation cover, maturity class, age, site quality, dead wood, nesting holes and woodpeckers traces, stand structure. Socioeconomic: Ownership category. Background information: Forestry management, land use.
Categories that may include TOF	Other Land (definitions of "Forest", "OWL" and "Other Land" are the same as FAO definitions); the following subcategories may include TOF: - agriculture land; - road/railroad; - alpine areas; - urban land.
TOF sets and subsets covered	All TOF sets and subsets are covered except set 2: TOF-URB (trees in a urban context).
Results on TOF	- Area, volume and potential wood production estimates. - NFI is used for reporting to all major international processes, such as UNCCC: Greenhouse gas emissions and biomass.
Comments	- National Forest Inventory is only available in Swedish, except the information provided online. - Data on TOF may be extractable for all TOF categories.
References	Axelsson, A.-L., Ståhl, G., et al. 2010. Sweden. <i>National forest Inventories - Pathways for Common Reporting</i> . E. G. Tomppo, Th.; Lawrence, M.; McRoberts, R.E., Springer: 555-565 (11). Swedish University of Agricultural Sciences. 2010. «Swedish National Forest Inventory.» from http://www.slu.se/en/collaborative-centres-and-projects/swedish-national-forest-inventory/inventory-design/ .

A Survey of Urban Forestry in Sweden

Objective	Provide a picture of the state of the management of publicly owned street and park trees in Sweden.
Institution in charge	Myercough College (Britain's national centre for education and training in arboriculture and urban forestry)
Scale, duration, periodicity	Countrywide Assessed once in 2006
Data used	National census of 2004 (from Sweden Statistics)
Methodology	(Based on Trees In Town II methodology) - The 107 towns and cities >10,000 inhabitants are assessed. - Postal questionnaires are sent to each local authorities to get factual data on urban tree resource. - The 39 questions are related to urban trees: staff involved, budgets, inventories, planning and management. - Statistical analyses complete the gathering of data.
Variables related to TOF	Spatial: location of the city assessed, town size class, area of the city. Biophysical: type of urban trees (street or park), number of street trees, number of park trees, percent of urban area with a tree cover. Socioeconomic: none. Background data: maintenance cost per tree in 2004 on various actions (planting, felling), frequency of inspections of trees.
Categories that may include TOF	Street and park trees
TOF sets and subsets covered	Part of set 2: TOF-URB: trees in urban areas - excluded: private gardens
Results	Response rate is 58 percent (62 local authorities out of 107); 73 percent of the respondents were responsible for street, park and woodland trees, 13 percent were only responsible for park trees, and 2 percent only for street trees in public domain (12 percent did not answer this question) On average, 51.53 percent of the urban area has trees, and average tree cover in urban areas is 9.67 percent.
Comments	- Methodology of this survey is close to the one used in Trees In Town II (See Trees In Town description sheet).
References	Saretok, L. 2006. A Survey of Urban Forestry in Sweden. Billsborough, U.K., Myercough College, 170 pp.

Note: This Sweden TOF assessment profile was completed with personal communications from Mr Jonas FRIDMAN, Head of the Swedish National Forest Inventory, Swedish University of Agricultural Sciences (SLU), jonas.fridman@srh.slu.se ; Mr Karl DUVEMO, Swedish Forest Agency, karl.duvemo@skogsstyrelsen.se ; and Dr Johan SVENSSON, Director of the National Inventory of Landscapes in Sweden, Swedish University of Agricultural Sciences (SLU), Faculty of Forest Sciences, johan.svensson@slu.se.

United Kingdom

Surveys on trees in the United Kingdom are conducted by four institutions:

- Forestry Commission is responsible for the National Inventory of Woodlands and Trees,
- Department for Communities and Local Government manages the Trees in Town program,
- Department of Agriculture and Rural Development inventories fruit trees and orchard trees,
- The Centre for Ecology and Hydrology is in charge of the Countryside Survey (not treated here, see “Inventory of Linear Tree Formations” profile sheet).

These four projects provide information on most of Trees Outside Forests in the United Kingdom.

Survey of Small Woodland and Trees (integrated into the National Inventory of Woodlands and Trees)	
Objective	To realize a national inventory of forest and tree resources for areas up to 2.0 ha.
Institution in charge	Forestry Commission: the Woodland Surveys Branch of Forest Research is responsible for the inventory. Other partners, such as the Macaulay Land Use Research Institute, are involved in the different counties and regions of GB.
Scale, duration, periodicity	Territory-wide (GB only: England, Wales, Scotland) Planned periodicity for sampling is 5 years
Data used	Aerial photographs at 1:25 000 scale
Methodology	Land area is divided into a 1 km x 1 km grid, with 2 strata (inland and coastal land), and 1 km ² sample plots are randomly selected to represent 1 percent of the inland area and 1 percent of the coastal area. Feature types are identified in each sample plot. For field data collection, each sample plot is divided in 16 (250 m x 250 m) subplots and 2 subplots are randomly selected (field sampling on 2 382 plots (Wright, 1998).
Variables related to TOF	Spatial: location, area covered by each feature. Biophysical: Spatial structure (upper, lower, shrub, field and ground layers), Forest type, Tree species, Number of trees per group, Dead trees (proportion of deadwood over 15 cm), health and damages, Natural regeneration, dendrometric characteristics (DBH, tree height, commercial tree height), Underwood species. Socioeconomic: Land tenure status. Background information: Thinning history.
Categories that may include TOF	All feature types used: <ul style="list-style-type: none"> - “Small wood” (woodland > 0.1 and <2 ha); - “Groups” (group of 2 or more trees with an area < 0.1 ha); - “Linear feature”: feature with a length of 25 m or more, and at least four times as long as it is broad. It can be up to 50 m wide or as narrow as a single line of trees. Two types are recognised: Narrow Linear Features (with a width of 16 m or less); and Wide Linear Features (with a width greater than 16 m); - “Individual trees” (at least 2 m tall).
TOF sets and subsets covered	<ul style="list-style-type: none"> - Small Stands, < 0.5 ha (set 3: TOF-Non A/U, subset 1). - Narrow Linear Formations, < 20 m width (set 3: TOF-Non A/U, subset 2). - Patches > 0.5 ha, with low tree cover (set 3: TOF-Non A/U, subsets 3 and 4).
Results	<ul style="list-style-type: none"> - Woodlands from 0.10 to 0.25 ha represents a total woodland area of 13 419 ha (0.5 percent of the total GB woodland area and 0.05 percent of total GB land area). - Woodland from 0.25 to 2 ha (including TOF sensu FAO up to 0.5 ha) represents a total woodland area of 107 075 ha (4.0 percent of the total GB woodland area and 0.47 percent of total GB land area). <p>Total TOF woodland area in GB thus stands between 0.05 and 0.52 percent of total GB land area, while total woodland area is estimated to 11.6 percent of the total GB land area.</p>

Comments	<ul style="list-style-type: none"> - Exact data on the extent of the woodland TOF sensu FAO covered by this assessment may be extracted from the original data set: “Woodland size” being recorded, data on woodlands under 0.5 ha are extractable. - Orchards and urban woodland are excluded. - Not implemented in Northern Ireland.
References	<p>Forestry Commission. 2003. <i>National Inventory of Woodland and Trees Great Britain</i>. Edinburgh, Scotland, Forestry Commission: 68 pp.</p> <p>Wright, D. 1998. The National Inventory of Woodland and Trees, information note. F. Commission, Forestry Practice: 8 pp.</p>

Trees in Towns II

Objective	To provide up-to-date information on England urban tree stock and urban tree management and recommend good practice.
Institution in charge	Department for Communities and Local Government Various interested parties involved in this project included the Office of the Deputy Prime Minister, research contractors, arboriculture organizations, colleges, the national urban forestry unit, associations, and the Forestry Commission. A Project Advisory Group (PAG) gathered regularly to provide support and advice to the project, gathering representatives of the arboricultural industry and local government organisations. Especially, PAG helped to set up the Local Authority questionnaire.
Scale, duration, periodicity	Territory-wide (England only) Commissioned in 2004, results published in 2008
Data used	Aerial photographs (1:25 000 - 1:10 000 and some with a 25 cm resolution)
Methodology	<p>TT II is structured into 3 distinct but interrelated phases:</p> <ul style="list-style-type: none"> - Strand 1: A national tree survey, with aerial photos and field sampling. - Strand 2: A survey of Local Authorities (LA), through questionnaires, which aims at providing an insight into and identify good and innovative practices in urban tree management by Local Authorities (including all County, Metropolitan, London Borough, Unitary, and District Councils in England, Transport for London, Parish and Town Councils). - The integration of Strands 1 and 2 using statistics. <p>Sampling design:</p> <ul style="list-style-type: none"> - Strand 1: National tree survey <ul style="list-style-type: none"> • Three levels of stratification: 9 regions, 3 town sizes (3-10,000; 10-80,000; over 80 000 population), land-use type (6 classes or “groupings”: low, medium and high-density residential, town centre/commercial, industrial, open space; and sub-categories, e.g. for “open spaces”: (1) Formal and informal open space (parks, gardens and informal amenity land), (2) Institutional open space (school and hospital grounds, cemeteries and crematoria), (3) Derelict, vacant and neglected land, (4) Areas of enclosed remnant countryside (low input agriculture, pony grazing, etc.). Land Class Types were initially identified from 1:25 000 and 1:10 000 scale mapping and aerial photography. • 147 towns and cities were surveyed: originally the plan was to look at 15 towns per region, with 5 from each town category (small, medium and large), plus 10 London Boroughs. Target towns were randomly selected from each of the Government regions and town size classes, and the survey plots were selected through an on-screen analysis of both aerial photography and digital mapping. • A total amount of 590 plots surveyed on the ground (up to 4 plots of 4 ha for each land use type in each town), measuring 200 m x 200 m. At least one plot per land use type was supposed to be sampled in each town, but not all of the six land use types were present in sufficiently large and uniform areas to allow even one survey plot to be identified in some towns. A sampling tool was developed (within ArcView) to randomly generate up to four 4-ha sample squares per land class polygon. • Aerial photographs (at a resolution of 25 cm) on 1 783 plots were also used to measure the extent of tree canopy cover. • Data were recorded on every clearly visible tree or group of trees and all visible shrubs >2.5 m tall. - Strand 2: Local Authorities survey <ul style="list-style-type: none"> • A detailed questionnaire sent to all local authorities in England: 389 in total, of which 258 were returned (66 percent). The questionnaires were sent to the LA officers in charge of the management of the LA's publicly-owned tree resource. The content of the questionnaire developed in consultation with the Project Advisory Group included seven sections dealing mainly with strategies, programmes, legal aspects and management of urban trees.

