

25. Options for FAO reporting on Trees Outside Forests

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EURAF is an NGO, based in Montpellier and Brussels (Transparency Register ID of [913270437706-82](https://register.transparency.europa.eu/913270437706-82)). It aims “to promote the adoption of agroforestry practices across Europe by supporting efforts to develop awareness, education, research, policy making and investments which foster the use of trees on farms”. It has a network of 31 affiliated entities in 23 countries.

This Policy Briefing is provided as an input to the FAO review of monitoring and reporting methods for Trees Outside Forests to be used in 2030 Forest Resource Assessment (with the review scheduled for completion in 2025). EURAF recommends greater coordination with the UNFCCC forest definitions and the move towards wall-to-wall identification of “lands” in national LULUCF inventories (particularly in Annex I countries). We also suggest that quantification of TOF should be based on the crown area of trees in agricultural land (croplands and grasslands) and in settlements. The opportunity could be taken to move away from the minimum block size threshold (0.5ha) used in the FAO categories of Other Wooded Land and Other Land With Tree Cover. Country-wide remote sensing techniques are increasingly available to estimate the crown area of individual trees, tree lines and small copses, irrespective of block-size. As an intermediate step, EU Member States are encouraged to contribute more completely to the TOF categories being used in the FRA-2025.

1 Introduction

There are three ways of classifying forests and tree cover: a) a unified international definition applying to all countries (FAO), b) internationally agreed thresholds within which countries set their limits (UNFCCC), c) countries using their own categorisations.

- A. The Food and Agriculture Organisation (FAO) Forest Resource Assessment gives a single definition of forest based on minimum area, % crown-cover and minimum potential tree height;
- B. The UNFCCC Marrakesh Accords set minimum and maximum limits for the three criteria above, and countries notify the UNFCCC Secretariat of the values (and changes) that they will use for climate change reporting related to forests, croplands, grasslands, wetlands, settlements and other land.
- C. A national rural cadastre, where parcels are classified as forest or agriculture, alongside ownership information. Definitions in cadastres tend to closely match method B above. Only a few countries (e.g. 4 in Europe and 4 of the main UNFCCC Non-Annex I countries) have national forest classifications which conform to the FAO definition.

2 FAO Forest Resource Assessment

The FAO Global Forest Resources Assessment (FRA) is produced every five years. It requires countries to report on a range of forest statistics for four mutually-exclusive land use categories: Forest, Other Wooded Land, Other Land, Inland Water. These categories cover 100% of land. The FRA defines “forest” [1] as in Box 1¹

Box 1: Forest. Definition - land spanning more than 0.5 ha with a cover more than 10% and trees higher than five metres, or trees able to reach those thresholds in situ, it does not include land that is predominantly under agricultural or urban land use.

Explanatory notes for “forest”.

1. Forest is determined both by the presence of trees and the absence of other predominant land uses. The trees should be able to reach a minimum height of 5 metres.
2. Includes areas with young trees that have not yet reached, but which are expected to reach, a canopy cover of at least 10 percent and tree height of 5 metres or more. It also includes areas that are temporarily unstocked due to clear-cutting as part of a forest management practice or natural disasters, and which are expected to be regenerated within 5 years. Local conditions may, in exceptional cases, justify that a longer time frame is used.

¹ The UN Convention on Biological Diversity definition is very similar [2]: “A land area of more than 0.5 ha, with a tree canopy cover of more than 10 %, which is not primarily under agriculture or other specific non-forest land use. In the case of young forest or regions where tree growth is climatically suppressed, the trees should be capable of reaching a height of 5m in situ, and of meeting the canopy cover requirement”.

3. *Includes forest roads, firebreaks and other small open areas; forest in national parks, nature reserves and other protected areas such as those of specific environmental, scientific, historical, cultural or spiritual interest.*
4. *Includes windbreaks, shelterbelts and corridors of trees with an area of more than 0.5 hectares and a width of more than 20 metres.*
5. *Includes abandoned shifting cultivation land with a regeneration of trees that have, or are expected to reach, a canopy cover of at least 10 percent and tree height of at least 5 metres.*
6. *Includes areas with mangroves in tidal zones, regardless whether this area is classified as land area or not.*
7. *Includes rubberwood, cork oak and Christmas tree plantations.*
8. *Includes areas with bamboo and palms provided that land use, height and canopy cover criteria are met.*
9. **Excludes** *tree stands in agricultural production systems, such as fruit tree plantations, oil palm plantations, olive orchards and agroforestry systems when crops are grown under tree cover. Note: Some agroforestry systems such as the “Taungya” system where crops are grown only during the first years of the forest rotation should be classified as forest.*

Two further categories were used in the FAO Forest Resource Assessment² from 1990 onwards (Box 2 & 3) [4]:

Box 2. Other Wooded Land (OWL). Definition “land not defined as forest”, spanning more than 0.5 hectares; with trees higher than 5 metres and a canopy cover of 5-10 percent, or trees able to reach these thresholds; or with a combined cover of shrubs³, bushes and trees above 10 percent. It does not include land that is predominantly under agricultural or urban land use.”

*Explanatory notes for OWL: the definition has two options - a) the canopy cover of trees⁴ is from 5-10% and the trees should be higher than 5m or able to reach 5m in situ, b) the canopy cover of trees is less than 5% but the combined cover of shrubs, bushes and trees is more than 10% - this includes **areas of shrubs and bushes where no trees are present**. b) includes areas with trees that will not reach a height of 5m in situ with a canopy cover of 10% or more (e.g. some alpine tree vegetation types, arid zone mangroves etc); c) includes areas with bamboo and palms, provided that land use height and canopy cover criteria are met.*

Box 3. Other Land with Tree Cover (OLTC). Definition: “land considered as ‘other land’,⁵ that is predominantly agricultural or urban land use and has patches of tree cover that span more than 0.5 hectares with a canopy cover of more than 10 percent of trees able to reach a height of 5 metres at maturity. It includes both forest and non-forest tree species.”

