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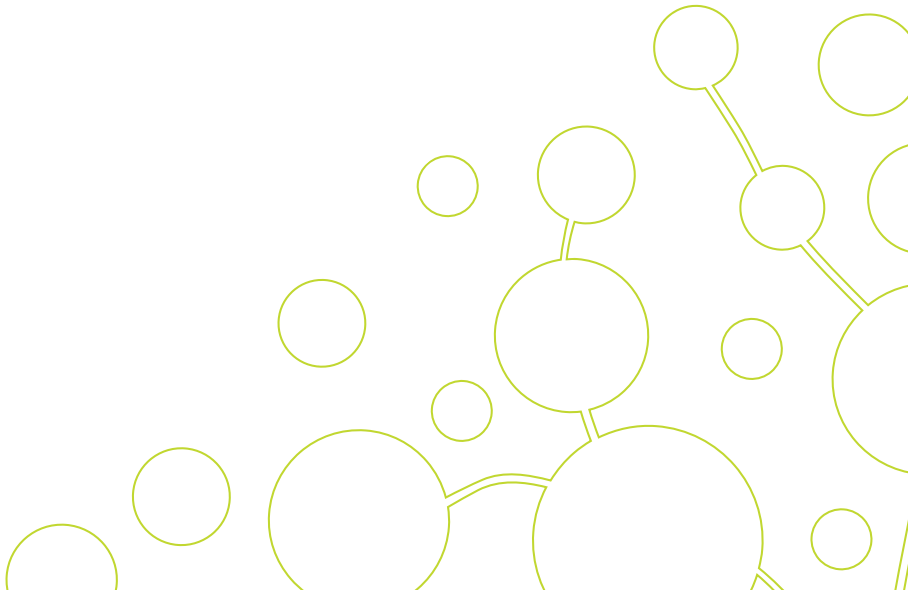
Pilot Study:

Forest Land Degradation Indicator



Forest Land Degradation Indicator

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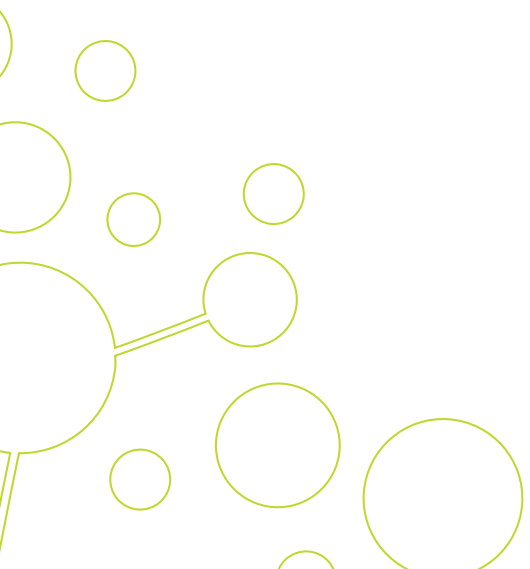

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T.G. Masaryka 22, 960 01 Zvolen, Slovak Republic
liaison.unit.bratislava@foresteurope.org
www.foresteurope.org

Authors:
Matej Schwarz - *FOREST EUROPE Liaison Unit Bratislava*
Rastislav Raši - *FOREST EUROPE Liaison Unit Bratislava*

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The views expressed in this publication are those of authors. The pilot study does not represent position of the FOREST EUROPE signatories.