Variables related to TOF	<p>Spatial: location, area</p> <p>Biophysical: Land cover, Tree species and variety/form, age, maturity, condition, dendrometric characteristics (DBH, tree height, crown spread, canopy cover).</p> <p>Socioeconomic: Land use, contribution to urban environment, visual contribution, density of inhabitants in the area, tree ownership status, management and the uses and values of urban trees.</p> <p>Background information: Thinning history.</p>
Categories that may include TOF	All categories of the assessment are part of the Urban TOF sensu FAO category: "Trees on land that is predominantly under urban use", whatever the size and shape of the stands.
TOF sets and subsets covered	Trees in urban areas (set 2: TOF-URB)
Results	<ul style="list-style-type: none"> - Distribution of trees in species groups and in classes of: diameter, height, crown spread, age, maturity, etc. - Tree density per city/town and per land-use category. Average density of urban trees and shrubs is 58.4 trees/ha, but densities ranged widely from 1 tree/ha to 886 tree/ha. Town size had no effect on tree density. A total number of 137 863 trees were recorded out of the 2 360 ha of urban areas inventoried.
Comments	<ul style="list-style-type: none"> - All trees in urban areas are considered, even in private property (mainly in gardens) or less accessible public land (e.g. schools, churchyards, allotments, etc.). - Cost to the Department was £296 683 (approx US\$470 000 in total and US\$800 per plot), which may hinder the replicability of such study in other countries. - Through comparison with TT I, results of TT II provided data on changes.
References	<p>Britt, C. & Johnston, M. 2008a. Trees in Town II, A new survey of urban trees in England and their condition and management. Queen's Printer and Controller of Her Majesty's Stationery Office; Research for Amenity Trees no. 9: 647. Britt, C. & Johnston, M. 2008b. Trees in Town II, A new survey of urban trees in England and their condition and management - Executive Summary. Queen's Printer and Controller of Her Majesty's Stationery Office; Research for Amenity Trees no.9. 36 pp.</p> <p>CLG. 2004. Project: Trees in Town (2). CLG Research Database Communities and Local Government. Retrieved December 2010 from http://www.rmd.communities.gov.uk/project.asp?intProjectID=11590.</p> <p>CLG. 2008. «Planning, building and the environment.» Communities and Local Government. Retrieved December 2010 from http://www.communities.gov.uk/publications/planningandbuilding/treesintownsii.</p>

Fruit and orchard survey	
Objective	To have statistics on the fruit tree cover and its evolution at country level.
Institution in charge	Economics and statistics Division of the Department of Agriculture and Rural Development (DARD) for Northern Ireland Department for Environment, Food and Rural Affairs (DEFRA) for England and Wales
Scale, duration, periodicity	Territory-wide (England, Wales, Northern Ireland) Assessment based on a 5-year cycle. Last survey published on March 2010
Methodology	Questionnaires sent to all growers having commercial orchards > 1 ha: - 580 responded in England and Wales (response rate of 72 percent) (National Statistics 2010) - 204 responded in Northern Ireland (Economics and Statistics Division of the Department of Agriculture and Rural Development 2002)
Variables related to TOF	Orchard area, Tree species, Fruit varieties, Productions
Categories that may include TOF	All categories in this assessment are TOF categories (orchards > 1 ha).
TOF sets and subsets covered	Trees on agriculture land (set 1: TOF-AGRI, partly covered)
Results	Total fruit orchard area for the UK is estimated as 24 000 ha (orchards > 1 ha). Results of the Orchard Fruit Survey 2009 dealt only with England and Wales, where the fruit orchard area (excluding orchards < 1 ha) is estimated at 16 788 ha.
Comments	<ul style="list-style-type: none"> - Orchards covering less than 1 ha are not taken into account. - Data resulting from this assessment may constitute a lower estimation of the Other Land with Tree Cover (OLwTC) FRA category as all orchards covered by this assessment are included into OLwTC. - Other small surveys provide data on orchards at the region scale (i.e. The Forth Valley Orchard Regeneration Initiative).
References	<p>Department for Environment Food and Rural Affairs, Department of Agriculture and Rural Development (Northern Ireland), et al. 2009. Chapter 3: The Structure of the Industry. Agriculture in the United Kingdom 2009. 3: 146.</p> <p>Economics and Statistics Division of the Department of Agriculture and Rural Development. 2002. <i>Survey of Orchard Fruit Production in Northern Ireland: Results for 2002</i>. Northern Ireland, Department of Agriculture and Rural Development.</p> <p>National Statistics. 2010. Survey of Orchard Fruit - October 2009 - England & Wales Department for Environment Food and Rural Affairs. 4 pp.</p>

This UK TOF assessment profile was completed with personal communications from Mr Mark Johnston, Research Fellow on Arboriculture and Urban Forestry at Myerscough College, and Mr Simon Gillam, Head of Economics and Statistics at Forestry Commission.

Uruguay

Two main sources can provide information on TOF at country scale in Uruguay: the first National Forest Inventory, and the General Agriculture Census.

First National Forest Inventory	
Objective	<p>To contribute to sustainable forest management, thanks to a continuous forest resources monitoring and assessment of biophysical, ecological, economical, social aspects of all forests. To assess forest cover change using remote sensing; to assess the wood volume and the conservation status of forests using field sampling.</p> <p>To involve public and private institutions related to forest resources in the project process and to improve the technical capacity for a Permanent Monitoring System of forest resources.</p>
Institution in charge	Dirección General Forestal (MGAP). Field data collection was subcontracted but supervised by DGF.
Scale, duration, periodicity	<p>Countrywide</p> <p>Started in 2008, preliminary results of the first assessment have been published in August 2010.</p> <p>Continuous over a 5-year cycle for the planted forest and 10-year cycle for native forest.</p>
Methodology	<p>2 phases:</p> <p>Forest Map (Phase) Based on the 2006 forest map, stratification was done using Landsat-5 TM images. This new forest map is divided in 8 strata: 1. Native Forest; 2. Eucalyptus grandis, saligna, dunnii; 3. Eucalyptus globulus ssp. globulus, ssp. maidenii, ssp. bicostata; 4. Eucalyptus other species; 5. Pinus; 6. Salicaceas; 7. Atlantic coastal Forest; 8. Mixed native and planted forest. An actualization of the Forest map will be done this year (2012).</p> <ol style="list-style-type: none"> 1. Sampling grid of 1.9 km x 1.9 km covering the whole country. 2. Watershed with the most representative forests were selected. 3. Within each selected watershed, a sampling point was assigned at the centre of each square, as long as the point fell on a forest area (sensu NFI). If the sampling point fell in a non forest area, then it was discarded. 4 769 permanent sampling plots (1PSP/361 ha approx) were then established countrywide. <p>Field sampling (Phase) So far, out of the 4 769 PSP, 1 242 PSP have been sampled in the first year of inventory (392 on native forests and 850 on planted forest), representing an area of forest inventoried of about 450 000 ha (26 percent of the country).</p> <p>Sampling plot design:</p> <ul style="list-style-type: none"> - Sampling plots on planted forest are concentric circles, where different measurements are taken: <ul style="list-style-type: none"> 113 m² (6 m), all trees with a height above 1.30 m are considered 314 m² (10 m), all trees with a diameter above 10 cm are considered 616 m² (14 m), all trees with a diameter above 25 cm are considered 1.018 m² (18 m), all trees with a diameter above 35 cm are considered - Sampling plots on native forest have a rectangular shape, 20 m x 10 m (200 m²), oriented perpendicular to major physical features.
Variables related to TOF	<p>Different variables are taken for planted and native forest, but for both the following variables are collected:</p> <p>Spatial: Localization; surface area estimated from satellite images, topographical situation exposition, slope.</p> <p>Biophysical: station quality, tree density, dendrometrics (DBH, height), growth, regeneration, treatments, vegetation, sanitary aspects.</p> <p>Socioeconomical: ownership.</p> <p>Background information: characteristics and vocation of the production.</p>

Categories that may include TOF	Planted Forest subclasses: <ul style="list-style-type: none"> - Windbreaks and “Service Forest”, if less than 20 m width or less than 0.5 ha - Agroforestry and sylvopasture systems
TOF sets and subsets covered	All TOF sets and subsets are covered except trees in urban context (set 2: TOF-URB)
Results	<ul style="list-style-type: none"> - Planted forest in Uruguay cover an estimated area of 969 500 ha, representing 56 percent of all national forests (1 721 658 ha). - - 53 percent of the PSP made on planted forests could be considered as TOF areas because the predominant use of the land was “agriculture”. Primary land uses in the PSP made on planted forests were: <ul style="list-style-type: none"> - 47 percent: forestry use - 28 percent: agroforestry use - 18 percent: pastoral use - 3 percent: agricultural use - 2 percent: agro-pastoral use - 1 percent: sylvo-agricultural use and - 1 percent: sylvo-pastoral use
Comments	<ul style="list-style-type: none"> - Since land use is provided, all land-use types involving human activities can be distinguished and evaluated separately. - No minimal width is set for linear structures, but they could probably be extracted (windbreaks and “Service Forest”).
References	<p>This assessment profile is based on personal communications from Mr. Ricardo D. Echeverría (Dirección General Forestal-MGAP, Montevideo, Uruguay) and on the following documents:</p> <p>Dirección General Forestal MGAP & FAO. 2010. Monitoreo de los Recursos Forestales - Inventario Forestal Nacional - Resumen de Resultados. R. D. Echeverría: 32 pp.</p> <p>Echeverría, R. 2008a. Inventario Forestal Nacional - Prueba Metodológica - Cuenca Río Negro, Subcuenca Río Tacuarembó Montevideo, Uruguay.</p>

General Census of Agriculture 2000- Censo General Agropecuario

Objective	<p>To provide basic data on the structure of the farming sector, at different levels: national, departmental and enumeration area. (The enumeration area is the smallest territorial division within departments. There are 637 enumeration areas in the country.)</p> <p>To update the sampling frame for continuous or occasional surveys in the farming sector.</p> <p>To provide a baseline for the improvement of the farming sector statistics, and contribute to the consolidation of an Integrated Farming Statistical System.</p>
Institution in charge	Dirección de Estadísticas Agropecuarias DIEA (MGAP)
Scale, duration, periodicity	<p>Countrywide</p> <p>Data collection 08/2000 - 11/2000</p> <p>10-year cycle, next one in 2011</p>
Methodology	<ul style="list-style-type: none"> - This census is a complete enumeration and survey of all farms of more than 1 ha. No sampling has been done. - A census map that corresponds as much as possible to other population censuses was first developed in collaboration with the National Institute of Statistics (INE). The geo-statistical units were defined using the digital geographical database (Primera Base de Datos Geográfica Digital, or BDGD), which provided geographical limits, transportation axes, etc. The 2000 census map was at 1:200 000 scale while the 2010 map is at 1:50 000 scale. <p>A field survey was then carried out in all farms > 1 ha. The survey consisted in field visits and interviews based on questionnaire forms, including the following TOF related sections:</p> <ul style="list-style-type: none"> - Farm area as of 30 June, 2000: <ul style="list-style-type: none"> • Planted and Natural Forest • Fruit trees and Vineyards • Land use - Household composition and labour force - Source of income (from farm activities) Farm and farmer main characteristics (e.g. gender, age, education) <p>All individual data on areas come from the questionnaire and are then totaled.</p>
Variables related to TOF	<p>Spatial: area, location</p> <p>Biophysical: irrigation, tree density</p> <p>Socioeconomics: Labour and social parameters, income, production, yield</p>
Categories that may include TOF	<p>All Fruit tree crops:</p> <ul style="list-style-type: none"> - Citrus - Fruit trees with deciduous leaves: Apples, Pears, Peaches, Prunes, Nectarines and Quince
TOF sets and subsets covered	Part of set 1: TOF-AGRI (trees on agricultural land)
Results	<ul style="list-style-type: none"> - Citrus cover 21 659 ha, representing 0.1 percent of the operated surface (being the total surface of all farms censused). - Other Fruit trees cover 10 490 ha, representing less than 0.1 percent of the operated surface (being the total surface of all farms censused).
Comments	<ul style="list-style-type: none"> - A web page provides interactive maps and information on the results. The census is regularly complemented by more specific surveys (livestock, plant production, and fishery). Within the crop section, citrus, tree crops and forest are assessed by specific censuses. Citrus surveys and Fruit tree surveys are carried out on a yearly basis. - Small farms < 1 ha encountered during the census were not surveyed but were recorded on the field forms. They represent a very low number and a small area. - Windbreaks are included in the cultivated land surface declaration (for farms > 1 ha). - Another census, in 2011, was designed following the new FAO recommendations for the decennial World Agricultural Census.

References

This assessment profile is based on personal communications from M. Alfredo Hernández (DIEA Director, Montevideo, Uruguay) and on the following documents:

Abayian, A. 2008. Definición de áreas geográficas en los censos de población y vivienda. Santiago, Chile.