Explanatory notes for OLTC. a) The difference between Forest and Other Land with Tree Cover is the land use criteria. b) OLTC Includes groups of trees and scattered trees (e.g. trees outside forest) in agricultural landscapes, parks, gardens and around buildings, provided that area, height and canopy cover criteria are met. c) . Includes tree stands in agricultural production systems, for example in fruit plantations and agroforestry systems when crops are grown under tree cover. Also includes tree plantations established mainly for other purposes than wood, such as oil palm plantations. d) Excludes scattered trees with a canopy cover less than 10 percent, small groups of trees covering less than 0.5 hectares and tree lines less than 20 metres wide.

The FAO definition of “**Trees outside Forest**” equates to “**Other Land with Tree Cover (OLTC)**”[6]. **It does not include “Other Wooded Land (OWL)”**, despite this category being “outside forest”. A further complication is that all FAO categories include only blocks bigger than 0.5ha. This gives rise to the quaint description for areas of TOF smaller than 0.5ha as “**Trees Outside Trees Outside Forests**” (TOTOF) [7]

A tree-block with “predominant” agricultural use would be considered as OLTC, provided it meets the same area and crown cover criteria as “forest”. If the agricultural use of the agroforest is secondary then the land will be

² The **forest** definition has significantly changed since the first FAO international forest assessment. For instance in its 1968 World Forest Inventory, FAO defined “forest land” as “all land with a ‘forest cover’, that is with trees whose crowns cover more than 20% of the area and that is not used primarily for purposes other than forestry” [3].

³ **Shrub** for the FAO is a woody perennial plant, generally more than 0.5 m and less than 5 m in height at maturity and without a definite crown. The height limits for trees and shrubs should be interpreted with flexibility, particularly the minimum tree and maximum shrub height, which may vary between 5 m and 7 m

⁴ **Tree** for the FAO is a woody perennial with a single main stem, or in the case of coppice with several stems, having more or less definite crown including bamboos, palms, and other woody plants meeting the above criteria. More detail in a European context is available in [5].

⁵ The UNFCCC definition of “**other land**” is preferred — i.e. any land that is not forest, agriculture, settlement or wetland. EU Member States have provided lists of non-agricultural activities in rural areas which would be considered as “other land”, e.g. carparks, solar panels playing-fields and airports.

considered as “forest” or “Other Wooded Land” depending on the tree crown cover. This means that most systems of shade coffee or cocoa and other agroforestry crops would be considered as OLTC, as would plantations of oil palm grown primarily for purposes other than wood; but plantations of rubber and bamboo would be considered as forest [8], even if they have replaced native forests with higher levels of biodiversity [9].

The decision on whether forest or agriculture is the “predominant” land use is difficult [10], and also has consequences for potential funding of REDD+ projects, since this applies only to “efforts to **REduce Emissions from Deforestation and forest Degradation**”. REDD+ projects are sometimes seen as encouraging agricultural intensification in monocultures, rather than the ecological intensification of multi-strata agroforestry [11].

In the 2015 FRA Other Land with Tree Cover (OLTC - i.e. TOF) was reported on by 78 of the 234 countries, and represented 5.18% of total “tree based systems” (i.e. Forest + OWL + OLTC). Forest represented 72.87% of the area, and Other Wooded Land (OWL) 21.95%. If OWL is considered as “outside the forest” then a more complete definition of ToF is OLTC + OWL, or 27.14% of the total tree-based system area. In the FRA-2020 the area of both OWL and OLTC declined significantly from FRA-2015 (Table 1), and the reasons for this are unclear

Table 1: Overall Statistics from the FAO Forest Resource Assessment in 1990, 2000, 2005, 2010 2015 and 2020. Data *abstracted* from FAO Databases. The FAO assumes that Trees Outside Forests are ONLY “Other Land With Tree Cover (OLTC)” The area of “Other Wooded Land (OWL) is ignored in TOF calculations (despite being “outside forest”. Areas are in thousand ha. (FRA 2020 data [here](#))

FRA	Countries	Forest Area	OthWoodLand	OthLand	OLTC	Land Area	report	Forest%	OWL%	OLTC%
TOTAL 2020	236	4,058,931	976,619	8,002,997	143,865	13,038,547	85	78.4%	18.9%	2.8%
TOTAL 2015	234	3,999,134	1,204,471	7,845,172	284,262	13,048,777	78	72.9%	21.9%	5.2%
TOTAL 2010	234	4,015,673	974,163	7,412,851	280,080	13,047,706	76	76.2%	18.5%	5.3%
TOTAL 2005	234	4,032,743	953,692	7,420,089	267,949	13,047,113	74	76.8%	18.2%	5.1%
TOTAL 2000	233	4,053,582	954,448	7,397,928	253,315	13,045,347	70	77.0%	18.1%	4.8%
TOTAL 1990	233	4,128,269	978,454	7,298,290	247,080	13,044,703	65	77.1%	18.3%	4.6%

De Foresta et al [12] reported on TOF-recording in the Forest Resource Assessment and recommended three subcategories (Box 4) with minimum block-size of 0.05ha (Figure 1). These subcategories provide both maximum and minimum thresholds, but a parcel with many boundary trees, like bocage in Normandy (Figure 2), would still not be classified as TOF if the block size was less than than 0.05ha.

Box 4: Subclasses of TOF recommended by de Foresta et al (2013)

ToF-AGRI: i.e. all lands predominantly under an agricultural use with trees and/or shrubs, whatever their spatial pattern (in line, in stands, scattered), provided that the area is ≥ 0.05 ha, the canopy cover is $\geq 5\%$ if trees are present, or $\geq 10\%$ if combined trees, bushes and shrubs, the width ≥ 3 m and the length ≥ 25 m.

ToF-URB: i.e. all lands predominantly under an urban use with trees and/or shrubs whatever their spatial pattern (in line, in stands, scattered), provided that the area is ≥ 0.05 ha, the canopy cover is $\geq 5\%$ if trees are present, or $\geq 10\%$ if combined trees, bushes and shrubs, the width ≥ 3 m and the length ≥ 25 m.