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1 Background

The FOREST EUROPE Expert Level Meeting (ELM) held in January 2015 decided to start the participatory process of updating the pan-European indicators for sustainable forest management (SFM). Based on this decision, the FOREST EUROPE Advisory Group on Updating the Pan-European Indicators (hereinafter Advisory Group) was established, followed by two meetings in Madrid (11 February 2015 and 10 March 2015). Simultaneously, two online consultations with national focal points and stakeholders were organised. The updating work was accomplished at the workshop in April 2015 and the results, (among other changes) were three new quantitative indicators, namely the land degradation, forest fragmentation and common forest bird species indicators, to be presented at the next ELM in July 2015. The ELM accepted all the presented indicators and suggested these to be included in the updated set of Pan-European Indicators for SFM. Subsequently, this set of **Updated Pan-European Indicators for SFM** was annexed to the Madrid Ministerial Declaration and endorsed by signatories. Within this annex, the indicator 2.5 was complemented with the footnote *"Requires to be further developed and checked under which Criterion (2 or 5) better fits."* This requirement was transformed into the FOREST EUROPE Work Programme as activity 4.2.3. *"Pilot studies on the new indicators (2.5 Forest land degradation, 4.7 Forest fragmentation, 4.10 Common forest bird species) shall be elaborated to determine if data are available and reliable and if the indicators are feasible for reporting".*

The short name of the adopted indicator 2.5 was "Forest land degradation" and the full-text was "Trends in forest land degradation".

The suggestion of the land degradation indicator was inspired by the work of UNCCD[1]; however, when the Advisory Group was discussing the introduction of this indicator into the C&I set, there was no clear idea how land degradation should be incorporated into the whole concept of SFM and to which criterion this new indicator should belong. Similarly, there was no consensus regarding the differences between degradation and damage or between degradation of forest and of forest land. In the document "Background information for the updated pan-European indicators for sustainable forest management" (hereinafter Background document), an initial definition of land degradation (based on UNCCD documents) was suggested for consideration. However, the definition was very broad, overlapping with many other SFM indicators on forest health and vitality or biological diversity), and therefore it required thorough reconsideration and development of a definition more suitable for reporting within the framework of SFM indicators.

All the above-mentioned issues were included into the programme of the FOREST EUROPE Expert Group on Implementation of the Updated pan-European Indicators for SFM (hereinafter Expert Group) and the conclusions were taken into consideration also in this pilot study.

[1] United Nations Convention to Combat Desertification

2 Conceptual Issues

2.1 Land degradation concepts

2.1.1 Initial Advisory Group concept for Forest land degradation

In the process of updating the pan-European indicators for SFM, the Advisory Group in 2015 suggested to adopt the concept being developed by the UNCCD. At the time of the Advisory Group meetings (2015), some metrics based on analysis of remote-sensed variables were considered as a proxy of the Net Primary Productivity (NPP), which was described in the Background document. This method was considered to be appropriate for the areas where fertilization inputs are quite low or non-existent, i.e. also for forests.

With the aim to align this pan-European indicator for SFM on the trends in forest land degradation with the ongoing work of the UNCCD to measure land degradation in the world, the methodology known as "land productivity dynamics" (the World Atlas of Desertification, 3rd edition), was, at this stage, recommended to be considered as possible metric (see below).

The estimated "land productivity dynamics", vegetation condition and its dynamics (i.e. declining, stable or increasing of the land productivity) was initially suggested in the Background document as a good proxy for ecosystem functioning in terms of variations in soil quality, climate influence or human induced land use and land use changes. For each observation point, the standing biomass, being the total biomass of the given area at the moment in time, would be calculated annually, over the entire 1982 - 2018 observation period, using satellite data. This would allow for the calculation of long-term changes and fluctuations in the standing biomass. These changes and fluctuations would be subsequently combined with measures of deviations from the current locally defined maximum productivity levels derived from higher spatial resolution (1x1km) data set from the 'Vegetation' sensors on Europe's SPOT satellites, spanning the period from 2006 to 2010. This combination is the basis to determine land-productivity dynamics. For each 5 x 5 km square, it can be assessed if stable, declining or improving standing biomass dynamics have led to land-productivity conditions at, or below the current local potential. The latter is either natural potential, human land use determined potential or combination of both. Whilst not an absolute measure of land-productivity, this robust approach would provide a consistent, uniformed and repeatable index with which to flag areas of concern, as well as to identify the areas of improvement.