Dirección de Estadísticas Agropecuarias. 2000. Censo Agropecuario 2000. From <http://www.mgap.gub.uy/portal/hgxpp001.aspx?7,5,296,O,S,0,MNU;E;28;5;MNU;,.>

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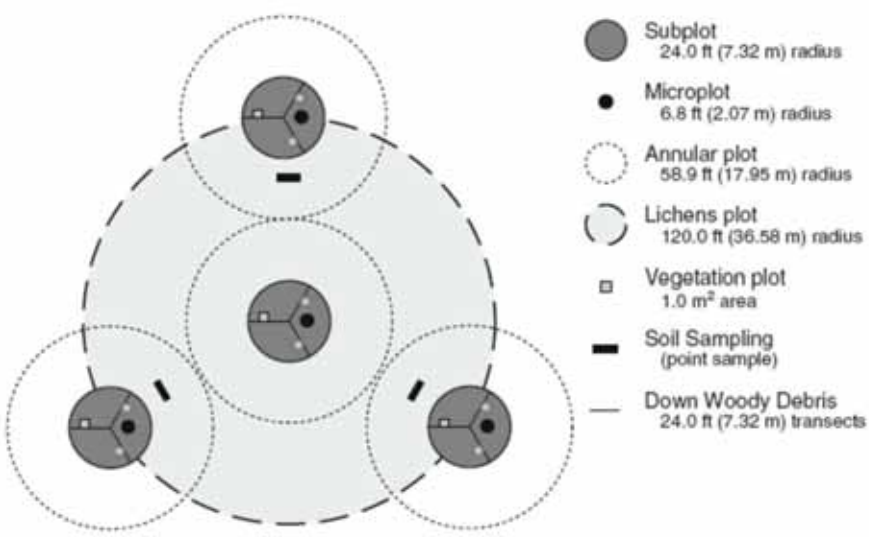
Four large-area surveys provide information on TOF in the United States of America:

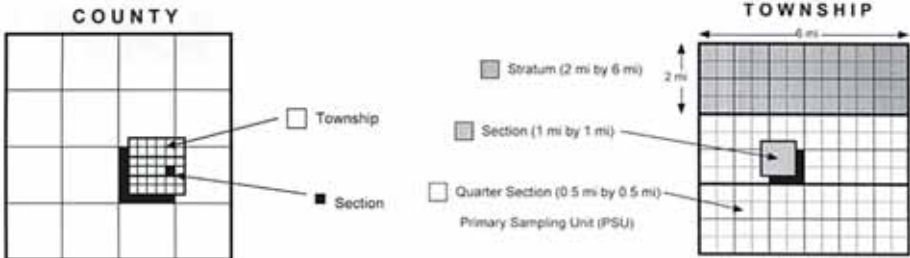
- The Forest Inventory and Analysis National Program (FIA),
- The Natural Resources Inventory (NRI) program,
- The Inventory of Trees in Non-forest Areas in the Great Plains States,
- The “Forest on the Edge project”: an assessment of urban trees.

Forest Inventory and Analysis National Program (FIA)	
Objective	To provide the information needed to assess America’s forests and project how forests are likely to appear 10 to 50 years from now (USDA Forest Service, 2010)
Institution in charge	USDA Forest Service
Scale, duration, periodicity	Countrywide Annual survey based on a 5-year cycle in the eastern U.S. and 10-year cycle in the West. Last national report was published in 2007.
Data used	Satellite imagery ranging from 1-m USDA NAIP imagery to Landsat at 30-m and MODIS at 250-m resolution.
Methodology	<p>Forest Inventory and Analysis, previously known as Forest Survey, is a statistically based, systematic random sample. It has evolved to address diverse topics such as forest health, carbon storage, wildlife habitat, air pollution, and invasive plants. Spacing at the field plot level is one plot every 5 km (McRoberts et al, 2010).</p> <p>It uses a double-sampling design including a preliminary stratification phase, and two phases of sampling:</p> <ol style="list-style-type: none"> 1. Remote sensing phase aims at stratifying forest areas in roughly homogeneous strata. 2. The second phase begins with setting sample locations. FIA applies a nationally consistent sampling protocol using a quasi-systematic design covering all ownerships in the entire country. This sampling design is based on a tessellation of hexagons, each hexagon representing approximately 2 403 ha. The base federal sample consists of one sample in a randomly selected location in each hexagon. High resolution aerial imagery is then used to check that the sample qualifies as “forest”: an area that is occupied by trees with at least 10 percent canopy cover, and that meets minimum area (0.4 ha) and width (36.6 m) requirements (Liknes et al. 2010). Tree-covered areas in agricultural production and in urban settings are not considered forest land (Smith et al. 2009). If the sample qualifies as forest, a 0.4 ha permanent plot is established for field measurements and observations. 3. The third phase consists in a subset of plots from Phase 2. Additional measurements on phase 3 plots relate to forest ecosystem function, condition and health.
Variables related to TOF	<p>Spatial: plot location</p> <p>Biophysical: Phase 2 samples: Forest type, Number of trees, Dead trees, Regeneration status, dendrometric characteristics (for trees > 12.7 cm DBH), species composition Stand age, Disturbance, Plant association, Ground cover, Stand size class. Phase 3 samples: crown condition, soil erosion potential, soil fertility and/or toxicity, lichens, ozone bioindicators, vegetation structure, and down woody material.</p> <p>Socioeconomic: Ownership status</p> <p>Background information: Present land use, treatments and thinning history</p>
Categories that may include TOF	All categories may potentially include TOF in the form of smallwoods, between 0.4 ha (the minimal threshold size for a forest in FIA assessment) and 0.5 ha (the minimum threshold size for a forest by FAO-FRA definition).

TOF sets and subsets covered	Part of set 3: TOF-Non A/U, subset 1 (the Small woods subset)
Results	These areas include windbreaks, shelterbelts, other agricultural land and farmsteads with trees, and riparian wooded strips. There are also another 1 million ash trees in the urban areas of South Dakota.
Comments	The list of research applications using FIA data is growing as more scientists become familiar with the program. For instance, a study carried out in a few counties of Maryland concluded that 30 - 50 percent of the FIA non-forest samples contained trees and were located in urban, suburban, industrial, and rural areas (Riemann, 2003). Another example is the "Working Tree" study (Perry et al., 2008) that assessed the woody resources in 11 Midwestern states, suggesting that substantial areas of working trees (which mostly qualify as TOF) are not inventoried because of the focus of FIA on "forest". Recently, Liknes et al. (2010), using various satellite image datasets concluded that satellite-derived estimates of tree cover area (including non-forest lands) differed from FIA estimates (including only forest land) by as much as 200 000 ha in both North Dakota and South Dakota.
References	<p>Liknes, G.C., Perry, C.H., & Meneguzzo, D.M. 2010. <i>Assessing tree cover in Agricultural Landscapes Using High-Resolution Aerial Imagery</i>, Journal of Terrestrial Observation: 2(1): Article 5. Available at: http://docs.lib.purdue.edu/jto/vol2/iss1/art5</p> <p>McRoberts, R.E., Hansen, M.H. and Smith, W.B. 2010. United States of America (USA). <i>National Forest Inventories - Pathways for Common Reporting</i>, eds. E. G. Tomppo, Th.; Lawrence, M.; McRoberts, R.E., Springer: 567-581 (15).</p> <p>Perry, C. H., Woodall, C. W., Liknes G.C. & Schoeneberger, M.M. 2009. Filling the gap: improving estimates of working tree resources in agricultural landscapes. <i>Agroforestry Systems</i> 75 (1): 91-101.</p> <p>Riemann, R. 2003. <i>Pilot Inventory of FIA plots traditionally called «nonforest»</i>. Newton Square, PA, US Dept. of Agriculture, Forest Service, Northeastern Research Station.</p> <p>Smith, W. Brad, tech. coord.; Miles, Patrick D., data coord.; Perry, Charles H., map coord.; Pugh, Scott A., Data CD coord. 2009. <i>Forest Resources of the United States, 2007</i>. Gen. Tech. Rep. WO-78. Washington, DC: U.S. Department of Agriculture, Forest Service, Washington Office. 336 pp.</p> <p>USDA Forest Service. 2010. «Forest Inventory and Analysis National Program.» Retrieved January 2011 from http://www.fia.fs.fed.us/.</p>

National Resources Inventory (NRI)

Objective	To assess conditions and trends for soil, water, and related natural resources (including trees and land use) on non-federal lands in the United States.
Institution in charge	Natural Resources Conservation Service (NRCS) of U.S. Department of Agriculture In collaboration with Iowa State University's Center for Survey Statistics and Methodology (ISU-CSSM)
Scale, duration, periodicity	Countrywide 5-year cycle Last NRI (2007) was released in 2010
Data used	High resolution remote-sensing images
Methodology	<p>NRI is a statistically based sample of land use, natural resource conditions and trends on U.S. non-federal lands. Non-federal lands include privately owned lands, tribal and trust lands, and lands controlled by state and local governments and represent about 75 percent of the total land area in the USA.</p> <ol style="list-style-type: none"> (1) Geospatial technologies and remote sensing, to monitor natural resource conditions and trends, based on the collection of data using photo interpretation for an annually observed core sample of 42 000 "primary sampling units" (PSUs) and a rotating sample (31 000 PSUs) each year. (2) Inventory on sample points and segments (see below) (3) Statistical analysis and production of national and state estimates (Farmland Information Center, 2010) <p>Sampling design (USDA, 2009): The basic design of NRI surveys is a stratified, two-stage area sample that can be modified for specific national survey objectives and used as a frame for special studies.</p> <ol style="list-style-type: none"> (1) In the first stage of sampling, a county (standard-sized county is a square ~38.6 km on a side) is divided in equal size townships. A township is split into 3 strata (3.2 x 9.6 km), which are further divided up into "segments". A "segment", also called "Primary Sampling Unit" or PSU, is an area of land (typically square to rectangular) that is usually 64.7 ha in size. Its size is based on the shape, size, and complexity of the resources being inventoried (Figures 1 and 2). <p>An approximate 4 percent sampling rate is obtained by selecting 2 PSUs within each stratum.</p> <div style="text-align: right;">  <ul style="list-style-type: none"> Subplot 24.0 ft (7.32 m) radius Microplot 6.8 ft (2.07 m) radius Annular plot 58.9 ft (17.95 m) radius Lichens plot 120.0 ft (36.58 m) radius Vegetation plot 1.0 m² area Soil Sampling (point sample) Down Woody Debris 24.0 ft (7.32 m) transects </div>

	 <p>(2) The second stage of sampling consists in choosing randomly three sample points within each PSU. Some data are collected for the entire segment, while others are collected at the segment sample points. Sampling rates across the US generally range from 2 to 6 percent of the land area: NRI sample contains approximately 300 000 sample segments for 800 000 sample points.</p>
Variables related to TOF	<p>Spatial: plot location, surfaces inventoried Biophysical: Land cover, Tree canopy cover Background information: ownership, land use, agricultural history, irrigation practices, conservation practices, regional natural resource classifications</p>
Categories that may include TOF	<p>Two main classes: “Developed land” and “Rural land”. Both may contain TOF:</p> <ol style="list-style-type: none"> 1. Developed Lands: These are areas of intensive anthropogenic use. Much of the land is covered by structures and impervious surfaces (to identify which lands have been permanently removed from the rural land base). It is further divided into 3 categories, each containing TOF in part of their area: <ul style="list-style-type: none"> - Large tracts of urban and built-up land; - Small tracts of built-up land (< 4 ha); - Land in a rural transportation corridor. 2. Rural Lands: further divided into 6 categories based on land cover/use criteria. They all may include TOF in part of the area they cover: <ul style="list-style-type: none"> - Cropland - CRP (Conservation Reserve Program) Land - Pastureland - Rangeland - Forest land - Other rural land
TOF sets and subsets covered	<p>All TOF sets and subsets are covered.</p>
Results	<p>Data on TOF may be extractable for some categories, but only through a re-analysis of raw image data.</p>
Comments	<p>A special study focused on Rangelands. It included a field inventory of trees (USDA, 2004).</p>
References	<p>Farmland Information Center. 2010. «2007 National Resources Inventory: Changes in Land Cover/Use.» Jennifer Dempsey; Northampton, MA: American Farmland Trust; FIC Fact Sheet and Technical Memo; 4 pp.</p> <p>Perry, C. H., Woodall, C. W., and Schoeneberger M.M. 2005. <i>Inventoring Trees in Agricultural Landscapes : Towards an Accounting of Working Trees</i>. 9th N.Am. Agroforestry Conference, Rochester, Minnesota.</p> <p>USDA. 2004. <i>National Resources Inventory Rangeland Field Study—Introduction</i>. National Resources Inventory Rangeland Field Study. Chapter 1: 3.</p> <p>USDA. 2009. «Summary Report: 2007 National Resources Inventory.» Natural Resources Conservation Service (NRCS) and Center for Survey Statistics and Methodology; Iowa State University, Ames, Iowa. 123 pp.</p>