ToF-NON A/U: i.e. all lands not predominantly under agricultural or urban use, with either a) small tree stands ($0.05 \leq \text{area} < 0.5$ ha), with canopy cover $\geq 5\%$ if trees are present, or $\geq 10\%$ if combined trees, bushes and shrubs. Or b) narrow linear tree formations, ($3 \text{ m} \leq \text{width} < 20 \text{ m}$), with canopy cover $\geq 5\%$ if trees are present, or $\geq 10\%$ if combined trees, bushes and shrubs.

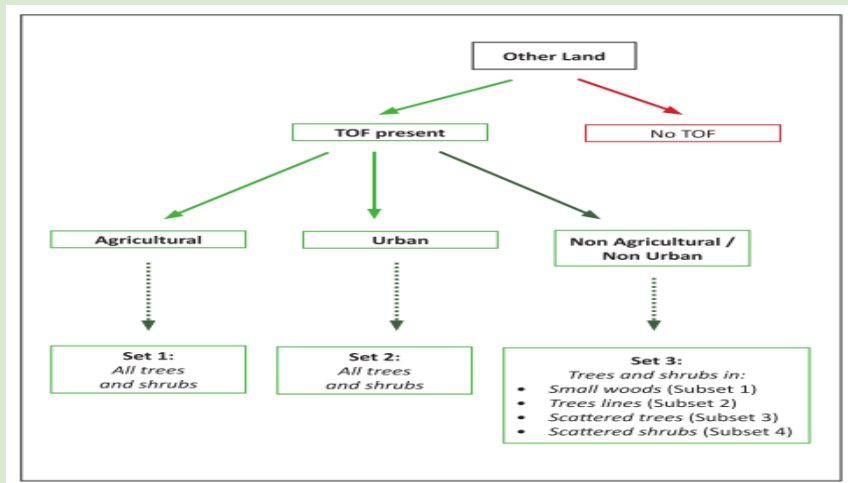


Figure 1: Suggested classification of “Trees outside Forests” for use in the Forest Resource Assessment 2015. This assumes that ToF is present only in “Other Land” and not within the “Other Wooded Land” category. [12]

However, neither the 2015 nor 2020 Forest Resource Assessments commented on the recommendations of de Foresta *et al* 2013. In the 2020 FRA, only around 85 of the 239 participating countries used the OLTC category. There were only 32 countries which had palm plantations, 64 with tree orchards, 57 with agroforestry and 44 with trees in urban settings. The current FRA methodology therefore seems to greatly under-report agroforestry and trees in urban settings worldwide.

De Foresta also recommended development of global TOF assessment using the remote sensing survey methodologies⁶ linked to the seven themes used in the FRA (Table 2)



Figure 2: A typical bocage-agroforestry landscape in Normandy, France. Since the boundary trees are not in blocks > 0.5ha they will not be reported as ToF in the FAO Forest Resource Assessment [12]

⁶ This covers the Earth’s whole land surface and has about 13,500 10km x 10km samples, of which about 9,000 are outside deserts and areas with permanent ice. This grid of sample plots is the same as used for the national forest assessments supported by FAO and by many national forest inventory programmes. Landsat images (from around 1990, 2000 and 2005) were interpreted and classified using an automated supervised approach. Nearly 7 million polygons were analysed at each time interval to enable detection of forest area, forest gains and forest losses 5 hectares or greater in size.

Table 2: The seven FRA 2010 themes, their associated variables, and their proposed equivalent for a future global ToF Assessment [12].

Themes for FRA 2010	Proposed themes for a global TOF assessment
Extent of forest resources <ul style="list-style-type: none"> Area of forest Growing stock of forests Forest carbon stock in living biomass 	Extent of TOF resources <ul style="list-style-type: none"> Area with TOF <ul style="list-style-type: none"> Area with TOF on agricultural land Area with TOF on urban land Area with TOF on non urban/ non agricultural land Growing stock of TOF Carbon stock in living TOF biomass
Forest biological diversity <ul style="list-style-type: none"> Area of primary forest Area of forest designated primarily for conservation of biodiversity Area of forest within protected areas 	TOF biological diversity <ul style="list-style-type: none"> Area of TOF systems with high biodiversity value such as agroforests and agroforest parklands Number of tree species involved in TOF systems
Forest health and vitality <ul style="list-style-type: none"> Area of forest affected by fire Area of forest affected by insects (and diseases?) 	TOF health and vitality <ul style="list-style-type: none"> Area with TOF affected by fire Area with TOF affected by insects and diseases
Productive functions of forest resources <ul style="list-style-type: none"> Area of forest designated primarily for production Area of planted forest Total wood removals 	Productive functions of TOF resources <ul style="list-style-type: none"> Total wood removal from areas with TOF Total non wood removal from areas with TOF (by category: fruit, gum latex and resin, leaf, bark)
Protective functions of forest resources <ul style="list-style-type: none"> Area of forest designated primarily for protection of soil and water 	Protective functions of TOF resources <ul style="list-style-type: none"> Area with TOF ensuring protection of soil and water
Socio-economic functions of forests <ul style="list-style-type: none"> Area of forest under private ownership Value of total wood removals Employment in primary production of goods 	Socio-economic functions of land with TOF <ul style="list-style-type: none"> Area with TOF under private or/and community ownership Area with TOF under State ownership Value of total wood removals from TOF Value of total non-wood removals from TOF Employment in primary production of goods from TOF
Legal, policy and institutional framework <ul style="list-style-type: none"> Forest area with management plan Human resources in public forest institutions Number of students graduating in forestry 	Legal, policy and institutional framework <ul style="list-style-type: none"> Area with TOF under disputed ownership status Human resources in public institutions dealing with TOF Number of students graduating in agroforestry and in urban forestry

ToF is hardly mentioned in the FAO Voluntary Guidelines on National Forest Monitoring and Assessment (NFMA). Sections I & II of these guidelines [13], covering the NFMA definition, scope and principles does say that ToF “*should be included within the term Forest Resources*”, but the draft of Section III (covering “*compilation of good practices and technical recommendations on NFMA*”) [14] merely says that countries should decide for themselves whether ToF is included in their monitoring or not [13].

