Chapter 44
Turkey

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44.1 Forest Inventory in Turkey

44.1.1 History and Objectives

Turkey has not established a statistical National Forest Inventory (NFI) to date. Yet it has a respectably long history of forest inventory (FI) and planning which can be reasonably deemed to date back to the second half of the ninetieth century. Today, FI in Turkey is essentially implemented with a view to establish the current status of forests required for preparation of forest management plans for separate planning units.

As reported by Eraslan (1985) and Eler (2008) who extensively investigated the historical development of FI works in Turkey, the first forest management plan (FMP) was completed in 1918 for a land area of 7147 ha. Later, the Turkish government decided to establish a modern forest management system which led to the enactment of the Forest Law (No: 3116) in 1937. In line with the purpose of this law, the First-Cycle Forest Management Plans were completed between 1944 and 1946. Based upon the data gathered through these first-cycle forest management

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plans (FMPs), the total forest area of Turkey was estimated at 10.5 million ha which is approximately half of the current forest area of Turkey. This vast difference between the two estimates has its origin in the under representation of forest land due to the statistical method used at that time and the availability of aerial photography for only parts of the country. In 1955 a sampling-based forest inventory, that would be based on aerial photographs was planned. However due to the absence of aerial photographs for the entire forest land of the country, the project was not progressed.

In 1963, a new era of planned development began in Turkey. The government work programme for the years 1963 to 1972 included provisions for the establishment of a NFI and preparation of a new FMP cycle. According to this work programme, one tenth of the country would be surveyed annually, which consisted of the interpretation of aerial photographs at a scale of 1:20,000 and a ground assessment of forest conditions by a large number of planning teams. The programme was successfully concluded in 1972 as foreseen. The most remarkable result was, that the country's total forest area was then estimated to be 20.2 million ha, a high contrast to the 10.5 million ha estimated just 26 years before. Evidently, as mentioned before, the forest land did not double within the two and a half decades. Rather the forest inventory of the first-cycle FMPs severely underestimate the extent of the forest land due to methodological shortcomings and insufficient coverage of the country's forest land with aerial photography, which were mostly overcome in the succeeding cycle producing a far more accurate estimate.

In the 1970s, a new system of planning was explored that could be conveniently adapted to the diverse geographic conditions of the country, the different forest structures and to the changing demands and provisions of non-timber forest goods and services. Prototypes of such plans were proposed between the years 1973 and 1991 (Asan and Yesil 1996). Eventually, the "Ecosystem-based Functional Planning" system was developed and officially adopted by the relevant government agency through a regulation in 2008. According to this regulation, the assessment of forest functions were emphasised, and a specific survey adapted to the different forest functions and forest types was prescribed. With this regulation, the scope of the FI in Turkey has been extended to provide more precise information about non-timber goods and services of forest.

FI and FMP work is coordinated and controlled by the Department of Forest Management and Planning under the General Directorate of Forests (GDF). Since 2012 a relatively new National Forest Inventory division was established that is working on the development of a statistical NFI.

The administration and management of state owned forests, which is the case for more than 99 % of the forest land, are organised strictly hierarchy. There are 27 Regional Forest Directorates controlling 218 State Forest Enterprises which comprise a total of 1340 Forest Chiefdoms, which are the basic forest management planning (FMP) units and hence the forest inventory units in Turkey.

44.1.2 Sampling Methods and Periodicity

Hierarchically dependent spatial structures recognised in the forest management plans in Turkey are shown in Table 44.1 (Zengin et al. 2013).

FI work for the purpose of FMP has been traditionally carried out by planning teams employed in the GDF Department of Forest Management and Planning. Yet these works are being increasingly given out to contracting private firms as well. Typically, a planning team, whether government-employed or private, consists of a head forest engineer and several forest engineers. In a normal course of the work program, the team first collects all available printed and electronic data during early spring (e.g. official maps, aerial photos, previous plan documents etc). Then the team prepares the programme of field work which routinely takes place in the summer time. After the ground survey which consists of measurements and professional assessments and lasts 3–4 months, the team returns to the office where the collected data are linked to the respective spatial information of the forest planning units. The elaboration of a FMP is normally completed within one year, after which the team officially starts to work on the FMP of the next planning unit, i.e., Forest Chiefdom. The FMP for a forest planning unit and the associated FI cover a horizon of 10 or 20 years, depending on the length of the rotation cycle of the stocking. A 10 year period is normally stipulated for short rotation plantations, such as of Turkish red pine (*Pinus brutia*), and a 20 year period for a longer rotation plantation, such as of Scot's pine (*Pinus sylvestris*).

Sampling methods and procedures are detailed in the FMP Regulation. According to this regulation, FI must be based on field measurement, aerial photographs and/or satellite images. Both, remote sensing data, and field assessments and measurements constitute the input variables for the estimation algorithms applied by the Turkish FI.