It was considered, that an adequate interpretation of this indicator in combination with National Forests Inventories (NFIs) or other available information (both at regional and national level) related to different degradation processes, and with the information obtained from the other indicators of the Criterion 2, this could help to monitor and assess the health and vitality of forests in Europe.

The data necessary for the implementation of the above mentioned concept and definition would be available from the World Atlas of Desertification (WAD), periodical updates of which were expected every five years (three editions were issued so far, 1992, 1997 and 2018). However, the actual WAD concept differs from the concept described above.

2.1.2 Concept of the World Atlas of Desertification (WAD concept)

The last edition of the WAD, issued in 2018, provides a broad view on the land degradation issue.

Land degradation in the WAD refers to **reduction of land productivity as a result of the overuse or over-appropriation** by humans. This may also include changes in vegetation cover (tree species composition, coppice instead of high forest).

Since land degradation is a global problem, the WAD3 considers all regions of the world and not just dry lands - although emphasis is placed on the latter – and therefore the term 'land degradation' is used in this WAD instead of 'desertification'.

The components included in the WAD are as follows:

- accessibility
- aridity
- inputs to agriculture
- built-up areas
- water stress
- population change
- fires
- income level
- irrigation
- land productivity
- population density
- climate-vegetation trends
- forest loss
- livestock

2.1.3 Land degradation neutrality concept (LDN)

UNCCD concept gradually developed to "Zero LDD concept" (Zero land degradation and desertification - A New Sustainable Development Goal for Rio+ 20[2,3]) or Land degradation neutrality concept. Neutrality is defined as *"a state whereby the amount and quality of land resources necessary to support ecosystem functions and services and enhance food security remain stable or increase"* and its monitoring is to be based on the balance between **the area** of gains (significant positive changes in LDN indicators, i.e. improvements) and **the area** of losses (significant negative changes in LDN indicator i.e. degradation), within each land type across the landscape. The LDN indicators are land cover (land cover change), land productivity (net primary production) and carbon stocks (soil organic carbon).

All these LDN indicators overlap with the existing pan-European indicators (e.g. 1.1 Forest area, 1.4 Carbon stock and 3.1 Increment & fellings). Therefore, there is no need to introduce the LDN indicators into the pan-European set.

[2] *"...the time has come for the international community to commit itself to a land degradation neutral world by setting sustainable development goals on land use, with targets towards achieving **zero net land degradation**."* Africa Consensus Statement to Rio+20", Addis Ababa, 25 October 2011

[3] The United Nations Conference on Sustainable Development (Rio+20) took place in Rio de Janeiro, Brazil on 20-22 June 2012. Its outcome document "The future we want" stated in this respect *"206. We recognize the need for urgent action **to reverse land degradation**. In view of this, we will strive to achieve a **land-degradation-neutral world** in the context of sustainable development."*

The above-mentioned information suggests that the actual LDN concept is based on the assessing the state of particular pieces of land more than on the assessing the processes acting on them. However, this concept still deals with many other aspects of land degradation, for example with particular land degradation processes. Data on these processes could serve as the basis for the process-based land degradation indicator (trends in the selected processes would be assessed instead of the area of the degraded land). For the issues related to this approach see the table below.

Table 1 *Land degradation processes in the LDN concept (from Orr et al, 2017) compared with pan-European indicators for SFM*