Discussion of TOF in the FRA Main Reports has been declining. The FRA-2000 had a whole chapter devoted to Trees Outside the Forest, but the FRA-2015 reduced this to the comments shown in Box 5, and by FRA-2020, TOF received only two passing mentions.

BOX 5 - FRA- 2015: *While not technically considered as forest, according to the standard forest definition used by FAO and many other international organisations, trees outside forests are a valuable source of many products and services found in forests. In some countries they provide critical supplies of wood, fruits and other non-wood forest products. For FRA 2015 the area of trees outside forests was reported to be 280 million ha in 2015, which is an increase from the 246 million ha reported for 1990; however, only 84 countries, representing 51 percent of global forest area, reported on this variable.⁷ While substantially more difficult and costly to measure than forest at a national level, trees outside forests are clearly an important natural resource in many countries.*

Table 3 shows that, even in European countries with sophisticated land use/cover mapping tools, there is great variability in the reporting of OWL and OLTC. In the FRA-2020, several Member States recorded zero hectares of one or other category, or both - in the case of Poland.

⁷ Note from Table 1 that in 2015 only 78 countries gave non-blank or non-zero figures for “Other Land With Tree Cover (OLTC)”, not the 84 given here.

Table 3 National returns from EU Member States + UK and Switzerland to the FRA-2020

Country	Forest Land ('000 ha)	Other Wooded Land ('000 ha)	Other Land with Tree Cover ('000ha)	%Trees outside Forest (OWL+OLTC)
2020 returns ('000 ha)				
Denmark	628.44	36.95	2.67	5.9%
Estonia	2438.4	94.44	3.6	3.9%
Finland	22409	746	9	3.3%
France	17253	843	206	5.7%
Germany	11419	0	400	3.4%
Greece	3901.8	2634.72	1000	48.2%
Hungary	2053.01	200	82.24	12.1%
Ireland	782.02	65.74	0.67	7.8%
Italy	9566.13	1865.84	2718.37	32.4%
Latvia	3410.79	107.8	182.61	7.8%
Lithuania	2201	62.1	19.5	3.6%
Luxembourg	88.7	2.7	0	3.0%
Malta	0.46	0.07	4.7	91.2%
Netherlands	369.5	0	21.55	5.5%
Poland	9483	0	0	0.0%
Portugal	3312	1543	0	31.8%
Romania	6929.05	15.57	0	0.2%
Slovakia	1925.9	20.41	0	1.0%
Slovenia	1237.83	27.42	288	20.3%
Spain	18572.17	9381.82	3902.36	41.7%
Sweden	27980	2364	0	7.8%
Total	159231.4	21030.4	9149.3	15.9%
Switzerland	1269.11	74.92	301.69	22.9%
United Kingdom	3190	20	24	1.4%

Schnell et al [15] reviewed the efforts being used worldwide to quantify ToF resources with remote sensing, and suggested that national TOF inventories should be based on high resolution images, supplemented by Lidar where possible, measuring all trees above an agreed dbh or crown diameter threshold. The number and volume of trees would be reported using the 3 land use categories suggested by the FAO — i.e. urban, agriculture and “natural formations”. This approach also matches the Indian definition of ToF - “all those trees, which have attained 10 cm or more dbh on land which is not notified as forests” [16]. It could be used alongside the records of “landscape-feature” trees and tree-rows held by EU Member States, where the threshold tree crown-diameter is often set as 2 metres [17] (See Section 5).

3 UNFCCC - National Inventories of GHG Emissions and Removals⁸

The definition of forest in the UNFCCC Marrakesh Accords (UNFCCC/CP/2001/13/Add1) is :

Forest is a minimum area of land of 0.05-1.0 hectares with tree crown-cover (or equivalent stocking level) of more than 10-30 per cent with trees with the potential to reach a minimum height of 2-5 metres at maturity in situ. A forest may consist either of closed forest formations where trees of various storeys and undergrowth cover a high proportion of the ground or open forest. Young natural stands and all plantations which have yet to reach a crown-cover of 10-30 per cent or tree height of 2-5 metres are included under forest, as are areas normally forming part of the forest area which are temporarily unstocked as a result of human intervention such as harvesting or natural causes but which are expected to revert to forest.

⁸ Annual inventories of emissions and removals of direct GHGs (carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O), perfluorocarbons (PFCs), hydrofluorocarbons (HFCs), sulphur hexafluoride (SF₆) and nitrogen trifluoride (NF₃)) from 4 sectors: (a) Energy; (b) Industrial Processes and Product Use; (c) Agriculture Forestry and Other Land Use (AFOLU), and (d) Waste, for all years from the base year (or period) to two years before the inventory is due.

Countries which are signatories to Annex 1⁹ of the UNFCCC are required to report the thresholds which they have set for “forest” within the permitted ranges for the three key criteria (area, %crown-cover, tree height). This enables a country-specific distinction between forest land and agricultural land (reported in UNFCCC terms as “cropland” or “grassland”). The other 3 land-use categories used in UNFCCC reporting are wetlands, settlements and other.

Only 6 EU Member States¹⁰ from 28 use the FAO criteria (0.5ha, 10% crown-cover, 5m potential height) in full (Table 4), and only Norway of the 13 non-EU Annex I countries.

Table 4 - Threshold values used in the definition of “forest land” by EU Member States - Annex II Regulation 2018/841)

Member State	Area (ha)	Tree crown cover (%)	Tree height (m)	Minimum width (m)
Malta	1,0	30	5	
Spain	1,0	20	3	25
Portugal	1,0	10	5	20
Hungary	0,5	30	5	10
Estonia	0,5	30	2	
Belgium	0,5	20	5	
Netherlands	0,5	20	5	30
Denmark	0,5	10	5	20
Finland	0,5	10	5	20
France	0,5	10	5	
Italy	0,5	10	5	
Luxembourg	0,5	10	5	
Sweden	0,5	10	5	10
Greece	0,3	25	2	
Slovakia	0,3	20	5	
Cyprus	0,3	10	5	
Slovenia	0,25	30	2	
Romania	0,25	10	5	20
Lithuania	0,1	30	5	10
Ireland	0,1	20	5	20
Latvia	0,1	20	5	20
United Kingdom	0,1	20	2	20
Bulgaria	0,1	10	5	
Germany	0,1	10	5	
Croatia	0,1	10	2	
Poland	0,1	10	2	10
Austria	0,05	30	2	10
Czech Republic	0,05	30	2	20

Developing countries are not signatories to Annex 1 of the UNFCCC, but they are now expected to provide country-specific values for the three forest criteria (Table 5). Only 4 (Cambodia, Philippines, South Korea, Togo) of the 55 non-Annex I countries which have registered their forest definitions with the UNFCCC use the FAO “standard” of 10% crown cover, 0.5 ha minimum area and 5m tree potential height *in situ*. It is therefore possible that many countries are reporting “forest” area in successive FRAs using their national definitions rather than the FAO “standard”.