The first step of FI is to draft a preliminary map of forest stands by means of the most-up-to-date aerial photography and/or satellite images, and the previous maps of the plan. Stand types are determined by the criteria of tree species and tree species mixture, stand development class and crown closure. The 5 stand development classes and the 4 categories of crown closure employed for this purpose are presented in Table 44.2.

As a rule, forest sampling in the field is conducted using of a systematic sampling method. Forest sampling is required to finalise the mapping of the stand types. The above mentioned preliminary map of forest stands is utilised as the basis for sampling in the field. Size and spacing of plots are determined by the type of forest management, the crown cover, and the forest function (Table 44.3). It should be noted that sampling plots are not permanent, i.e. the sampling design and plots of consecutive inventories on the same land change over time.

Table 44.1 Elements of spatial arrangement in forest management planning in Turkey

Spatial element	Description	Typical area (ha) range	Criteria	Function
Planning unit	Forest land, with definite ownership, boundaries and management objectives, managed according to a particular management plan	5000–40,000	–Ownership –Socio-economic situation and management intensity –Administration and organisation	–Forest Chiefdom, the basic administrative unit in state forests –Entirety of forest track if owned by non-state entities
Working circle	Forest area, within a planning unit, allocated merely to producing certain goods and services to achieve a specific management objective	100–1000	–Tree species –Stand structure –Management type –Rotation period –Management objectives –Site productivity	–Level of defining the actual and optimal forest structures –Level of calculating the allowable cut
Compartment	A permanent land unit, delimited by natural or man-made lines, homogenous as much as possible with respect to site conditions, stand structure and applied silvicultural technique, hence serving as a reference to keep track of measurements, records, administration and inspection	15–100	–Terrain features –Forest functions –Site conditions –Measures against storm and wildfire hazards –Tree species –Stand structure –Roads and transport possibilities –Management intensity	–Basic level of site-specific data and information –Level of daily and seasonal forestry operations –Basis for unit-cost calculations
Subcompartment or stand	Parts of a compartment definitely homogenous in terms of site conditions, stand structure and applied silvicultural technique	1–10	–Tree species and mixture –Development class –Crown cover –Distribution of trees to diameter intervals	–Smallest homogenous piece of forest for calculating volume and yield elements –Smallest homogenous piece of forest subject to uniform silvicultural technique

Table 44.2 Stand development classes and crown closure categories

Stand development classes			Stand crown closure categories		
Description	dbh (cm)	Symbol	Description	Closure (%)	Symbol
Establishment and density stage	<8	a	Stocked with gaps and glades	1–10	B
Pole and post stage	8–19.9	b	Loosely stocked	11–40	1
Thin tree stage	20–35.9	c	Moderately stocked	41–70	2
Middle tree stage	36–51.9	d	Fully stocked	71–100	3
Thick tree stage	≥52	e			

Table 44.3 Size and spacing of sampling plots in the Turkish FMP

Management type/system	Crown cover (%)	Forest function	Spacing of sampling plots (m × m)	Sample plot size (m^2)
Even-aged	41–100	Timber	300 × 300	400–600
	41–100	Non-timber	600 × 600	400–600
	11–40	Timber and/or non-timber	600 × 600	800
	≤10	Non-timber	Not sampled	Not sampled
Uneven-aged	–	Timber	150 × 300	600
		Non-timber	600 × 600	600
Coppice	1 to 3 plots in grown-up parcels			100
Industrial plantation	At least 5 plots in grown-up parcels			400

44.1.3 Data Collection

FI data is collected as part of the FMP process for each of the 1340 Forest Chiefdoms. Table 44.4 shows measured and assessed attributes on a typical sampling plot of the forest inventory for the purpose of FMP.

Conceptually, FI in Turkey comprises the collection and assessment of information on all that exist in the forest, including plants, animals and minerals, as well as on goods and services that the forest provides, socio-economic conditions, and forest pests and diseases. More specifically, FI in Turkey consists of the following eight inventory components:

- Land inventory
- Site inventory
- Biodiversity inventory
- Timber stock and increment inventory

Table 44.4 Measurements and assessment performed on a typical sampling plot

Purpose	Attribute or object	Description
Timber stock and increment	Tree species	Identification of species of all tally trees with dbh > 8 cm
	Diameter at breast height	Measurement of all tally trees with dbh > 8 cm
	Height	Measurement of average height of 3 trees
	Number of annual rings	Counting the number of annual rings on the last 1-cm sections of increment cores of 1–3 trees per plot
	Ring width	Measurement of width of the last 10 years annual rings
Site productivity	Age and top height	Measurement via cores of height and age of at least 3 of the dominant trees in pure and even-aged forests
	Diameter and height	Measurement of diameter and height of 1–3 trees with a dbh > 38 cm and free from shelter effect in uneven-aged forests
Trees to be removed silvicultural operations	Trees to stay or be removed, and snags	Determination of trees to stay or to be cut with consideration of the stand's sunlight need, competition among individual trees, forest openings, soil protection against erosion, etc. Snags are determined separately
Timber (wood) quality	Stem quality	Assessment of stem quality into 4 categories based on stem shape and condition, and branches
Secondary assets	Vegetal, animal and mineral assets	Observation of secondary assets of plants, animals and minerals, or their parts, on or in between sampling plots (resin, laurel, acorn etc.)
Forest health	Biotic and abiotic hazards	Observation and examination of browsing and grazing, forest clearance, wind- and storm-fallen trees, and traces of harms attributable to frost, pests, fungi, etc.