Degradation process	Coverage by the existing pan-European indicators for SFM	Notes
Landscape modification	N/A	Landscape modification is related to land use planning. Links with forestry are just indirect.
Water and wind induced soil erosion	Uncovered yet	In sustainably managed forests, soil erosion is limited. It can result from felling, timber extraction and use of machinery, inappropriate forest road maintenance, or from grazing in forests. Many plots eroded in the past by unsustainable agriculture practices are now forested to some extent or designated for (re)afforestation.
Soil surface sealing, compaction	Mostly uncovered (surface sealing by development activities may partially corresponding with indicator 1.1	In forests, the extent of sealed surfaces is limited (paved roads) and unimportant. Severe soil compaction is also not very important in forestry as it is almost exclusively restricted to unpaved roads and roadside landings. Roads, in general, are intended to decrease degradation of the remaining land.
Soil salinisation and alcalinisation	Partially covered by indicator 2.2, however, this indicator relies just on data from sparse grid of plots (ICP Forest Level II)	Even where relevant, forestry cannot be responsible for these processes. Both of them are quite rare and not very important on forest land in the majority of countries.
Soil acidification	Partially covered by indicator 2.2, however, this indicator relies just on data from sparse grid of plots (ICP Forest Level II)	Acidification, due to "acid precipitation", is quite widespread, however, nowadays slow and not very relevant. Forestry cannot be in this case responsible (even where relevant).

Degradation process	Coverage by the existing pan-European indicators for SFM	Notes
Soil fertility decline	Partially covered by indicator 2.2, however, this indicator relies just on data from sparse grid of plots (ICP Forest Level II)	In general, forestry causes soil fertility decline (some nutrients are withdrawn), but the process is usually too slow to be monitored. It progresses in steps (after each felling) followed by periods of slow recovery of nutrients. In forestry, the process may be important mainly in short-rotation plantations (see also nutrition mining in the WAD concept).
Soil contamination	Uncovered yet	Many times, it is related to acidification or alkalinisation. Forestry is usually not responsible for this process.
Soil extraction	Uncovered yet	Unimportant in forestry
Aridification	Uncovered yet	As aridification refers to climate, responsibility of forestry for this process is very limited (though sometimes discussed).
Decline in vegetation cover	Partially covered by indicator 1.1, if also density of vegetation is considered, then also indicators 1.2, 2.3 and 2.4 may be interpreted in this respect.	"Decline" probably refers to the area covered by any vegetation, which represents the areas heavily damaged by unsustainable practices (in this case the indicator is equal to Mountain Green Cover Index - SDG Indicator 15.4.2). If it means also decline in vegetation density (e.g. interception capacity), unstocked areas and coppice stands could be considered to be degraded, however, reasonable thresholds would then be needed. **In the second case, the process refers more to degradation of forest rather than of land.**
Decline in vegetation cover functioning	Uncovered and probably N/A	Definitions of "decline" and "functioning" are probably missing. Probably it is just a theoretical concept **referring more to the degradation of forest rather than of land.**
Decline in biomass	Almost completely covered by the indicator 1.2 (calculation of biomass from growing stock is probably the most accurate and feasible way of biomass monitoring).	Decline probably refers to volume or biomass weight. In forestry, in general, decrease in biomass volume (due to felling) is usually just temporary and fully recoverable. Therefore, it makes no sense to consider it as degradation. **Even permanent decline in biomass may refer to forest degradation not that of land.**

Degradation process	Coverage by the existing pan-European indicators for SFM	Notes
Decline in biodiversity	Covered by 10 pan-European biodiversity indicators, however, not on **the level of a single plot**. Assessment of biodiversity on each plot would not be feasible.	There are several ways of assessing biodiversity, each of them producing different results, e.g. simple species diversity in a region, assessment of populations' dynamics of each or selected species, assessment based on biodiversity proxies, etc. Assessment of biodiversity on the site level is even more controversial (it is unclear, what to consider as the minimum area for a reasonable assessment).
Depletion of seed bank	Covered by indicator 4.6	This "process" is applicable just to a country or a region, not with a single plot.
Increase in weeds	Uncovered yet	**This process refers more to the degradation of forest rather than of land (soil).**
Increase in invasive species	Only invasive tree species are covered (indicator 4.4)	**This process refers more to the degradation of forest rather than of land (soil).**
Habitat loss	Uncovered yet	Just a theoretical concept without any practical implications. Any change of land use or crop means the gain of some habitat at the expense of another. However, such a change can be positive, negative or neutral; it should not be automatically considered as degradation. On top of that, degradation of biota does not necessarily mean degradation of land. **Even if negative, this process refers more to the degradation of forest rather than of land.**
Hydrological modification	Uncovered yet	"Negative" change of water regime undoubtedly is a form of land degradation, while "positive" change is not. Sometimes hydrological modification can result from forest management but not often.
Change in ground water level/quality	Uncovered yet	This "process" is just a form of the previous one.