Table 5: Parameters used in the definition of Forest supplied to the UNFCCC by non-Annex I Countries, in order to be eligible for CDM afforestation projects. Full details are available on the UNFCCC CDM website¹¹.

⁹ Each Party included in Annex I shall, for the purposes of applying the definition of “forest” as contained in paragraph 1 (a) above, select a single minimum tree crown-cover value between 10 and 30 per cent, a single minimum land area value between 0.05 and 1 hectare and a single minimum tree height value between 2 and 5 metres. The selection of a Party shall be fixed for the duration of the first commitment period. The selection shall be included as an integral part of its report to enable the calculation of its assigned amount pursuant to Article 3, paragraphs 7 and 8, in accordance with decision 19/CP.7, and shall include the values for tree crown-cover, tree height and the minimum land area. Each Party shall justify in its reporting that such values are consistent with the information that has historically been reported to the Food and Agriculture Organization of the United Nations or other international bodies, and if they differ, explain why and how such values were chosen.

¹⁰ Italy is one of the six EU-MS which implements FAO criteria at a national level, but is considering a reduction in the minimum area to 0.2ha and an increase in canopy cover to 20% (Pisanelli pers comm). Spain has announced a change from 2025 onwards.

¹¹ <https://cdm.unfccc.int/DNA/bak/allCountriesARInfos.html>

Country	Minimum Crown Cover (%)	Minimum Area (ha)	Minimum Tree Height (potential in situ)
Albania	30	0.1	3
Argentina	22.5	1	3
Azerbaijan	20	0.5	2.5
Belize	30	0.3	5
Bolivia	30	0.5	4
Brazil	30	1	5
Burkina Faso	10	0,05	2
Cambodia	10	0.5	5
Chile	25	0.5	5
China	20	0.067	2
Colombia	30	1	5
Costa Rica	30	1	5
Côte d'Ivoire	30	0,1	5
Democratic Republic of the Congo	30	0,5	3
Dominican Republic	20	0.0629	5
Ecuador	30	1	5
El Salvador	30	0.5	5
Ethiopia	20	0.05	2
Ghana	15	0.1	5
Guatemala	30	0.5	5
Honduras	30	1	5
India	15	0.05	2
Indonesia	30	0,25	5
Kenya	30	0.1	2
Kyrgyzstan	20	0,5	3
Lao People's Democratic Republic	20	0,5	5
Madagascar	30	1	5
Malaysia	30	0.5	5
Mali	30	1	2
Mexico	30	1	4
Mongolia	10	1	2
Morocco	25	1	2
Mozambique	30	1	5
Myanmar	10	0.1	2
Nicaragua	20	1	4
Niger	30	1	4
Pakistan	30	0.05	3
Panama	30	1	5
Paraguay	25	0.5	5
Peru	30	0.5	5
Philippines	10	0.5	5
Republic of Korea	10	0.5	5
Republic of Moldova	30	0.25	5
Rwanda	10	0.05	3
Senegal	30	0.5	2
South Africa	30	0.05	2
Sri Lanka	20	0.05	3
Thailand	30	0.16	3
Togo	10	0.5	5
Trinidad and Tobago	10	0.4	3
Uganda	30	1	5
United Republic of Tanzania	10	0.05	2
Uruguay	30	0,25	3
Viet Nam	30	0.5	3
Yemen	30	0.5	3

The thresholds chosen for crown-cover make a great difference to the area potentially available for afforestation projects (Figure 3). Use of the maximum UNFCCC-permitted crown-cover threshold of 30% was much criticised when the UNFCCC-CDM was introduced, since it was seen as enabling areas of sparse natural forest to be classed as “non-forest” and therefore be eligible for new plantations funded through the CDM [18,19]. Zomer et al. [20] found that modifying the crown-cover threshold for “forest” from 30% to 10% reduced the worldwide availability of “non-forest” land for afforestation projects from 7.73 billion km² to 2.28 billion km².

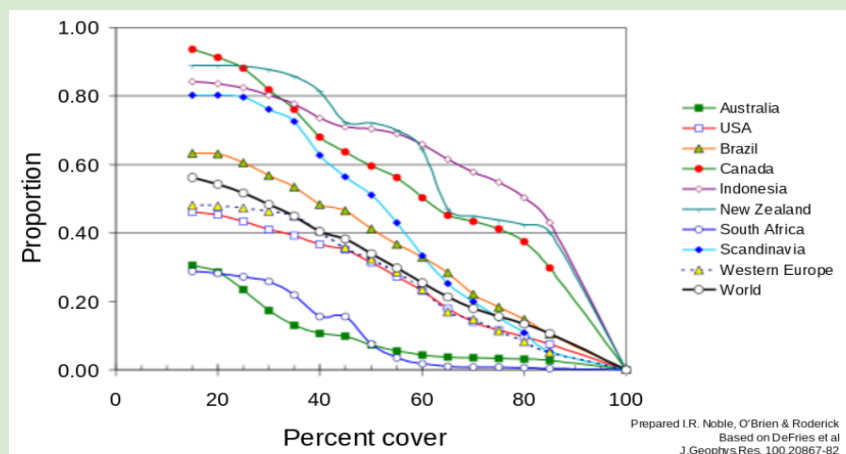


Figure 3: Proportion of wooded land classified as “forest” using different % crown-cover thresholds [21]

Zomer et al [22] also calculated that **43% of agricultural land worldwide has at least 10% tree cover**, with major differences between continents (Figure 4), and very high levels in Central America and SE Asia.