- Non-wood forest products inventory
- Non-timber forest service inventory
- Socio-economic situation inventory
- Forest health inventory.

44.1.4 Data Processing, Reporting and Use of Results

All data and information collected on sampling plots are used to estimate the total standing stock and increment of the planning unit, as well as the distribution of

stock and increment by tree species, diameter classes, wood quality and silvicultural status of trees. Plot data are standardised to per hectare values of the number of trees, the timber volume, the increment and the allowable cut. Subsequently, the plot level per hectare values are averaged to find the per hectare estimate by stand types. Totals are the result of the multiplication between the average per hectare estimate per stand type and the respective known surface areas of the stand types. Finally, the summation over all stand types gives the grand total over the entire forest planning unit. This bottom-up summation approach can be further continued to get estimates for higher hierarchical level, i.e. the State Forest Enterprises, the Regional Forest Directorates and finally the entire country (Asan 2000; GDF 2011).

The data and results of the Turkish FI serve as a basis for decision-making in forest-related policies at regional, national and international levels, and also for the evaluation of the consequences of decisions made. Also, such data and results are reflected in a number of international reporting processes in which Turkey has engaged mainly including the Forest Resources Assessment (FRA) of the Food and Agriculture Organization of the United Nations (FAO), the submissions on Land Use, Land-Use Change and Forestry (LULUCF) under the United Nations Framework Convention on Climate Change (UNFCCC) and the indicators for sustainable forest management for FOREST EUROPE.

44.1.5 Development of a Statistical National Forest Inventory (NFI)

Interests in administering forest inventory at national scale date back to the late 1930s, and first attempts to introduce a NFI system in Turkey emerged in the 1970s. To date, however, a formal Turkish NFI has not been established. Eraslan, an eminent Turkish professor of forest management planning, argued in 1978, for instance, that a separate NFI might not be necessary in countries like Turkey in which almost the entire forest land is state-owned (Eraslan 1978). And by the same argument, he expressed his opinion that the forest inventories conducted for the purpose and as part of forest management planning provide the necessary information for the Turkish forest sector. In fact, what he suggested then is the situation today. This means that country-wide data and information about forests and forest conditions in Turkey are essentially estimated and reported by summing the forest planning unit level inventory data. That is, the data are collected at different times by different teams and using temporary sampling plots (Özkan et al. 2011). Nevertheless, interest in NFI has not withered away in Turkey. Certain developments and activities from 2000 towards the establishment of an NFI are worth mentioning here:

- An international Symposium on Turkish National Forest Inventory was organised in September 2002.
- A project titled "Establishing the basis for the Turkish National Forest Inventory: Phase I" was launched in November 2010, contracted by the Dutch Agency for International Business and Cooperation to Forest Ecosystems Consult b.v. and Alterra b.v. This project was intended to form the basis of a longer forest inventory project. In the first phase the focus was on the development of methods and the testing of these methods in a smaller area. Unfortunately, this project was not effectual as intended since it could not be passed on to the next phase(s).
- The Division of National Forest Inventory has been established within the GDF Department of Forest Management and Planning. This division is charged with the tasks of coordinating NFI related works and of international forest reporting.
- A pilot project was recently initiated aiming at the comparison of traditional FI data with data to be obtained by the NFI methodology using permanent plots. The spatial scope of this pilot project is the territory of a Regional Forest Directorate.

44.2 Land Use and Forest Resources

44.2.1 Classification of Land and Forests

44.2.1.1 General Land Classification

Turkey is a relatively vast country. As a matter of fact, it stands to have a land area larger than any other country in Europe, except the European part of Russia. Owing not only to its size but to its transcontinental Eurasian location right between Western Asia and Europe, a myriad of land cover and land use types are commonly observed in Turkey. Despite this diversity, Turkey's land area can be broadly classified, with bridging to FRA land classes, for the purpose of this report as shown in Table 44.5.

The main issue in such a classification relates to the definition of forest and the statistical consequences thereof. By national definitions more than 27 % of the country is forest. Nonetheless this ratio is to drop to somewhere between 14 and 15 % according to FAO forest definition.