Inventory of Trees in Non forest Areas in the Great Plains States

Objective	To characterize the tree resource in non-forest areas (and supplement FIA inventory), to develop and conduct statistically valid regional inventories of rural agroforests and urban and community forests.
Institution in charge	National Inventory and Monitoring Applications Center (NIMAC) , US Forest Service NIMAC partnered with state co-operators from various sectors (Higher Education, municipalities, Farmers associations, etc.) to implement this study.
Scale, duration, periodicity	Region-wide (the Plains States = North Dakota, South Dakota, Nebraska, and Kansas) Set up once in 2008, 2 years long
Data used	FIA's field inventory methodology and RS analysis with Landsat 30 x 30 m (1 pixel).
Methodology	<p>Great Plains are approximately 97 percent non-forest, and consist mostly of agricultural and grassland vegetation communities.</p> <p>This inventory of non forested areas is the first phase of the Great Plains Tree and Forest Invasives Initiative (GPI). It includes rural and urban lands NIMAC extended traditional FIA plot and sample design methodology to the Plains States Non Forest Trees inventory.</p> <p>It is a stratified, two-phase sample design.</p> <p>Per pixel, land cover category, percent impervious surface, and percent canopy cover are estimated. Then:</p> <ol style="list-style-type: none"> (1) Step 1 consists in stratifying the four-state area into two strata (canopy and no canopy using a derivative of the National Land Cover Dataset (NLCD)) (2) Step 2 is the first phase of the two-phase sample. It consists in selecting elements within each stratum. Photo-interpretation plots (PI plots) from the FIA were used. (points covering the whole national territory). Each PI plot consists in 21 uniformly spaced points (within a circle of 674 m²). The land use of each of the 21 points is assessed (using FIA classification and field data) and the count of points falling in the Non Forest Trees (NFT) land use category is recorded for each PI plot. For economical reasons a sampling intensity of 18 000 PI plots/State was predetermined. The number of PI plots with Non Forest Trees in each stratum was counted, allowing to find out the representative quantity of PI plots per stratum. (3) Step 3 is the second phase of sampling. A subsample of the PI plots was selected randomly in a spatially balanced manner for field inventory. For each PI plot, three substratum classes were assigned depending on the number of NFT land-use points (n/21). No ground plots were sampled in the first substratum of each stratum (the substrata with no NFT "points").
Variables related to TOF	<p>Spatial: location of tree resource</p> <p>Biophysical: Tree species, Number of trees, dendrometric characteristics (DBH for trees > 2.54 cm, tree height), health (percentage of canopy dieback), function (e.g. windbreaks, shelterbelts, wildlife areas, narrow riparian tree belts).</p> <p>Socioeconomic: Land use.</p>
Categories that may include TOF	All trees outside forests are assessed, but there is no attempt to categorize the trees.
TOF sets and subsets covered	All TOF sets and subsets are covered by this assessment.

Results	As an example of the kind of results: In South Dakota, Ash tree is the fifth most abundant forest land tree species, with an estimated 21 million ash trees (2.5 cm diameter or greater). But the measurement plots in non-forested land show that the greatest percentage of the ash resource (28 million trees) is in rural, non-forested areas. These areas include windbreaks, shelterbelts, other agricultural land and farmsteads with trees, and riparian wooded strips. There are also another 1 million ash trees in the urban areas of South Dakota.
Comments	Built on the statistically valid FIA sample set, the adopted sampling design is a trade-off between a desire for compatibility with FIA methodology and cost effectiveness in the field.
References	<p>Josiah, S. 2008. Great Plains Tree & Forest Invasives Initiative. National S&PF Leadership Team, US Forest Service, Charlotte, NC, USA.</p> <p>Lister, A., Scott, C. & Rasmussen, S. 2008. Inventory of trees in nonforest areas in the Great Plains States. Forest Inventory and Analysis (FIA) Symposium, Park City, UT, USA.</p> <p>Piva, R. J., Lister, A. J., & Haugan D. 2009. «South Dakota's forest resources, 2007.» (Research Note NRS-32), U.S. Department of Agriculture, Forest Service, Northern Research Station; 4 pp.</p> <p>Western Forestry Leadership Coalition. 2009. Great Plains Tree and Forest Invasives Initiative. A multi-state cooperative effort for education, mitigation and utilization, U.S. Forest Service: 2 pp.</p>

“Sustaining America’s Urban Trees and Forests” study: an assessment of urban trees and forests

Objective	To assess the cover of Urban Trees in the USA by: <ul style="list-style-type: none"> - providing an overview of the current status and benefits of America’s urban forests, - comparing differences in urban forest canopy cover among regions, - discussing challenges facing urban forests and their implications for urban forest management.
Institution in charge	Forest Service of the U.S. Department of Agriculture
Scale, duration, periodicity	Countrywide (except Alaska and Hawaii that provided incomplete data) First report in 2010
Data used	<ul style="list-style-type: none"> - National Land Cover Database (NLCD) estimates of 2007 based on Landsat satellite imagery from 2001 (resolution is 30 m) - U.S. Census Bureau data for delimitation of urban areas and population data - Satellite images (Google Earth) - High resolution Aerial photo (at 1 m)
Methodology	<p>This assessment is part of The Forests on the Edge project that aims at increasing public understanding of the contributions of and pressures on US forests, and at creating new tools for strategic planning.</p> <p>The main results (on Urban Tree Cover and Tree Canopy Cover) are provided at county scale and then gathered to provide results at a National scale.</p> <p>Two main variables were assessed, using different methods:</p> <ol style="list-style-type: none"> 1. Tree canopy cover at county scale was directly extracted from NLCD. Tree canopy cover per capita was calculated as tree canopy cover (m²) divided by the county population. 2. The National Urban Tree Cover estimate. Because NLCD tends to underestimate tree cover, tree cover in urban areas was photo-interpreted using imagery from Google Earth. A total number of 9 436 points, randomly located in urban areas over the whole country, were photo-interpreted in relation to tree cover. Urban tree cover was calculated as the percentage of total points that fell upon tree canopies and then, urban tree cover within each state was weighted by total urban land in the state to calculate national urban tree cover.
Variables related to TOF	Spatial: location of tree resource (Western Forestry Leadership Coalition, 2009) Biophysical: Tree canopy cover, density of trees Background information: Land use
Categories that may include TOF	The assessment covered all urban trees. But there was no further categorization.
TOF sets and subsets covered	Trees in urban areas, set 2: TOF-URB
Results	<ul style="list-style-type: none"> - Maps on the percent of urban areas per county, urban canopy cover per person, etc. - A little more than 3 percent of the conterminous USA was classified as “urban”. This small percentage of land supports 79 percent of the population, or more than 220 million people. - Average tree cover in urban areas of the conterminous USA was estimated at 35 percent. - Nationally, urban forests in the United States are estimated to contain about 3.8 billion trees, with an estimated structural asset value of US\$2.4 trillion.
Comments	<ul style="list-style-type: none"> - Provides important qualitative results in addition to tree cover data - Provides no data on most biophysical aspects such as species composition and volumetric data.
References	Nowak, D.J., Stein, S.M., et al. 2010. «Sustaining America’s Urban Trees and Forests.» <i>A Forests on the Edge report</i> , NRS-62: 28.

Many forest inventories and wood resources assessment programs were carried out at different levels in Zambia. The national assessment reported here is the first comprehensive Land use assessment; it is based on the ILUA/NFMA (National Forest Assessment and Monitoring System) project.

Integrated Land Use Assessment 2005-2008	
Objective	To assess forestry and other related resources and land use practices. To provide up-to-date qualitative and quantitative information on the state, use, management and trends of these resources (FAO 2005; FAO and Zambia Forest Department 2008).
Institution in charge	Zambia Forestry Department (MTENR)
Scale, duration, periodicity	Countrywide 3 years (2005-2008) ILUA II, a 4-year project, was launched in 2010. Its main purpose is to support implementation of Sustainable Forest Management (SFM) and REDD (FAO 2010).
Data used	Field measurements, observations and local interviews
Methodology	ILUA is based on the FAO National Forest Assessment and Monitoring System (NFMA) methodology (see NFMA description sheet), with in-depth analysis and policy dialogue. Sampling: - Systematic sampling grid (30' x 30' equivalent to 50 x 50 km) leading to 248 plot clusters called "tracts" or "sampling units" of which only 221 were accessible and finally inventoried. - The sampling scheme followed the NFMA methodology: 1 km ² tracts with 4 field plots (250 m x 20 m) and sub-plots specific to forest measurements. Mapping: - The Land Use/Land Cover Map was done by the Survey Department of the Ministry of Lands, using Landsat 5TM and ETM+ donated by the Global Land Cover Network. The interpretation was done at a 1:50 000 scale with a minimum mapping unit of 30 m (for linear structures) and followed the FAO FRA categories of Land Use. (FAO and Zambia Forest Department 2008)
Variables related to TOF	Spatial: Plot location, tree location, plot orientation and sketch Biophysical: Tree number and species, for the trees outside forests with DBH ≥ 7 cm: tree measurements (DBH, Height, health, quality, damages), Tree canopy cover Socioeconomic: Land use (LU Section), land ownership, products and services (including NWFP) Background information: land management
Categories that may include TOF	TOF can be found within some of the subcategories of Other Land: - Natural: • Grassland • Marshland - Managed • Perennial Crop • Pasture • Fallow (H < 5 m) - Built-up area • Rural
TOF sets and subsets covered	All TOF sets and subsets are covered by this assessment (no exclusion)

Results	<ul style="list-style-type: none"> - A Land Use/Land Cover map was done. - 21 percent (15 771 081 ha) of the country surface is classified as Other land representing 3 percent of the growing stock (97 Millions of m³)(FAO and Zambia Forest Department 2008)
Comments	<ul style="list-style-type: none"> - Since ILUA followed the FAO classification recommendations, information on TOF can be easily gathered. - Urban areas being relatively small, no sampling units fell on urban LU, and this category was not sampled. With the denser sampling scheme of ILUA II, urban trees may be better assessed. - Since there is no minimal area limit for the Other Land, there is no way of extracting information for woodlots with Forest or OWL characteristics but smaller than 0.5ha.
References	<p>FAO. 2005. <i>Integrated Land Use Assessment - Zambia - Field Manual</i>. 5th Edition. M. Saket, D. Altrell, P. Vuorinen et al. Rome, Italy, FAO: 98.</p> <p>FAO. 2010. FRA 2010 - country reporting process. Retrieved October 14, 2010, from http://www.fao.org/forestry/62318/en/.</p> <p>FAO & Zambia Forest Department. 2008. <i>Integrated Land Use Assessment 2005-2008</i>. Republic of Zambia. J. Mukhosha and A. Siampale. Rome, Italy.</p>

Narrow tree linear formations assessments: Examples in France, Italy and the UK

Hedgerows, scattered trees, and shelterbelts play an important role for biodiversity. For Europe, these elements are part of the new environmental aspects of European Common Agricultural Policy (Guillerme, Alet et al. 2009)

In most European countries, tree lines forming hedgerows are found in pasture areas. Since the 1960s, a large part of these linear structures have disappeared but recent environmental problems highlighted the benefits provided by such tree lines and new policies now support their planting and maintenance. The majority of research in the last 2 or 3 decades concerns western France and Britain, even though hedgerows have been recognised as important in other countries such as Belgium, Germany, Italy, Poland and Switzerland. Outside Europe, studies are scarce but exist in Africa, China, the USA, Canada, Ecuador or Bolivia (Baudry, Bunce et al. 2000). Unfortunately, these researches are mostly based on qualitative analysis or provide results only at a local scale.

This profile sheet presents three examples of national assessments of tree linear formations. These examples all use remote-sensing derived datasets and field sampling. They show that different sampling strategies can be implemented for assessing the same TOF category:

- France: a national inventory of linear tree formations, based on the sampling of transects intercepting hedgerows;
- Italy: a national inventory of linear tree formations, based on a stratified 3-phase sampling;
- The United Kingdom: a national survey of linear tree formations, based on a random sampling of permanent plots in the framework of a systematic grid.