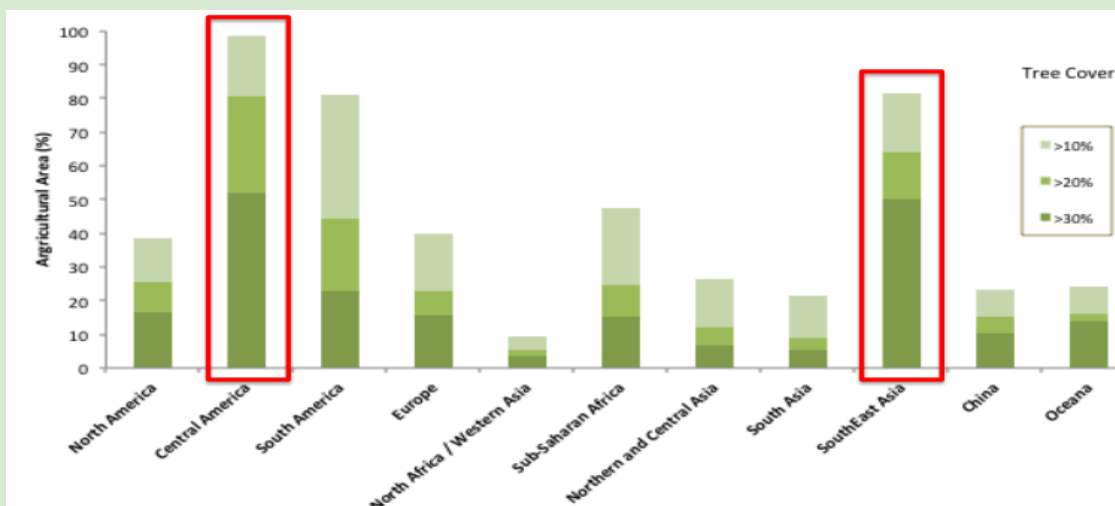


Figure 4: Percentage of agricultural land with tree cover, year 2000 [22]

In preparation for COP21 in Paris, 162 UNFCCC signatories submitted “Intended Nationally Determined Contributions” (INDCs) and 103 of these included some GHG mitigation activities in the agricultural sector [23]. Many also mentioned the mitigating role of forests and/or agroforestry [24,25]. Grassi & Detener [26] summed the suggested LULUCF/AFOLU projected emissions for 2030 for 72 countries and found that pledged reductions in emissions from the land use sector represent 20-25% of their overall emission reductions.

There are major methodological issues with the INDCs, and all countries will be expected by the UNFCCC to ensure that their pledges and reporting follow the IPCC guidelines [27–30]. This will mean improved differentiation between areas of “forest” and those of other land use categories. There are five land uses in the IPCC Guidelines, in addition to “forest” (see above for definition), and agroforestry is mentioned in two of them. Note that the UNFCCC “other” category is largely barren land, and unlikely to be relevant to ToF.

1. **Cropland.** Which includes all annual and perennial crops as well as temporary fallow land (i.e., land rested for one or several years before being cultivated again). Annual crops may include cereals, oils seeds, vegetables, root crops and forages. Perennial crops can include trees and shrubs, in combination with herbaceous crops (e.g. **agroforestry**) or as orchards, vineyards and plantations such as cocoa, coffee, tea, oil palm, coconut, rubber trees, and bananas, except where these lands meet the criteria for categorisation as forest land. Arable land which is normally used for cultivation of annual crops but which is temporarily used for forage crops or grazing as part of an annual crop-pasture rotation is included under cropland.
2. **Grassland.**¹² Includes rangelands and pasture land that is not considered as cropland, and systems with vegetation that fall below the threshold used in the forest land category and are not expected to exceed, without human intervention, the threshold used in the forest land category.¹³ The category also includes all grassland from wildlands to recreational areas as well as agricultural and **silvi-pastoral systems**, subdivided into managed and unmanaged, consistent with national definitions.
3. **Wetlands.** Which include land that is covered or saturated by water for all or part of the year, and that is not classified as Forest land, Cropland, Grassland or Settlements. It includes inland organic soils and wetlands on mineral soils, coastal wetlands including mangrove forests, tidal marshes and seagrass meadows and constructed wetlands for wastewater treatment. It also includes reservoirs, natural rivers and lakes [31].
4. **Settlements.** Which includes all developed land, including transportation infrastructure and human settlements of any size, unless they are already included under other categories. This should be consistent with national definitions.
5. **Other land.** Which includes bare soil, rock, ice, and all land areas that do not fall into any of the other five categories.

In EU countries like Denmark [32], Ireland [33] and the Netherlands [34], official GHG inventories are starting to record TOF as a separate category. This is another reason for greater coordination between FAO-FRA and UNFCCC.

¹² For the Kyoto Protocol this is termed Grazing-Land.

¹³ This land use category includes non-herbaceous perennial species which can be grazed. The EU the definition of “permanent grassland and permanent pastures” (Article 4 Regulation N° 1307/2013) is “land used to grow grasses or other herbaceous forage naturally (self-seeded) or through cultivation (sown) and that has not been included in the crop rotation of the holding for five years or more, it may include other species such as **shrubs and/or trees** which can be grazed provided that the grasses and other herbaceous forage remain **predominant**, as well as (where Member States so decide) land which can be grazed and which forms part of established local practices where grasses and other herbaceous forage are traditionally not predominant in grazing areas.

The IPCC-UNFCCC Guidelines identify three **Approaches** for the characterisation of land use, and three **Tiers** for the calculation of GHG fluxes from these different land uses (Figure 5). The expectation is that UNFCCC parties will gradually move towards higher Approaches and Tiers, as their expertise and resources improve. In more detail, taking the case of land use estimation:

- **Approach 1** identifies the total area for each of the 6 land-use categories within a country, but does not provide detailed information on the nature of conversions between these land uses.
- **Approach 2** introduces tracking of a matrix of conversions of all the land-use categories.
- **Approach 3** extends the information available in Approach 2 by allowing land-use conversions to be tracked on a spatially explicit basis (i.e. a comprehensive national land-use GIS system).