In Turkey, 'forest' can be a land cover, a land use, or an administrative unit (Lund 2014). The essential reason for the substantial discrepancy between the FAO statistics and the Turkish national statistics as to forest land area appears to be the criterion of land cover: A land tract of certain extent with less than 10 % crown cover of trees is not defined as "forest" but other wooded land (OWL) by FAO criteria, whereas the very same land tract is nationally defined as "degraded forest" that is legally considered to be within the Turkish forest regime. Meanwhile, the

Table 44.5 Classification of land area and inland water bodies in Turkey, 2012 (FAO 2015)

National		Corresponding FRA categories (1000 ha)			
Classes	Area	Forest	OWL	Other land	Inland water bodies
(a). Normal (productive) forest	11,559	11,559	–	–	–
(b). Degraded forest	10,119	–	10,119	–	–
(c). Other land	55,118	–	–	55,118	–
Total land area (a +b + c)	76,796	–	–	–	–
(d). Inland water bodies	1393	–	–	–	1393
Total country area (a + b + c + d)	78,189	–	–	–	–

national definition for "normal (productive) forest" appears to be very close to the FAO "forest" definition. Therefore, the national category "normal (productive) forest" is used to report for FAO category "forest" while the nationally-defined "degraded forest" is reported for the FAO defined category OWL".

Approximately 70 % of the "other land" category comprises agricultural and range lands and human settlements. Particularly, 2,751,000 ha of the area of "other land" are "other land with tree cover (OLwTC)" composed mainly of fruit and olive groves. Unfortunately and surprisingly enough, statistics on the poplar growing lands is lacking perhaps because poplar trees on private poplar growing fields are not seen either an agricultural nor a forest product. Furthermore, along with the state-owned and private forest lands, individuals and other private entities own woodlands that fall outside the national definition of 'forest'. Although such 'non-forest private woodlands' (NFPWs) are recognised to account collectively for a small proportion of the total forest area, there has been no inventory of their area. In fact, a formal interaction between the forestry administration and NFPW ownerships takes place only when an application is filed by the owner to obtain permission for tree harvesting from the regional forestry administration. However, these woodlands are still important because they are scattered throughout the country, and are of value to a substantial number of households and individuals (Ok and Kayacan 2005).

44.2.1.2 Forest Classifications by Use

Until recently, forests in Turkey were conveniently classified based on their suitability for timber production. Accordingly, a forest area was regarded as a "production forest" when it was technically and economically feasible to continuously produce roundwood therein, whereas forests where such feasibility was absent were classified as "protection forests". However, adoption in 2008 of the regulation "Ecosystem-based Functional Planning of Forest Management" has been a fairly

influential step in this as well as many other respects of Turkish forestry, even though the formal application manual was not issued until 2014 (GDF 2014a).

In keeping with the new approach to State forest resources and their management, forest areas are now classified by the predominant functions assigned to them in FMPs. The three main categories are (1) economic function, (2) ecological function, and (3) social and cultural function. As stated in the manual, when assigning functions to forest areas, a number of criteria and indicators should be employed (Table 44.6).

Forests in Turkey can be conveniently classified by the three main functions representing the forest uses as in detailed in Table 44.7. Note that the figures in each cell of the table may represent forest areas solely and predominantly designated to the corresponding function. As it can be observed in Table 44.7, economic function has prevailed in Turkish forestry. Notably, economic function does dominantly comprise timber production as opposed to non-wood forest products. Nevertheless there appears to be little doubt that ecological and socio-cultural uses of forest lands has escalated tremendously within the past decade in Turkey.

44.2.1.3 Classification by Ownership Categories

Turkey is unique in Europe with respect to its dominance of state owned forest land. Nearly all (99.92 %) of country's total forest area is owned by the state. The rest is under the ownership of either non-state public entities or private entities (Table 44.8). Private entities hold more forest and are larger in number than

Table 44.6 Description of the main forest functions used in FMP

Economic	Ecological	Socio-cultural
–Production of timber (roundwood) production –Production of non-wood forest products	–Nature protection –Erosion prevention –Climate protection	–Water –Public health –Aesthetics –Ecotourism and recreation –National defence –Scientific studies

Table 44.7 Forest area distribution by main forest functions[a] (GDF 2014b)

Main forest functions	2002			2012		
	Normal	Degraded	Total	Normal	Degraded	Total
	1000 ha	1000 ha	1000 ha	1000 ha	1000 ha	1000 ha
Economic	8616	7596	16,212	7942	5680	13,622
Ecological	1788	2883	4671	2912	4001	6912
Socio-cultural	88	85	173	705	439	1144
Total	10,493	10,564	21,056	11,559	10,119	21,678

[a]Totals may not add up due to rounding

Table 44.8 Pattern of forest ownership according to the national forest definition, by number and area (2012)

Owner	State-owned	Non-State public	Private
Descriptive	Owned by the State at national scale	Owned under a legal personality by universities, foundations, municipalities, village communities, and some public institutions	Owned by private natural persons and corporations
Statistics[a]	Total area in this category: 21,661,000 ha (of which 11,542,000 ha is normal or productive forests and 10,119,000 ha degraded forest)	Total of ownerships: 89 Total area in this category: 7820 ha	Total of ownerships: 437 Total area in this category: 9310 ha

[a]*Data source* Personal communication with the relevant department of GDF

non-state public entities. There are only a few business companies in the private ownership category; most private owners are individuals.