France: “Inventaire des Formations linéaires arborées”(Inventory of Linear Tree formations)

Objective	To provide up-to-date information on national tree stock outside forests within the linear formations.
Institution in charge	The National Forest Inventory (IFN), in partnership with regional forestry services
Scale, duration, periodicity	Countrywide Periodicity for sampling is 10 year
Data used	Aerial photographs and satellite images with a 50 cm resolution: BD ortho® (RGE), produced by the National Geography Institute (IGN).
Methodology	<p>For IFN, a linear tree formation (“Formation Linéaire Arborée”, FLA) consists of trees with a potential height >1.3 m, forming a line > 25 m length with no gap > 10 m and a width <20 m. In practice IFN distinguishes 3 types:</p> <ul style="list-style-type: none"> - tree line (“alignement”): made up of at least 4 trees, with a regular diameter of trees and a regular space between the trees, - wooded corridor (“cordon boisé”): a line of trees and/or shrubs with 80 percent of the biomass not concentrated on 2 m width, - hedgerow (“haie”): line of trees and/or shrubs irregularly spaced, of various species, heights and diameters, with a concentration of 80 percent of the biomass on less than 2 m width. <p>The inventory is structured into 2 main interrelated phases. The amount and location of FLA are determined in phase 1, through photo-interpretation for tree lines and in phase 2 through field assessment for the 2 other types. Biophysical, managerial and other variables are recorded in phase 2 through a field inventory:</p> <ul style="list-style-type: none"> - Phase 1: Remote-sensing analysis <ul style="list-style-type: none"> • The country land area is divided into a 1x1 km grid. • On each 1 km square, a “main point” is randomly selected within the square for inventory. • a 1-km long transect, centred on the “main point” is established and oriented randomly within each square, • In non-forest areas, tree lines intersected by the transect are counted and measured. • Each year, 10 percent of the “main points” are sampled this way.

Methodology	<p>- Phase 2: Field Inventory</p> <ul style="list-style-type: none"> • A sub-sample of the FLA, intercepted by the transect is inventoried to get detailed data on species, volumes, density. • Sample plots are 50 m long (whenever possible: 25 m on each side of the “interception point”) and follow the axis of the FLA (even when this axis is not straight). • Tree lines in densely urbanised areas and tree lines made up of cultivated species are excluded from this inventory.
Variables related to TOF	<p>Spatial: GIS geo-reference of every tree or group of trees, proximity to river or road, banks or stonewall.</p> <p>Biophysical: type, width and length of the FLA, dead trees, tree species, abundance per species, tree cover, dimension category of trees (small, medium, large, very large), dendrometric characteristics for one tree per dimension category (total height, commercial height, tree crown shape, stem shape, DBH, dead branches, diameter class).</p> <p>Background data: Land-use, maintenance (use of chemicals, thinning, etc).</p>
Categories that may include TOF	The three main FLA categories (Tree line, Forest String and Hedgerow) are all TOF categories.
TOF sets and subsets covered	Narrow Linear formations (set 3 TOF-Non A/U, subset 2)
Results	Some results are available at sub-national scale. Results at national scale are planned to be available soon.
Comments	An IFN field team of 2 persons inventories between 3-4 and 6-8 intersection plots per day. A very large number of variables are measured or estimated (Inventaire Forestier National, 2010), which raises the question of the cost efficiency of the assessment, and the question of how this enormous amount of accumulated data can be efficiently analysed and used...
References	<p>Baudry, J., Bunce, R. G. H., et al. 2000. Hedgerows: An international perspective on their origin, function and management. <i>Journal of Environmental Management</i>(60): 7-22.</p> <p>Bélouard, T., Vidal, C., et al. 2005. <i>Le nouvel inventaire forestier de l'IFN - Un sondage systématique et annuel</i>. De l'observation des écosystèmes forestiers à l'information sur lla forêt, Paris.</p> <p>Guillaume, S., Alet, B. et al. 2009. L'arbre hors forêt en France. Diversité, usages et perspectives. <i>Revue Forestière Française</i> 61: 543-560.</p> <p>IFN. 2010. <i>La forêt française - Pour bien comprendre les résultats publiés</i>. Nogent-sur-Vernisson, France.</p> <p>Inventaire Forestier National. N.D. Les haies et les alignements d'arbres. 50-51 (2).</p> <p>Inventaire Forestier National 2009a. Inventaires des haies et nouveau protocole. <i>Rapport d'activités 2008 de l'Inventaire forestier national</i>: 16 (1).</p> <p>Inventaire Forestier National. 2009b. La Carte des haies de Vendée, IFN; Région Pays de la Loire; FRCPL. 4. pp</p> <p>Inventaire Forestier National. 2010. Les Formations linéaires arborées. <i>Campagne d'inventaire 2009</i>: 173-214 (42).</p>

Italy: The assessment of hedgerows and woodlots

Objective	To assess the importance of narrow linear tree formations and small woods at national scale, in the framework of the National Forest Inventory.
Institution in charge	The Forest and Range Management Research Institute (ISAFRA), known as the Forest Monitoring and Planning Research Unit of the Agriculture Research Council (CRA-MPF).
Scale, duration, periodicity	Countrywide The first Italian NFI was carried out between 1983 and 1986. The second NFI (INFC), was implemented in 2002 and its results were published in 2007.
Data used	Digital ortho-photos
Methodology	<p>INFC used the FAO definitions of forest, other wooded land, etc. “Small woods” and “linear tree formations” considered in this inventory thus respectively correspond to TOF set 3 (TOF NonA/U), subset 1 - small wood < 0.5 ha, and subset 2 - narrow linear formation < 20 m width (De Natale, Chincarini et al. 2011).</p> <p>The INFC used a one phase design with photo-interpretation of unaligned systematically distributed photopoints. The country was divided into a 1 km x 1 km grid made up of approximately 301 000 cells. In each cell, a sampling point was set randomly (unaligned systematic sampling), which was associated to a 150 m x 150 m sampling plot. The two TOF subsets were present in 4 521 sampling plots.</p> <p>At sub-national level, in one administrative region (Veneto province) a field inventory was also carried out, to set-up and test a sampling protocol for linear tree formations: 105 sampling plots were selected randomly among the photo-interpretation sampling units intercepting linear tree formations associated with agricultural landscape and water courses. Two different sample plots were used, a 15 m x 5 m plot to measure tree attributes and a smaller inner 10 m x 1.25 m sub-plot for floristic surveys.</p>
Variables related to TOF	<p>Photo-interpretation: surrounding land-use, width, length, size, distance from forest, closeness to other hedgerows or woodlots.</p> <p>Field survey: stand structure, dendrometric characteristics, deadwood, and vegetation composition.</p>
Categories that may include TOF	The two categories considered in this inventory, small woods and linear tree formations, are specific TOF categories.
TOF sets and subsets covered	<ul style="list-style-type: none"> - Set 3 (TOF NonA/U), subset 1 (0.1ha≤small wood < 0.5 ha) - Set 3 (TOF NonA/U), subset 2 (3m width≤narrow linear formation < 20m width).
Results	<ul style="list-style-type: none"> - The combined area covered by small wood and linear tree formation is estimated to 452 000 ha, or 1.5 percent of the country area. For comparison, the percentage of forested area (Forest + Other Wooded Land) is 34.7 percent. - 299 500 ha are covered by linear tree formations; 152 600 ha are covered by smallwoods. - Most small woods and linear tree formations are located in agriculture dominated landscapes (82 percent of the total area). - The field survey in Veneto allowed, inter alia, to estimate the mean crown cover for linear tree formations at 82.1 percent.
Comments	This inventory shows that, in countries where NFI covers both forest and non-forest land, it is possible to build up on the framework of the NFI and integrate the two TOF subsets - “small woods” and “Narrow Linear Features” - in the photo-interpretation phase to provide reliable estimates of these two subsets at relatively low cost.
References	<p>De Natale, F., Chincarini, M., Gasparini P, Morelli S., Paletto A. & Tosi, V. 2011. The assessment of hedgerows and woodlots in Italy. Agricultural Research Council; 9.</p> <p>Gasparini, P., Tosi, V. & Di Cosmo L. 2010. Italy. In <i>National forest Inventories - Pathways for Common Reporting</i>, eds. E. G. Tomppo, T. Geschwantner, M. Lawrence, & R.E. McRoberts. Heidelberg, Germany. Springer. Chapter 19: 311-331.</p>

The United Kingdom: the Countryside Survey	
Objective	To gather information on natural resources and identify trends in changes in the UK countryside at a countrywide level, across England, Scotland and Wales. To provide data on woody linear features such as tree lines or hedgerows.
Institution in charge	Countryside Survey team, part of the Centre for Ecology and Hydrology (CEH) The 2007 Countryside Survey represented a partnership of nine government funded bodies led by the Natural Environment Research Council (NERC) and the Department for Environment, Food and Rural Affairs (DEFRA). It also involved the support and advice of many dedicated individuals from these and other organisations (farmers, scientists, landowners).
Scale, duration, periodicity	Countrywide (England, Wales, Scotland, Northern Ireland) Assessment based on an approx 8-year long cycle. Last survey published in 2008
Methodology	<p>The first Countryside Survey (CS) was realised in 1978. The CS has developed and expanded every time it was carried out, in 1984, 1990, 1998 and 2007 (at intervals of about 8 years).</p> <p>Countryside Survey (CS) is made up of two main independent parts:</p> <p>1. The Field Survey focuses on habitats, vegetation, soils and freshwater. CS includes all lands except urban lands (Scott, 2008).</p> <p>CS 2007 results were released in 2008 and only part of the inventoried data is related to TOF, the “Linear Features Category”, which includes the following categories:</p> <ul style="list-style-type: none"> • “Hedges”: line of woody vegetation that has been subject to management so that trees no longer take their natural shape. Hedges may be present with any feature below. These are also known as ‘managed’ hedgerows, • “Lines of trees/shrubs and relict hedge and fence”: line of trees or shrubs, in which trees/shrubs take their natural shape, including those originally planted as hedges with a fence. • “Lines of trees/shrubs and relict hedge”: line of trees or shrubs, in which trees/shrubs take their natural shape, including those originally planted as hedges. Includes avenues of trees. May also include banks/grass strips. <p>CS Field Survey data comprises information collected from a stratified random sample of squares at the intersection of a 15-km grid covering Great Britain (Scott, 2008). For CS 2007, the sample consisted of a set of 591 (1 km x 1 km) ‘sample squares’, randomly selected from this grid within the various Land Classes representing the variations in the climate and geology of England, Scotland and Wales. The individual squares are chosen so that they represent all major habitat types in the UK and enough squares are selected for each type to make sure that the statistical analysis for that habitat is robust and reliable (Countryside Survey, 2010). A similar approach was used within the Northern Ireland Countryside Survey (NICS), based on 288 squares, 0.5 km x 0.5 km (Scott, 2008).</p> <p>Within each sample square, woody species in linear tree formations were inventoried on up to 10 plots of 1 m x 30 m for each of the following habitats: hedgerows, roads and tracks, streams, ditches and riversides. woody species of hedgerows.</p> <p>2. The Land Cover Map – intended to be published in 2011 – uses satellite data to form a digital map of the different types of land and vegetation across the UK. The classification process is carried out by ‘training’ a computer to recognize certain values of ground surfaces and vegetation types in the satellite data and assign them to a Land Cover type, equivalent to one of the UK’s Broad Habitats (Countryside Survey, 2010). The CS uses the “Broad Habitat Classification” developed as a part of the UK Biodiversity Action Plan and containing classes including TOF. CS also identifies “Priority Habitats” as the ones at risk, and “Hedgerows” is one of them.</p> <p>The two surveys are undertaken separately but the results are brought together where possible in the CS report for the UK.</p>