Recent approval of a revised LULUCF target of -310 MtCO₂ equiv for the European Union in 2030, has given a major challenge to Member States of the Union ([ref](#)), and the Regulation also stipulates that MS should move to “... *spatially-explicit land-use conversion data for the identification and tracking of land-use categories and conversions between land-use categories*”, together with detailed modelling approaches to estimate fluxes of GHG on specific parcels. This is the IPPC “high resolution and high accuracy” approach shown in Figure 5. This commitment is very exciting for European agroforestry, since most Member States will have to improve their inventories of trees on agricultural land, and their models of the impact of trees on emissions from grassland and cropland management.

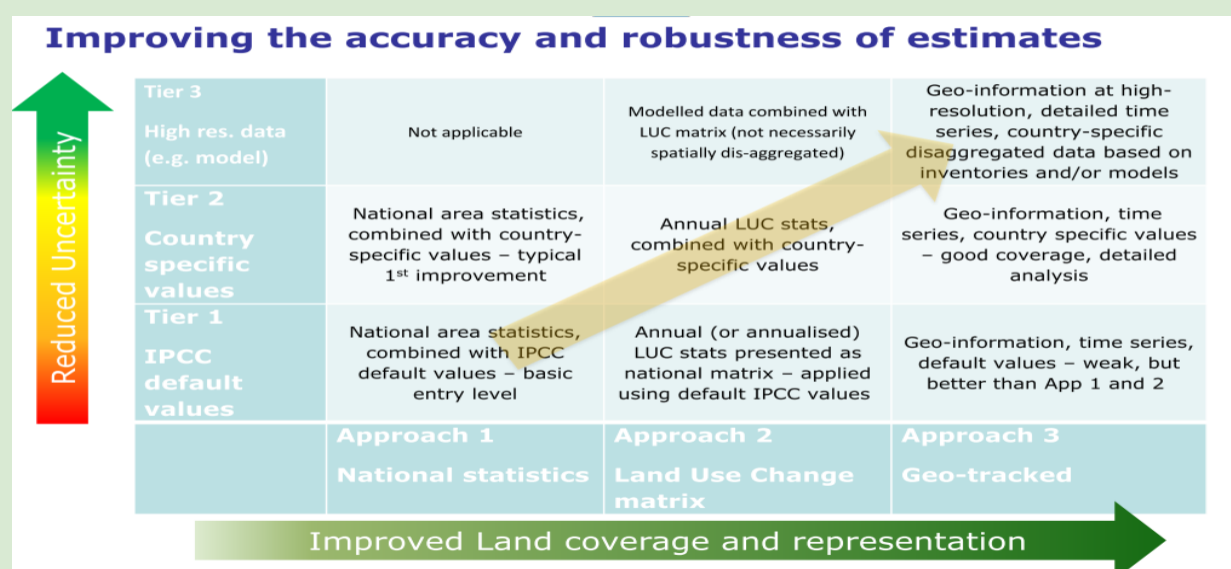


Figure 5: UNFCCC Greenhouse Gas Emissions reporting in Europe will increasingly use the more accurate and robust Tier 3 and Approach 3 methodologies [35].

4 Forest definitions in Cadastral Systems

Lund [36] found national thresholds of tree crown-cover for “forest land” varying from 0% to 80%, minimum areas from 0.05ha to 1ha (with minimum widths from 2.5 m to 50 metres), and potential tree height from 1m to 7m). He listed more than 300 different national forest classifications, and other studies have pointed to the wide range of definitions in Europe [37], and a great variation in forest inventory methodologies [38].

Thus, while both developed and developing countries have provided thresholds for the three criteria which define “forest land” according to the Marrakesh Accords, a different set of rules **may** be used for national legal or “cadastral” databases. In the Netherlands, for example, as soon as more than 20 tree seedlings/ha are planted within an agricultural parcel it has to be listed in the national cadastre as “forest/nature”, with an immediate reduction in land value and rate of tax [39].

Thus the national “cadastre” (or similar land register) is the best place to start when looking for the fine detail on whether an individual parcel is classed as forest or agriculture. Cadastral systems exist, at least in part, in most UNFCCC Annex 1 countries.

- Australia (tenure of Australia’s forests - [ref](#)):

- Canada: most provinces maintain a searchable cadastre showing boundaries of agricultural and forest parcels, e.g. Quebec¹⁴, [Ontario](#) .. and probably most others
- EU: all countries implement a Land Parcel Identification System (LPIS) which shows the boundary of farmers fields (reference layer), and the areas used for different agricultural crops (agricultural layer). Any landowner with land which is eligible for agricultural direct payments will make agricultural returns (IACS) which confirm the use of the land in the current year, including areas which are considered as forest and which are not eligible for agricultural payments [17]. Many activities are coordinated by the Permanent Committee on Cadastre in the European Union ([ref](#))
- Japan ([ref](#))
- New Zealand: Land Information New Zealand (LINZ) provides a [rural evaluation tool](#) integrating ownership and many other layers of land use and land potential
- Russian Federation ([ref](#)):
- Switzerland: a searchable national database with many layers including [land use](#).
- Turkey: forest cadastre and ownership cadastre conducted by different agencies ([ref](#)).
- USA: some States maintain a cadastre showing boundaries, owners and details of land use including agriculture and forestry - e.g. [Montana](#), [Utah](#)

In non-Annex I countries there are also interesting examples of cadastral systems which have been integrated with high resolution imagery of land cover: e.g. in India [40–43]. The Global Land Cover Facility provides world coverage of vegetation type and tree crown-cover with a 250 m pixel grid [44] but for integration with cadastral datasets much higher resolution is required

In Europe, national Land Parcel Information Systems (LPIS) often hold information on isolated trees, trees in line and trees ingroups on agricultural land on farms, together with areas classified as forest. However, the LPIS is not a complete rural land register, since it only holds returns from farmers and managers of farmland. For a complete rural Cadastre, countries would require to integrate data from National Forest Inventories (NFI). Aggregated European National Forest Inventory data is available through the European Forestry Institute EFISCEN system [45].