44.2.1.4 Forest Management and Cutting Systems

Almost 96 % of the forests in Turkey are managed under an even-aged silviculture system, the rest comprising mostly fir-dominated uneven-aged stands under a selection cutting system. Approximately 13 million ha of the even-aged forests are dominated by conifers (62 %), and 8 million ha by broadleaved tree species (38 %). Nearly two thirds of the uneven-aged forests are conifers dominated (more than 300 thousand ha), the rest is dominated by broadleaves (about 220 thousand ha) (GDF 2014b).

The prevailing forest forms in Turkey are high forests (17.3 million ha or 80 %) and coppices (4.4 million ha or 20 %). Forests in either form are categorised as either normal (productive) if they have a crown cover exceeding 10 %, or degraded (non-productive) in case of a crown cover of less than 10 % (Table 44.9).

In 2011 silvicultural interventions of all kinds were registered on a total area of 586,384 ha (approximately 2.7 % of the total forest area). In about 81.4 % of this area (477,458 ha) forest tending was carried on while the regeneration areas constituted only about 4.7 % (27,397 ha) thereof. Finally, 81,529 ha of coppice lands were treated for conversion to high forest which corresponded to 13.9 % of all areas of silvicultural works in that year. It is worth noting that the technique of natural regeneration was applied on nearly two thirds of the entire regeneration areas (GDF 2011).

Table 44.9 Area distribution of forest forms in Turkey for selected years (FAO 2015)[a]

Forest Form	1973	1999	2002	2005	2010	2012
High forest	10,935	14,418	15,175	15,548	16,662	17,261
of which normal	6177	8238	8733	8979	9783	10,282
of which degraded	4758	6181	6443	6569	6880	6979
Coppice forest	9265	6345	5881	5700	4875	4418
of which normal	2680	1790	1760	1683	1420	1277
of which degraded	6585	4555	4121	4017	3454	3141
Total forest	20,199	20,763	21,056	21,248	21,537	21,678
of which normal	8856	10,028	10,493	10,662	11,203	11,559
of which degraded	11,343	10,736	10,564	10,586	10,334	10,119

[a]Totals may not add up due to rounding

44.2.1.5 Legal and Other Restrictions for Wood Use

In Turkish forestry the first and foremost wood supply restriction legally imposed on forest lands is the status of protected area. Protected areas are designated by the National Parks Law (1983) into four categories: National park, nature parks, nature monument, and nature protection area. Each of these categories has a different scope and features, yet their common feature is the prohibition of timber production and cutting. The primary function is to serve for ecological and/or sociocultural benefits. In addition to the lands in the aforementioned categories, there exist further categories of forests with wood use restrictions or even full prohibition. Examples include gene conservation forests, seed stands and clonal seed orchards. As of the year 2012, protected areas, designated legally or administratively for conservation of biodiversity, total more than 1.1 million ha, most of which is forest land as defined by FAO definitions, compared to about 860 thousand ha of coverage in 2005 (FAO 2015).

Finally, there are a number of silvicultural and other regulations that restrict wood supply from forests to a certain extent. For instance, the maximum size of forest regeneration (or cutting) areas is restricted for plantations. The area must not exceed 25 ha in even-aged forests assigned to fulfil predominantly economic functions, and must be kept below 5 ha if the forest fulfils predominantly ecological functions. Clear-cutting is prohibited in these forests as well.

44.2.1.6 Further Classification of Forests

In addition to the previously described classifications of the forest area further classifications are used in the Turkish national statistics and reporting. The most common variable for additional classification is the dominant tree species (Table 44.10).

Table 44.10 Forest area (1000 ha) by tree species in productive and degraded forest (2012)[a]

Tree species	Total area (1000 ha)	Normal (productive) forest Area (1000 ha)	Degraded forest area (1000 ha)
Turkish red pine (*Pinus brutia*)	5855	3208	2647
Oak (*Quercus* spp.)	5153	2106	3047
Crimaen pine (*Pinus nigra*)	4693	2580	2113
Beech (*Fagus orientalis*)	1962	1621	340
Scots pine (*Pinus sylvestris*)	1480	751	729
Fir (*Abies* spp.)	670	407	263
Juniper (*Juniperus* spp.)	575	91	484
Turkish cedar (*Cedrus libani*)	464	220	243
Oriental spruce (*Picea orientalis*)	334	230	104
Alder (*Alnus* spp.)	141	100	41
Chestnut (*Castenea sativa*)	111	75	36
Stone pine (*Pinus pinea*)	89	61	28
Hornbeam *(Carpinus* spp.)	20	15	4.7
Lime tree (*Tilia* spp.)	11.5	9.6	1.9
Ash tree (*Fraxinus* spp.)	9.4	8.5	0.9
Poplar (*Populus* spp.)	6.5	1.9	4.7
Eucalyptus (*Eucalyptus* spp.)	2.4	2.4	0.1
Other species	102	70	32
Total	21,678	11,559	10,119