Variables related to TOF	<p>Spatial: plot location, area covered by each feature, length and position of the linear feature (GIS)</p> <p>Biophysical: Vegetation type (belt of scrubs or trees), Species, Cover, absence of non-native species, Dead trees, dendrometric characteristics (total height, height of the base of the hedge canopy, average DBH, Crown shape - natural or managed), health and vigor condition, Line of stumps, Gaps between trees</p> <p>Background data: Land use, maintenance, management evidence</p>
Categories that may include TOF	<p>In the Field Survey:</p> <ul style="list-style-type: none"> - Linear features / Hedges - Linear feature / Lines of trees/shrubs and relict hedge and fence - Linear feature / Lines of trees/shrubs and relict hedge <p>In the Land Cover Map:</p> <ul style="list-style-type: none"> - Agricultural crop / Orchard - Wide linear feature - Structures / Agricultural cartilage, Allotments, Car-park, Garden Centre/nursery Garden/ grounds with or without trees, or Public open space - Recreation / Camp site, Golf course, Other playing fields, or School playing fields
TOF sets and subsets covered	<p>By the Field Survey:</p> <ul style="list-style-type: none"> - - Narrow linear tree formations : set 3 (TOF Non A/U), subset 12 <p>By the Land Cover Map:</p> <ul style="list-style-type: none"> - All TOF sets and subsets except “Trees on land under a predominantly urban use” (set 2: TOF-URB)
Results	<ul style="list-style-type: none"> - The data collected enables estimates of estimates of the stock of hedgerows in kilometers for 2007 and estimates of change in stock between 1998 and 2007; - Trends give a clear signal that the vegetation of linear features became taller, more shaded and less diverse, reinforcing a long-term trend over the period 1978 to 2007. The length of ‘managed’ hedges decreased by 6 percent in Great Britain between 1998 and 2007, and there were corresponding increases in the length of remnant and relict hedges and in the length of lines of trees. This finding suggests a reduction in the management and maintenance of some hedgerows (Scott 2008), - There were on average 3.7 woody species per 30-m section of hedge in Great Britain in 2007, with no detectable change between 1998 and 2007,
Comments	<p>Information from CS 2007 will be used to update a range of biodiversity indicators, including: UK BAP Priority Habitats, Plant Diversity (specifically open habitats, woodlands and boundary habitats), Ecological Impacts of Air Pollution (specifically areas affected by acidity and nitrogen), Invasive Species, and River Quality (biological and chemical).</p>
References	<p>Barr, C.J. & Gillespie, M.K. 2000. Estimating hedgerow length and pattern characteristics in Great Britain using Countryside Survey data. <i>Journal of Environmental Management</i> 60: 23-32.</p> <p>Carey, P.D., Wallis, S., et al. 2009. <i>Countryside Survey: UK Results from 2007</i>. Bailrigg, GB, Centre for Ecology and Hydrology.</p> <p>Countryside Survey. 2010. Measuring change in our countryside. Retrieved January 2011, from http://www.countryside-survey.org.uk.</p> <p>Maskell, L.C., Norton, L.R., et al. 2008. CS Technical Report No.1/07 - Field Mapping Handbook. <i>Countryside Survey, Annex 5</i>. Centre for Ecology and Hydrology. 143 pp.</p> <p>Scott, W.A. 2008. CS Technical Report No.4/07 - Statistical Report. Countryside Survey, Annex 5. Centre for Ecology and Hydrology. 15 pp.</p> <p>Tansey, K., Chambers, I., et al. 2009. Object-oriented classification of very high resolution airborne imagery for the extraction of hedgerows and field margin cover in agricultural areas. <i>Applied Geography</i> 29: 145-157.</p>

2. Support Programmes Profiles



.....Land Degradation Assessment in Drylands (LADA).....

LADA is being implemented by United Nations Environment Programme (UNEP) and executed by FAO with the support of partners

Purpose:

To assess the causes and impacts of land degradation at global, national and local scales in order to detect hot spots and identify remedial measures.

Historical background:

LADA is a 4-year long project providing data on land degradation that started in 2006. It is based on WOCAT (World Overview of Conservation Approaches and Technologies) classification, which is another project providing global database on Sustainable Land Management (SLM).

LADA and WOCAT's aims and missions are complementary.

Methodology:

LADA follows a participatory, decentralized, country-driven and integrated approach. It makes ample use of participatory rural appraisals, expert assessment, field measurements, remote sensing, GIS, modelling and other modern means of data generation, networking and communication technologies for sharing of information at national and international levels.

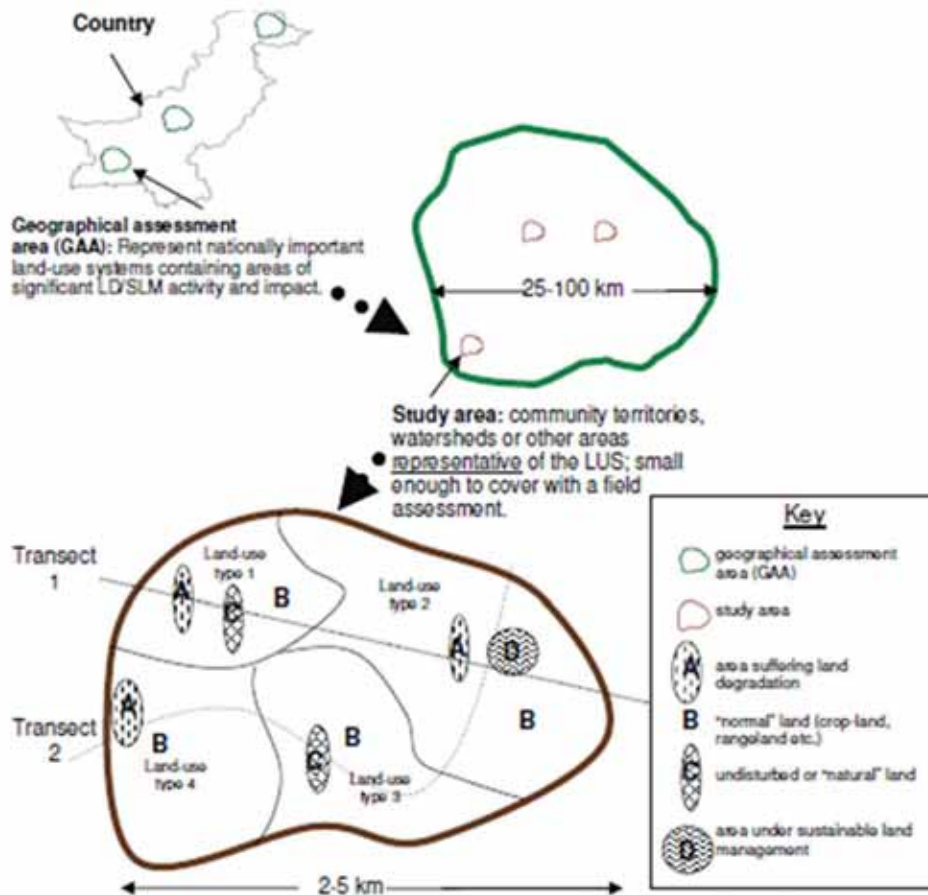
Methods and indicators have been selected and adapted for use across the main land use/ecosystems in dryland areas. The assessment addresses a number of different elements (soil, vegetation, water resources, agriculture and socio-economic assessment) and requires synthesis, analysis and output production in addition to data collection.

At a national scale, LADA is implemented in 6 pilot countries: Argentina, China, Cuba, Senegal (see Senegal TOF assessment profile, South Africa and Tunisia). Tools and methods are developed through regional training in these countries. Satellite images provide information on land cover change and hot spots of land degradation.

At a local scale, each country implements local assessments in 2 to 6 areas. Each local assessment compiles biophysical information, historic context, socio-economic factors and local perception and behaviour.

Sampling design:

The following sampling strategy is recommended. For each country, select 2 to 6 Geographic Assessment Areas (GAA). These areas of significant land degradation activity should be representative of at least one important land use system (LUS) and could be anything from a single watershed to a region of several hundred km². Logistics, existing activity and other factors may influence the choice of GAAs but it is essential that they remain in areas of national priority concern and interest with respect to land degradation or SLM.



N.B.

- The transects do not need to be a straight line. They are used to verify features discussed in the community discussion and to identify sites for detailed assessments, not as detailed quantitative sampling tools.
- Comparison is at the heart of the sampling strategy. Detailed assessments are conducted in areas of LD, SLM and undisturbed or "natural" land and the results from these are compared. e.g. A, B and C are compared in land-use 1; A, B and D are compared in land-use 2 etc.

Figure 1: Sampling units, plot and subplot design example (McDonagh, Bunning et al., 2009a).

Within each GAA, choose a few study areas (2 to 3 of variable size) for the field-level assessments. Study areas must be representative of the GAA, containing as many of the main land uses and forms of land degradation present in the GAA as possible. A study area may be a community and the territory it occupies.

On each study area, characterize a number of representative transects, and choose 3 pairs of field plots per Land Use Type for detailed assessments. (see Senegal TOF assessment sheet).

Variables related to TOF and assessed in the GAA of LADA:

There are two stages in the vegetation assessment: a rapid assessment of vegetation and land use, and a more detailed vegetation assessment, on selected sites in the study area.

1. Vegetation quality and composition on study area: Vegetation height, average diameter and vigour for the main perennial species (shrubs, trees) and herbaceous species (grasses, legumes)
2. Detailed assessment includes the identification of vegetation and land-use type, of vegetation cover, composition and species diversity, tree and shrubs measurements, plant health and quality, especially in terms of grazing for pasture and rangelands.

Land-use categories that include or may include tof:

To assess land degradation, LADA uses a detailed classification system adapted from WOCAT 2008.

Land-use categories that include TOF are the following:

- Tree and shrub cropping (sub-category of Cropland): permanent woody plants with crops harvested more than once after planting and usually lasting for more than 5 years (e.g. orchards / fruit trees, coffee, tea, vineyards, oil palm, cacao, coconut, fodder trees).
- Agroforestry (sub-category of Mixed): cropland and trees
- Agro-silvopastoralism (sub-category of Mixed): cropland, grazing land and trees

Land-use categories that may partly include TOF are the following:

- Natural forests (sub-category of Forests/woodlands): woods of indigenous trees, not planted by man, including riparian forests.
- Plantations, afforestation, woodlots (sub-category of Forests/woodlands): forest stands established by planting or seeding (including plots and wider belts, wind-/shelterbelts).
- Extensive grazing land (sub-category of Grazing lands): grazing on natural or semi-natural grasslands, grasslands with trees/shrubs (savannah vegetation) or open woodlands for livestock and wildlife.
- Silvo-pastoralism (sub-category of Mixed): forest and grazing land.
- Settlements, infrastructure networks (sub-category of Other land-use): roads, railways, pipe lines, power lines.
- Waterways (sub-category of Other land-use), drainage lin.

Funding process:

LADA projects are funded through various partnerships, including contributions of involved countries, or FAO, Global Environment Facility (GEF), United Nations Environment Programme (UNEP), Global Land Cover Network (GLCN), Water Soil Information (ISRIC), University of East Anglia, UNCCD, United Nations University (UNU), University of Sassari, WOCAT, etc.

Potential Data on TOF provided by LADA:

- At national level, production of land-use maps;
- At local level, LADA may be used for illustrating various features of each land use class identified as including TOF and provide more specific data, such as species composition, tree density, average DBH, tree volumes, etc.

Comments on TOF:

LADA focuses on land degradation, thus the geographical areas selected for the assessment may not be representative of the considered region or country. In each GAA, the small number of study sites may not be sufficient for ensuring statistical representativeness. However these study sites provide locally detailed illustrations of situations involving TOF.

References

- McDonagh, J., Bunning, S., et al. 2009a. LADA-L Part 1: Methodological Approach, Planning and Analysis. 76 pp.
- McDonagh, J., Bunning, S., et al. 2009b. LADA-L Part 2: Tools and Methods for Fieldwork. 76 pp.

..... Land Cover Classification System (LCCS)

Developed by the Food and Agriculture Organization of the United Nations (FAO) and the United Nations Environment Programme (UNEP)

Purpose:

To set up a reference classification system that encompasses all possible land cover classes to respond to the need for harmonized collection of data.

To be a reference base for applications ranging from forest and rangeland monitoring through production of statistics, planning, investment, biodiversity, climate change, to desertification control.