One EU example of a well integrated Cadastral and Land Use system is the SIGPAC in Spain. Here the Spanish Ministry of Agriculture, Food and Environment (MAGRAMA) has been obliged by the European Union Court of Auditors to introduce an automated classification system to make individual parcels with “excessive” tree cover ineligible for agricultural Basic Payments under the Common Agricultural Policy (CAP). Parcels with 0% eligibility are judged to be “forest” for the purposes of the CAP (Figure 6) even if, for the time being, they remain classified as tree pasture in the country's online forest map [46].

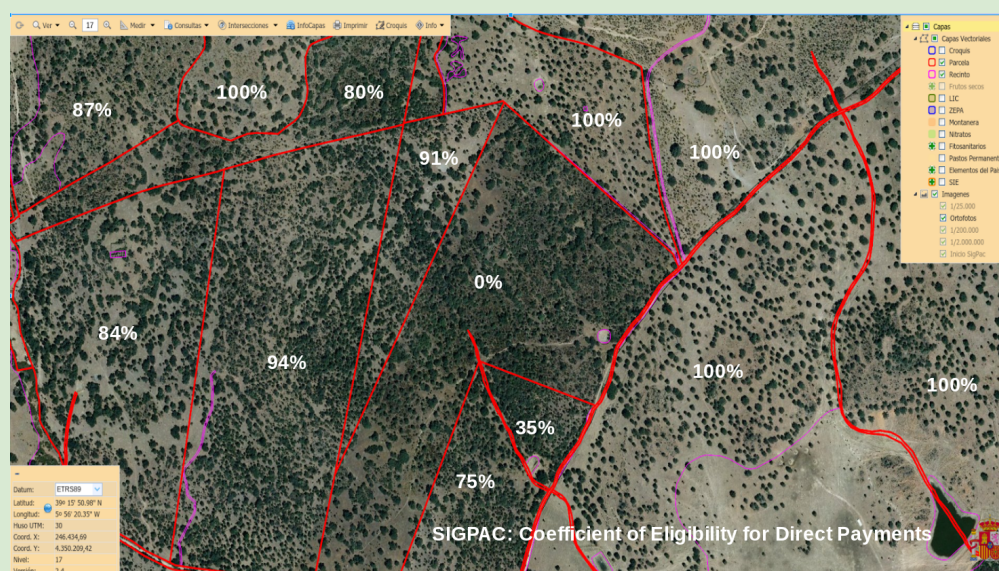


Figure 6: Problems of classification of wood pasture in Spain (and many countries of Europe). This shows a scene near Trujillo from the Spanish Land Parcel Identification System (SIGPAC). An automatic algorithm - based on tree crown-cover, slope and bare ground - has been used to calculate the eligibility of each parcel for agricultural direct payments. The parcel in the centre is judged to have 0% eligibility, and is therefore “forest” rather than “agriculture”.

¹⁴ <http://www.cptaq.gouv.qc.ca/index.php?id=231>; <http://mern.gouv.qc.ca/english/department/index.jsp>

5 Recent estimates of Trees outside Forests Using Remote Sensing

There are many recent examples of the use of Remote Sensing to characterise areas of trees outside forests. Some are given below:

- Campos-Taberner et al [47] used both Sentinel-1 and Sentinel-2 to classify land use in the Valencia region of Spain, including areas with trees, shrubs and wood pasture.
- Hassanin et al [48] used Sentinel-2 MSI satellite data to map trees outside forests in India.
- Brandt et al [49] detected 1.8 billion individual trees with more than 3m² crown diameter in a 1.3 million ha area of the West African Sahara using sub-metre resolution satellite imagery.
- den Herder et al [50] used the EU Copernicus “small woody features”, with an overlay of agricultural data from the Corine database to plot tree cover on 100m pixels in agricultural land in Europe. This Copernicus product is also available at 5m pixel resolution, and updates are planned every three years [51].
- Golicz et al [52] used similar methods to identify landscape features and agroforestry areas in Germany
- Maloc et al [53] used a LIDAR-based vegetation height model, a topographic landscape model and a forest mask to map trees outside forests in Switzerland. They also used the de Foresta approach for the identification of sub categories.
- Thomas et al [54] mapped TOF in Bangladesh - and identified more than 2.23 million ha with a mean canopy height of 7.3m
- Sarti et al [55] distinguished copses, isolated trees and hedgerows in Italy using Sentinel-2 imagery and recommended the method for large areas of agroforestry landscape.
- Valasques-Camacho et al [56] have reviewed the many techniques and products available to estimate tree crown cover and area in urban settings.
- Brandt et al [57] presented a 10-m map for 4.35 billion hectares in the tropics based on multi-temporal composites of Sentinel-1 and Sentinel-2, and identified 2719 million hectares of tropical land with >10% tree cover.
- Satellites reveal the effectiveness of European policy in enhancing forest structural diversity ([link](#))
- Application of CORINE land-cover mapping to estimate carbon stored in the vegetation of Ireland ([link](#))
- Integration of remote-sensing and ground-based observations for estimation of emissions and removals of greenhouse gases in forests ([link](#))
- European biomass satellite to support REF+ ([link](#))

6. Conclusions

1. Given the low areas and sparse returns from countries for Trees Outside Forests, EURAF is delighted that the FAO is undertaking a review of TOF monitoring methods, to be published in 2025.
2. The review of FAO methodologies should consider greater interoperability between FAO-FRA UNFCCC [58], for example, in the use of UNFCCC-Marrakesh Accord definitions
3. Areas of TOF should not be limited to parcels greater than 0.5ha: this gives rise to the confusing category - of "Trees Outside Trees Outside Forests"
4. The use of remote sensing to quantify individual trees and % tree cover in agricultural land and settlements is increasing exponentially: countries in the south could be assisted with these calculations. Tree cover (and biomass) in the FAO-FRA could be estimated using remote sensing outside "forest land" - with potential separation into “cropland” and “grassland” to match the UNFCCC categories.

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