[a]Totals may not add up due to rounding; areas less than 10 thousand ha are rounded to one decimal place while the indicated by one decimal place

The two most widespread coniferous tree species in Turkish forests are the Turkish red pine (*Pinus brutia*) and the Crimaen pine (*Pinus nigra*). Further major conifers include Scots pine (*P. sylvestris*), fir species (*Abies* spp.), juniper species (*Juniperus* spp.), the Turkish cedar (*Cedrus libani*) and the oriental spruce (*Picea orientalis*). Oak (*Quercus* spp.), comprising more than 20 taxa, and beech (*Fagus orientalis*) are the most widespread broadleaved tree species.

44.2.2 Wood Resources and Their Use

44.2.2.1 Standing Stock, Increment and Drain

Readers are referred to the relevant subsections in Sects. 44.1 and 44.3 for the technical details as to the calculation and estimation of standing stock and increment in Turkish FI. Definitions of standing stock and increment can be seen in Table 44.11.

Note also that the NFI concept of "drain" cannot be said to apply in Turkish forestry where there is no permanent plot-based inventory in planning units. But, even so, timber production (i.e., roundwood harvest statistics) may conveniently serve for illustrating the forest resources in Turkey. Table 44.12 shows the major forest and timber aspects of the Turkish forest resources.

According to national data derived from the renewed forest management plans, Turkey has 21.7 million ha of forest area. Total growing stock is 1494 million m^3 (68.8 m^3 per ha) standing tree volume over bark, annual increment is 42.2 million m^3 (1.9 m^3 per ha). Importantly, wood supplied from forest lands (timber roundwood production) amounts to less than half of the increment measured in the Turkish FI (see Sect. 44.3.3).

44.2.2.2 Tree Species and Their Commercial Use

Coniferous tree species prevail with respect to area covered and wood supplied in Turkey. Not surprisingly, however, the prevalence of conifers becomes reversed in favor of broadleaved species when it comes to fuelwood production.

As used in Turkish official statistics and reporting, roundwood harvested and sold from Turkish forests can be broadly described as either "fuelwood" or "industrial wood". Furthermore, industrial roundwood comprises seven types of roundwood products including (1) sawlog (2) transmission poles (3) mining poles/posts (4) pulpwood (5) fiberwood and chips (6) thin poles, and (7) other industrial wood (e.g. roundwood merely suitable for packaging, logistics, etc). Nevertheless, the market segment for sawlog is relatively distinct from that of the remaining industrial roundwood products, because of the unique quality of sawlogs needed for manufacturing sawn wood (Kayacan et al. 2012a). There is no further product distinction within the fuelwood category. It is important to note that the fuelwood category includes chips and fibre that are not only used for energy

Table 44.11 Definitions for volume of standing stock and increment in Turkish FI

Quantity	Definition
Standing stock	Above-ground volume of living trees with a dbh ≥ 8.0 cm over bark, including the bole (wood and bark) and the stem top, excluding branches and the above-ground part of the stump
Increment	(Mean) Annual volume increment of living trees with dbh ≥ 8.0 cm over bark

Table 44.12 Standing stock, increment and timber production by species category in Turkey, 2013[a] (GDF 2014b)

Descriptive attribute	Category	Total	Coniferous	Broadleaved
Forest area (1000 ha)	Total	21,678	13,231	8447
	Normal	11,559	7572	3986
	Degraded	10,119	5659	4461
Standing stock (1000 m^3)	Total	1,494,455	989,435	505,019
	Normal	1,417,483	942,020	475,462
	Degraded	76,972	47,415	29,557
Annual volume increment (1000 m^3)	Total	42,179	27,291	14,888
	Normal	40,020	26,150	13,870
	Degraded	2159	1141	1018
Timber (roundwood) production (1000 m^3)	Total	17,855	12,596	5260
	Industrial	13,668	10,848	2820
	Fuelwood	4187	1747	2440

[a]Totals may not add up due to rounding

production but also for manufacturing wood panels or other industrial products by the Turkish wood industry (Kayacan et al. 2012b).

The most widely used coniferous tree species for industrial purposes are Turkish red pine, Crimaen pine, Scots pine, fir, spruce and cedar. Meanwhile forests of oak and beech species provide mainly industrial roundwood for the Turkish wood industry. Whether retained as coppice or being converted to high forest, most coppices are dominated by oak species, and to a much lesser extent by beech (*Fagus orientalis*), hornbeam (*Carpinus* spp.) and chestnut (*Castanea sativa*) species, either in pure or mixed stands. Consequently, fuelwood supplied from the Turkish forests mainly is composed of the aforementioned broadleaved species, with oak predominating. Coniferous fuelwood generally results from the secondary production during the silvicultural treatments and industrial roundwood harvesting.