Historical background:

In 1994, the Africover Programme aimed at mapping land cover for the whole Africa and led to the development of the Land Cover Classification System (LCCS). The initial concept, based on existing classifications, nomenclatures and FAO documents, was discussed by various working groups and was finally operational for the Africover – East Africa project (1995-2002).

There is currently no internationally accepted land cover classification system. However, FAO has submitted LCCS for approval to become an international standard, and several studies already used LCCS to map their land cover (see paragraph Comments).

Methodology:

LCCS implementation is in two successive phases:

The Initial Dichotomous Classification Phase, which consists of three classification levels, defining 8 major land cover classes in the third level as indicated below (classes that may include TOF are coloured):

First level	Second level	Third level
PRIMARYLY VEGETATED AREA(S)	TERRESTRIAL	CULTIVATED AND MANAGED TERRESTRIAL AREA(S)
		NATURAL and SEMI-NATURAL TERRESTRIAL VEGETATION
	AQUATIC or REGULARLY FLOODED	CULTIVATED AQUATIC OR REGULARLY FLOODED AREA(S)
		NATURAL and SEMI-NATURAL AQUATIC OR REGULARLY FLOODED VEGETATION
PRIMARYLY NON-VEGETATED AREA(S)	TERRESTRIAL	ARTIFICIAL SURFACES AND ASSOCIATED AREA(S)
		BARE AREA(S)
	AQUATIC or REGULARLY FLOODED	ARTIFICIAL WATER BODIES, SNOW and ICE
		NATURAL WATER BODIES, SNOW and ICE

(source: FAO GLCN, 2010)

- The Follow-up Modular-hierarchical Phase, that uses 8 other different classifier sets (optional ones) to extend the classification in subcategories adapted to each country or region. A given land cover class is defined by the combination of a set of independent diagnostic attributes, the so-called classifiers. The more classifiers are used, the more precise and specific the land cover class and subclasses are. The classification can be stopped at any time and the corresponding land cover class determined. Each land cover class is described by three codes:

- A boolean formula, consisting of the string of classifiers used for class definition (e.g. A3A10B2),
- A standardized name of land cover class (e.g. “high closed forest”),
- A unique numerical (GIS-friendly) code (e.g. 20006).

Two other sets of optional classification attributes provide additional description of land cover characteristics:

- Environmental attributes, which influence land cover but are not essential for its definition, e.g. climate, landform, altitude, soils, lithology and erosion.
- Specific technical attributes, which relate to specific applications. They include the description of crop types in managed terrestrial areas, floristic aspects of natural and semi-natural terrestrial and aquatic vegetation, salinity of artificial and natural water bodies, etc. LCCS is an a priori classification. Therefore all the classes must be defined before any data collection. LCCS uses a basic physiognomic-structural classification to describe cultivated areas but it ensures a high degree of compatibility with existing agricultural classification systems. Depending on the level of detail reached, some of the LCCS classes thus include TOF by definition, while some others may include TOF (see Senegal TOF assessment profile). For instance, class A11 (cultivated and managed lands) may include TOF systems such as tree crop plantations, orchards, agroforests and parkland agroforests. To be sure that these TOF systems are taken into account, the system has to be taken a level of detail further and the dominant life form identified. Where this dominant life form is “trees” (code A1 in class A11) then the user can be sure that the TOF systems quoted above are included in the class.

Data on TOF provided by LCCS:

- Spatial information on classes that by definition include TOF and on classes that may include TOF.
- Areas of TOF classes.

Comments:

Main Advantages as regards TOF:

- LCCS has inherent flexibility. It is applicable to all climatic zones and environmental conditions, and is compatible with the existing classification systems,
- If well used, defined with enough classes in the Modular-hierarchical Phase, this classification is detailed enough to extract TOF categories one by one (see Senegal TOF assessment profile),
- LCCS is the only universally applicable system in operational use at present; it enables a comparison of land cover classes regardless of data source, economic sector or country.
- LCCS is used in many countries
- It inspired other systems (at regional or international scales), such as:
 - The North American Land Change Monitoring System (NALCMS), which aims at depicting information about land cover and land cover change in a seamless, consistent, and automated way across North America at regular intervals. Its classification legend is designed in three hierarchical levels using the FAO Land Classification System LCCS.
 - GLC2000, which provides accurate baseline land cover information to the International Conventions on Climate Change, the Convention to Combat Desertification, the Ramsar Convention and the Kyoto Protocol. It was designed by the European Commission's Joint Research Centre (EC-JRC) with an LCCS compatible legend allowing global standardization of land cover classification.
 - Globcover (project from the European Space Agency), that aims to produce a new global land cover database using images with a spatial resolution of 300 m (see Morocco TOF assessment Profile).

Main Limitations as regards TOF:

- Despite its flexibility, LCCS has also an inherent rigidity since all the classes have to be pre-defined in advance, which imposes a good preliminary knowledge of the landscapes to be mapped.
- Although LCCS may be linked to projects including field inventories, data directly provided by LCCS are restricted to localization and area of land cover classes.

Reference

FAO and United Nations Environment Programme (UNEP). 2010. GLCN Global land cover network. Retrieved November 2010, from <http://www.glcn.org>.

..... National Forest Monitoring and Assessment (NFMA)

NFMA has been developed by FAO since 2000 in response to the needs of member countries for adequate forest and tree data at national level

Purpose:

To assess and monitor forest and other natural resources (including trees outside forests), land uses and management practices in order to provide new qualitative and quantitative data on the state, use, management and trends of these resources and the ecosystems.

Historical background:

Few countries in the world today generate systematic data on the changing characteristics of their forest resources and trees outside forests (TOF). FAO estimated in 2005 that only 15 percent of the forest in developing countries was covered by regular, field-based forest inventories (Branthomme, 2010). To support member countries to carry out national forest monitoring and assessment activities, FAO designed its NFMA programme. This assessment model enlarges the information collected on tree resources by including systematic data collection on trees outside forests, identification of forest products and services and their beneficiaries, property rights and policies associated with such products and services, as well as the socioeconomic and institutional characteristics of forest use and users.

As of 2010, FAO has worked with over 50 countries in all regions of the world in addressing National Forest Monitoring and Assessment needs. Direct support has been provided in over 20 countries that have implemented national field inventories in collaboration with FAO and 20 more countries are expected to follow suit.

By the end of 2010, NFMA had been completed in 9 countries (FAO, 2010):

Bangladesh (see Bangladesh TOF assessment profile), Cameroon (see Cameroon TOF assessment profile), Costa Rica, Guatemala, Honduras, Lebanon, Philippines (see Philippines TOF assessment profile), Zambia (see Zambia TOF assessment profile), Nicaragua (see Nicaragua TOF assessment profile)

Methodology:

- Based on nationwide systematic sampling, local interviews and field data collections as well as remote sensing
- Applied through National Forest Inventories
- Made up of a set of 1st level predefined variables, definitions and options, and a set of sublevels that may be modified according to country specifications
- Developed through a multi-stakeholder process and by examining data needs according to information required for enhancement & monitoring of specific forest-related policies

NFMA may be completed with an ILUA (Integrated Land Use Assessment) that gathers more socio-economic data and a field sampling integrating all land uses. At present, just Zambia (see Zambia TOF assessment profile) and Kenya have carried out NFMA/ILUA studies.

Sampling design:

The inventory phase of the assessment starts from a systematic sample grid covering the entire country. Remote sensing is used for determining the preliminary land-use classification for the sampled sites.

The sampling units (SU) are selected at least at the intersection of every degree of latitude and longitude. The number of SU and the sampling frequency of monitoring are determined according to the required statistical reliability of the data and available financial and human resources.

Each sampling unit (SU) is a 1 km x 1 km square. Each SU contains 4 field plots.

Field plots are rectangles (20 m x 250 m) starting at each corner of an inner 500 m square and numbered clockwise from 1 to 4 (see Figure 1).

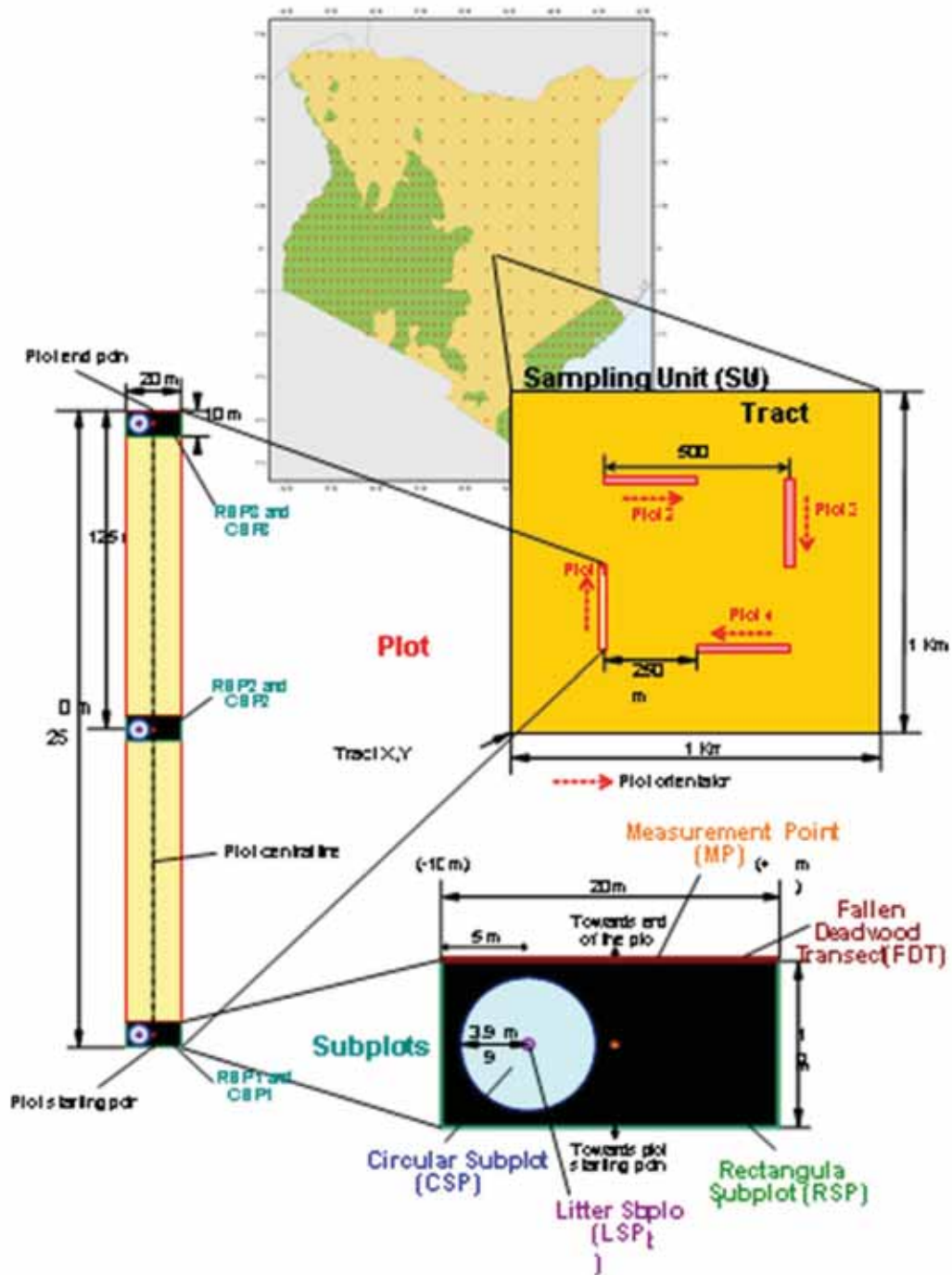


Figure 1: Sampling unit, plot and subplot design example. (Branthomme, 2009)

Each plot contains 3 sets of 3 subplots used for measuring litter, deadwood, soil condition and topography and is divided into Land Use / Cover Sections (LUCS), representing homogenous land use and vegetation units. The number of LUCS on a plot is thus variable.