44.3 Assessment of Wood Resources

44.3.1 Forest Available for Wood Supply

44.3.1.1 Assessment of Restrictions

Forests that are protected by law are excluded from timber management; hence no wood supply is foreseen from these lands including national parks, nature protection areas, nature parks, and nature monuments.

With regard to restrictions in managed forests, slope is a critical factor. Additionally, some other factors such as terrain and soil also affect the availability of wood supply from forests. For example, if a forest area is assigned the

management function of "nature conservation", little or practically no timber is planned for harvesting. Table 44.13 details the criteria and indicators for a forest area to be designated for "nature conservation" which severely reduces the possibility of wood supply.

A similar restriction on wood supply is imposed to manage forest areas if the function of "erosion prevention" is assigned. Although the criteria and thresholds are similar to those for nature conservation above, wood supply restrictions are incremental in these forests (Table 44.14).

44.3.1.2 Estimation

Forest areas with restrictions to wood supply can be generalised quantitatively through the bottom-up summation approach explained in the first section of this report.

Table 44.13 Criteria and thresholds for assigning the forest function of "nature conservation" in FMP

Criterion threshold		Conservation objective
Terrain slope	>80 %	Nature conservation for all species
Absolute soil depth	<25 cm	Nature conservation for all species
Physiologic soil depth	<50 cm	Nature conservation for all species
Soil stoniness	>50 %	Nature conservation for beech, Crimean pine, Scots pine, oak and spruce
	>80 %	Nature conservation for Turkish red pine and cedar
	>60 %	Nature conservation for the rest of the species
Forest upper zone	Forest areas within 100 to 150 m of the visible forest upper zone	Nature conservation for all species

Table 44.14 Criteria and thresholds for assigning the forest function of "erosion prevention" in FMP

Restriction criteria	Threshold
Slope	<12 %: None; 13–20 %: Mild; 21–58 %: Moderate; ≥59 %: High
Length of slope	<80 m: Mild; 81–210 m: Moderate; ≥211 m: High
Soil texture	Clay: Mild; Loam: Moderate; Sandy: High
Visual	Layer; gutter, gully

44.3.2 Wood Quality

44.3.2.1 Assessment and Classification of Stem Quality and Assortments

Stem quality assessments are usually a routine part of forest inventory (FI) for the purpose of forest management planning (FMP) in Turkey. Based on stem quality criteria observed and measured for each tree in the sample plot tally, stem quality assessments can be compiled at plot, stand and regional level.

By the FMP regulation, on a typical sampling plot all trees with a dbh $\geq$ 8 cm are numbered consecutively starting from 1, and assigned codes of species and quality class. Stem quality of a coniferous trees is assessed and classified on the bottom third of the total stem length (above stump), and on the bottom part of the stem on a length of 4–8 m (above stump) for broadleaved trees. The four classes of stem quality assessment are detailed in Table 44.15.

44.3.3 Assessment of Change in Wood Resources

44.3.3.1 Assessments and Measurements

Estimating the increment of standing timber volume is based on the measurements from temporary sample plots selected for the purpose of FMP. Due to the absence of an NFI system the concept of drain is not strictly applicable in the Turkish FI. Wood removed annually from Turkey forests may be reasonably well estimated using the annual timber harvested from the State Forest Enterprises.

44.3.3.2 Estimation of Increment

Increments of trees with a dbh $\geq$ 8 cm are calculated by means of a species specific single-tree increment tables for the locality, which is generally the forest planning

Table 44.15 Stem quality classes as assessed in Turkish FI

Stem quality class	Stem description
1	Upright, full-bodied, with circular cross-section, with no or few branches (suitable for 1st grade sawlog)
2	Slightly crooked and branched, with non-circular cross-section and/or slightly twisted (suitable for 2nd grade sawlog)
3	Severely crooked or branched or twisted (suitable for 3rd grade sawlog)
4	Misshapen, never suitable for sawlog production (suitable for fuelwood, fibre, chip and other industrial wood). Trees in coppices are classified in the 4th class of stem quality without exception

unit where the plot is located. Increments given in these tables are based on calculations according to Meyer's Interpolation Method (Meyer 1942) as described below:

$$i_v = \frac{\Delta v}{\Delta d} i_d \tag{44.1}$$

i_v Annual increment of volume in a single tree (m^3)
Δv Volume difference between two consecutive diameter intervals (dm^3)
Δd Range of diameter interval
i_d Annual diameter increase in a single tree (cm)

The application of this equation requires firstly that the single-tree volumes at different diameter intervals. Those volumes can be found in dbh based or dbh and height double tree volume tables. These single tree volume tables are readily available specifically for each forest planning unit, i.e. Forest Chiefdom. A new volume table can be constructed through tree stem analysis at different diameter intervals in case there is a newly designated planning unit, or a need for a volume table for a particular locality within a planning unit. Also, an existing volume table may be updated for the whole of an existing planning unit if deemed necessary.