Classification of LUCS is based on the Land Use / Cover Classes (LUCC) (see Figure 1):

- At the first level (global class level), LUCC are: 'Forests', 'Other wooded land', 'Other land' and 'Inland water', categories developed by the FAO global FRA to ensure harmonisation between countries.
- At other levels (national class levels), LUCC subclasses are country specific and meet national and sub-national information needs (see the various NFMA country TOF assessment profiles).

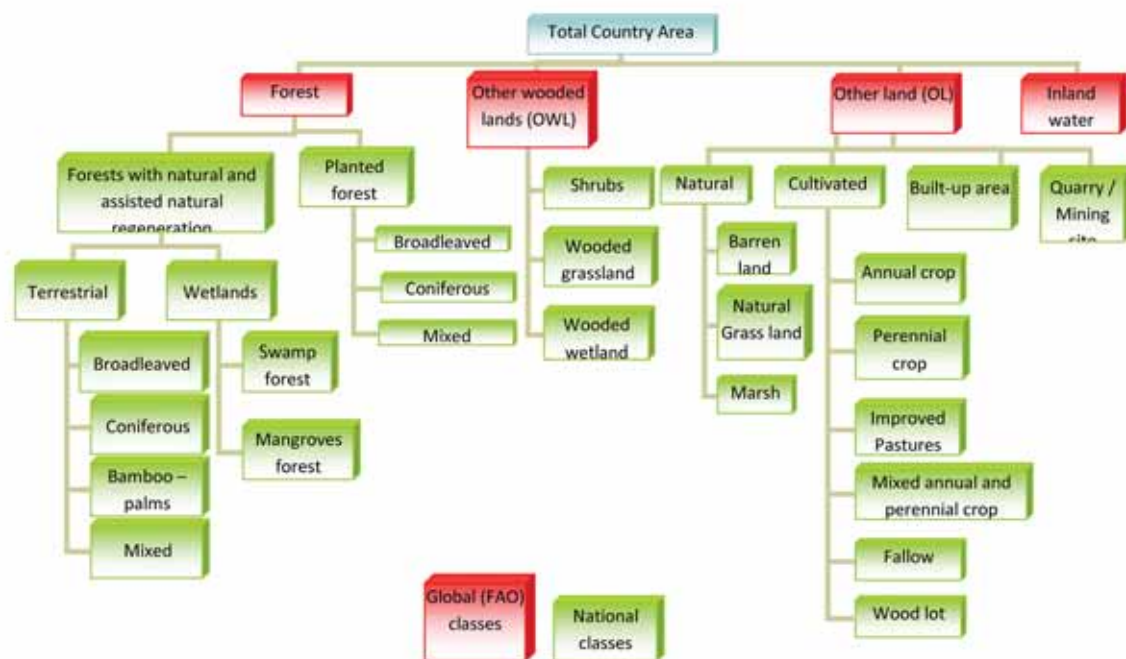


Figure 2: Example of Land use / cover classification diagram (Branthomme, 2009)

Variables related to TOF and assessed in NFMA:

- Qualitative data on the LUCC including TOF are extractable from the classification
- Areas of LUCC including TOF (see Nicaragua TOF assessment profile)
- For each LUCC including TOF, data provided are:
 - in Form F3: tree number, LUCS number, species scientific name, dbh, health, stem quality, etc.
 - in Form F5 on LUCS: vegetation cover, tree canopy cover, TOF distribution or shrub cover, services provided by the forest and trees, soil and water conservation, stand origin and structure,
 - in Form F6 on LUCC: products harvested in the LUCC, services provided by trees (soil protection, soil fertility, water conservation, shade, etc.),

Definitions, field forms and guidelines for measurements and data collection are available in annexes of NFMA reports to ensure that countries using NFMA will grant homogeneous data.

Implementing process:

NFMA structure varies from country to country, but the main organisation is common, involving:

- a National Project Coordinator (NPC), who is referent for the country;
- the Project Technical Unit (PTU), which aims at coordinating, executing and monitoring the NFMA at a national level;
- field teams, which are responsible for data collection, recording and transmission to the PTU. One field team contains 4 to 8 persons, specialized in key disciplines as forestry, botanic, sociology, wildlife, crop, soil, water, etc.

Potential Data on TOF provided by NFMA (at national level):

(See the various NFMA country TOF assessment profiles)

For each Land Use/Cover class identified as including TOF, results comprise: area by land use class, tree volumes, volumes per ha for major LUCs, growing stock, products and services from TOF, biomass, aboveground carbon, species composition, etc.

Comments on TOF:

Main advantages as regards TOF:

- It provides both qualitative and quantitative data on TOF.
- It is a complete assessment since it reports sets of spatial, biophysical and socio-economic data.

- It has a high reliability level at sample plot scale as each sample plot is assessed through remote sensing, biophysical measurements and, interviews.
- Its cost is relatively low, estimated to approx US\$1000 per sample unit (Saket, Branthomme et al., 2008), It is adaptable to any country, even those that already have national LUC classes.
- It is adapted to national reporting to internal processes such as FRA or the UNFCCC
- It has a detailed enough LUC classification so that all classes including TOF can be identified, even when a national class (2nd or 3rd level) is put in a wrong global class (1st level) (see Bangladesh TOF assessment profile).

Main limitations as regards TOF:

- Some TOF categories may not be distinguished separately: e.g. in Nicaragua, hedgerows, and small woodland areas (<0.5 ha) are not put in a special category.
- Precision at which global classes are produced is generally acceptable, but it can be low for some countries where there are disproportions between classes: then, sampling error is higher (FAO, 2008).

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This assessment profile was validated by Mr. Dan Altrell (FAO Forestry Officer - National Forest Inventory, Italy). It is based the following documents:

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FAO. 2010. National Forest Monitoring and Assessment (NFMA). FAO Support to National Forest Monitoring and Assessment Retrieved December 2010 from <http://www.fao.org/forestry/nfma/fr/>.

Saket, M., Branthomme, A., et al. 2008. Decision-making is informed, better coordinated across sectors, transparent and participatory. GEO Forest Monitoring Symposium, Foz do Iguaçu, Brazil, FAO Support to National Forest Monitoring and Assessments (NFMA).

···Woodfuel Integrated Supply/Demand Overview Mapping (WISDOM)···

Spatial analysis of Woodfuel flow,
developed by the Food and Agriculture Organization and National University of Mexico

Purpose:

WISDOM is a spatially explicit method for visualizing woodfuel priority areas or “hot spots”, enabling a potential wood energy planning and policy development. It is based on geographic information system (GIS) technology, which offers new possibilities for combining, or integrating, statistical and spatial information about the production (supply side) and consumption (demand side) of woodfuels (fuelwood, charcoal and other biofuels).

Historical background:

WISDOM methodology was developed in the context of FAO country assistance, by collaboration between FAO’s Wood Energy Programme and the Institute of Ecology of the National University of Mexico (UNAM), in 2003.

The WISDOM approach was further defined at the:

- City level: Bangui, Dar-es-Salaam, Arusha-Moshi, Kampala, Khartoum, Phnom Penh, Battambang, Vientiane, Luang Prabang, Maputo and on-going for N’Djamena
- Sub-national/Regional level: Purepecha in Mexico, Castilla y León in Spain, Niger Delta in Nigeria, Emilia Romagna in Italy and Darfur in Sudan
- Country level: Slovenia, Mexico, El Salvador, Senegal, Argentina, Italy, Rwanda, Mozambique, Croatia, Brazil and Central Africa Republic
- Subregional level: East Africa (10 countries), South East Asia (7 countries)

Methodology:

WISDOM is based on:

- Geo-referenced data bases.
- Minimum administrative and spatial unit of analysis. The spatial resolution is defined at the beginning of the study, on the basis of the desired level of detail and as constrained by the main parameters or proxy variables that will be used to “spatialize” the information. The spatial level of analysis (i.e. the size of the pixel in GIS raster data) is usually determined by the mapping detail of the available land use/land cover data.
- Modular and open structure. Once the common spatial base of reporting is defined, each module is developed in total autonomy using existing information and analytical tools and is directed to the collection, harmonization, cross-referencing and geo-referencing of relevant existing information for the area of study.
- A comprehensive coverage of woodfuel and biofuel resources and demand from different energy users.

The methodology may be divided into two sequential phases/contexts of analysis: WISDOM Base, which includes the analysis over the entire territory of the study area, and Woodshed analysis, which uses the result of the WISDOM Base to delineate the sustainable supply zone of selected consumption sites.

The WISDOM Base involves five main steps:

1. Definition of the spatial base (minimum administrative spatial unit of analysis)
2. Development of the DEMAND module (spatial distribution of woodfuel consumption)
3. Development of the SUPPLY module (a spatial representation of all natural and planted woodfuel sources)
4. Development of the INTEGRATION module (develop variables that integrate the information from the demand and supply modules)
5. Selection of the PRIORITY areas or woodfuel “hot spots” under different scenarios

The Woodshed analysis involves two additional steps:

6. Mapping of potential “commercial” woodfuel supplies suitable for urban, peri-urban and rural markets
7. Definition of woodshed, or potential sustainable supply zones, based on production potentials and physical accessibility parameters

Data on TOF provided by WISDOM:

WISDOM gives high relevance to TOF because these are often a major source of woodfuels serving local demand. Lack of data on TOF is a serious constraint that WISDOM can overcome by undertaking ad-hoc TOF surveys or rapid appraisals, as in the Slovenia and Rwanda case studies, or by providing best estimates based on available references. Surfaces, woody biomass growing stock and productivity can be extracted for TOF categories, with reliability depending from the used reference data.

WISDOM can act as incentive for national resource assessment as in Slovenia, where the national inventory considers the non forest wood resource as a specific category to be assessed (see Slovenia TOF assessment profile).

Comments:

Main advantages as regards TOF:

- It provides a consistent and holistic vision of the wood energy sector over an entire country or region; including an estimation on TOF resources.
- It constitutes an open framework and a flexible tool meant to adapt to existing information related to woodfuels demand and supply patterns.
- It allows the definition of critical data gaps resulting from the thorough review and harmonization of wood energy data.
- It promotes cooperation and synergies among stakeholders and institutions (Forestry, Agriculture, Energy, Rural Development, etc.).
- It enhances the political recognition of the real inter-sectoral role of wood energy.
- It contributes essential information for the promotion of sustainable management of forests, other wooded lands and trees outside forests.
- It encourages the establishment of national inventories in forest and non forest areas.

Main limitations as regards TOF:

- Non-forest area productivity is generally roughly estimated (unless ad-hoc TOF surveys are carried out), because data mostly come from forest focusing inventories such as most NFI.
- Based on pre-existing GIS data, with a very variable precision.

References:

FAO. 2003. «Woodfuels integrated supply/demand overview mapping-WISDOM.» from <http://www.fao.org/docrep/005/y4719e/y4719e00.htm#TopOfPage>

Drigo, R. & Salbitano, F. 2009. WISDOM for cities: Analysis of wood energy and urbanization using WISDOM methodology. Eds. M. A. Trossero & M. Gauthier. Rome, FAO Forestry Department. Urban forestry – Wood energy: 126.<http://www.fao.org/fileadmin/templates/FCIT/PDF/WISDOM.pdf>

WISDOM case studies where TOF surveys were undertaken: Drigo, R. & Veselič, Ž. 2006. Woodfuel Integrated Supply / Demand Overview Mapping (WISDOM) - Slovenia - Spatial woodfuel production and consumption analysis. FAO Forestry Department – Wood Energy Working Paper.

FAO link (chapter-wise) <http://www.fao.org/docrep/009/j8027e/j8027e00.HTM>

Full paper: <http://www.WISDOMprojects.net/global/csdetail.asp?id=8>

Drigo, R. & Nzabanita, V. 2011. WISDOM Rwanda - Spatial analysis of woodfuel production and consumption in Rwanda applying the WISDOM methodology. Working Paper of Project “Rationalisation de la filière bois-énergie” (TCP/RWA/3103). (available from FAO Wood Energy website)

Non-FAO WISDOM publications are available at: <http://www.WISDOMprojects.net/global/index.asp>

This assessment profile was validated by Mr. Rudy Drigo (FAO Consultant, Wood Energy Programme).