With the aid of increment core bark thickness as well as the width of latest 10 year annual rings are measured and multiplied by 2 in order to find the 10 year periodic diameter increase. The mean annual diameter increase is thence calculated by dividing the 10 year periodic increase.

The bottom-up approach explained earlier in the relevant sections of this report is conceivably valid for estimation of increment as well. The estimation process begins with the sample plot-level figures, continues with conversion to per hectare values and averaging them for a specific stand type, and ends with adding up the figures for all stand types in order to reach to planning unit-level increment figures. One could naturally find the national figures by summation of relevant figures for all planning units.

44.3.3.3 Estimation of Drain

Due to the absence of a statistical NFI system the concept of drain is not strictly applicable in Turkish FI. As a matter of fact, there is practically no basis for estimating the cut and mortality, together being the drain.

In principle, annual timber harvest is prescribed by the annual allowable cuts and can be calculated beforehand during the planning. Traditionally, annual allowable cuts have been deliberately kept well below the volume increment, making room for ecological needs. As a matter of fact, in 2012 the total annual allowable cuts amounted to about 17 million m^3, and this figure is merely about 40 % of the total annual increment 42.2 million m^3 (GDF 2014b).

However, a discrepancy between the actual and prescribed (allowable) cuts is inevitable to some extent due not only to the quantitative features of the allowable

cut estimate but also to the pressing socio-economic demands when it comes to actual felling. What is more, natural forest hazards such as wild fires and pest outbreaks and storms at unexpected times and/or unforeseen scales may aggravate discrepancy between the prescribed and actual cuts. For instance, in 2012 a total of approximately 19 million m^3 of timber (fuelwood in stores converted to cubic metre by multiplying by a factor of 0.7) was actually harvested and removed from the forests in Turkey. This is noticeably larger than the allowable cut but still constituting only about 45 % of the annual increment corresponding to the same year (GDF 2014b).

The forest removal figures are represented by the actually harvested volumes of industrial roundwood and fuelwood that are measured with the supervision of the forest chiefs of the State Forest Enterprises normally right after the felling. While volumes of harvested hardwood species include bark, volumes of the harvested softwood species are measured after debarking in the field. After measurement the harvested timber is removed from the forest compartment or sub-compartment by the buyer in the case of stumpage sales or by the government-employed workers if the harvested timber is to be later sold at roadside or from the outdoor depots.

As a final word in here, illegal cutting is fortunately not a grave issue in Turkey any more as it was in 1980s and 1990s although it can still occur to a small degree.

44.3.4 Other Wooded Land and Trees Outside Forests

44.3.4.1 Assessment and Measurement

First of all, as mentioned earlier in this report the FAO definition of Other Wooded Land (OWL) does not apply in Turkey since the FAO defined OWL are classified as "degraded forest" in Turkey. Even so, several categories can be mentioned as part of other wooded land and trees outside forests in connection with FI in Turkey. Of these, agricultural lands with olive and fruit trees are systematically reported whose statistics are shown in Table 44.16. In view of the data two things are apparent: first, fruit groves have been more than double the area of total olive

Table 44.16 Area of fruit and olive tree groves in Turkey for selected years between 1990 and 2012 (FAO 2015)

Year	Fruit tree groves area (1000 ha)	Olive tree groves area (1000 ha)	Total area (1000 ha)
1990	1348	600	1948
2000	1418	600	2018
2005	1598	662	2260
2010	1748	784	2532
2011	1820	798	2618
2012	1937	814	2751

groves. Second, lands in either subcategory can be said to have expanded moderately within the past two decades.

Another category of other wooded land and trees outside forest comprises the so called "non-forest private woodlands (NFPW's)". In Turkey, these are the non-forest private lands with forest trees covering three hectares or less area. Owners of NFPW's are not obliged to register or report as being an owner of NFPW. In other words, ownership of an NFPW is no different legally from the ownership of a bare land in term of cadastre records. Consequently, no statistics are available as to the totality of NFPW's in Turkey. Nevertheless these woodlands are believed to be important because they are scattered throughout the country, and are of value to a substantial number of households and individuals even though the total area is not believed to be extensive (Ok and Kayacan 2005). Notably, an owner of NFPW is required to file a petition to the local forest administration for approval only when they decide to cut some or all of the trees for domestic or commercial purpose. That is the only legal interaction between such ownerships and the forest administration.

Finally, private poplar growing lands are not defined as forest in Turkey, yet they can be considered as other wooded land or trees outside forests. As pointed out earlier, there is no registration obligation of private poplar fields either as an agricultural asset or a forest stand.

44.3.4.2 Estimation

In Turkey, basically no assessments are made on other wooded lands and trees outside forests as regards wood volume and area. The only exception is in relation to certain official agricultural forecasts concerning fruit and olive groves.

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