2.1.4 ITTO concept

During its meetings, the Expert Group on Implementation of Updated pan-European Indicators for SFM accepted to get inspiration from the concept developed by the International Tropical Timber Organization[4] (ITTO). Understanding of the process of degradation of forests and forest land have been developed to suit the situations of countries with tropical forests. However, some of the ideas, definitions and categories are suitable also for forests in temperate and boreal regions.

According to the ITTO (2015), SFM means that multiple objectives and needs are *met without degrading the forest resource*. Intentional changes in forest ecosystem made in order of timber (or non-wood goods) production are not considered as degradation unless the management employs unsustainable practices. This makes the general concept of SFM and the ITTO concept of land degradation complementary.

This concept recognises several categories of forests based on varying degree of management intensity or degradation processes:

- Undisturbed/unmanaged natural forest (i.e. undisturbed-by-man according to FOREST EUROPE categories),
- Managed natural forest,
- Degraded natural forest,
- Secondary forest (successional forest),
- Degraded forest lands (presently unstocked and, due to soil degradation, extraordinarily difficult to re-establish stocking).

In the above list, degraded forest land represents the highest degree of forest land/soil degradation, as well as the final stage of natural forest degradation.

This concept of forest and land degradation is closely related to the idea of restoration of degraded forest and land. Forest restoration is expected to be achieved by natural regeneration enriched/supported by planting of missing species. Degraded land should be restored by planting, including the use of agroforestry systems or the method of improved fallows (ITTO 2016). There are also links between degradation concept as well as measures and provisions that are being applied to prevent degradation of forest soils (maintenance of soil productivity) and water (maintenance of water retention capacity) in managed forests.

[4] The International Tropical Timber Organization (ITTO) is an intergovernmental organization promoting sustainable management and conservation of tropical forests and the expansion and diversification of international trade in tropical timber from sustainably managed and legally harvested forests. Similarly to FOREST EUROPE, ITTO acts as C&I process.

Figure 2-1 *Links between ITTO forest categories (from ITTO 2016)*

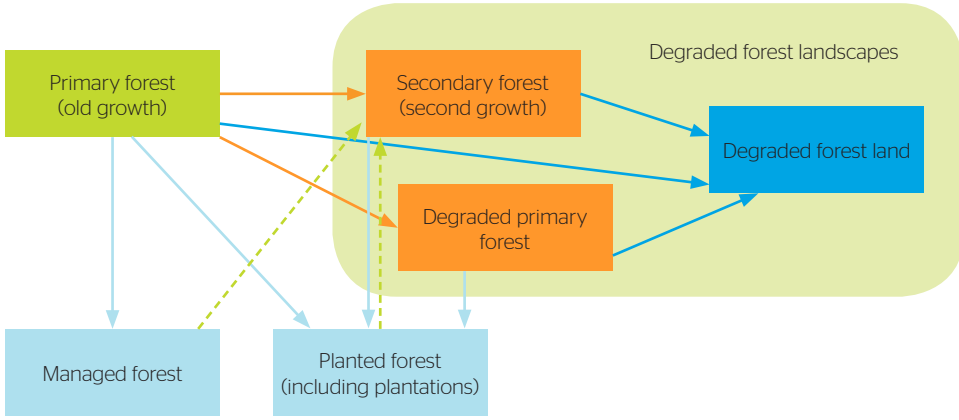


Table 2 *Definitions of the above categories (ITTO 2016) are as follows:*

Primary forest	Forest that has never been subject to human disturbance, or has been affected by hunting, gathering and tree-cutting so little that its natural structure, functions and dynamics have not undergone any changes that would exceed the elastic capacity of the ecosystem.
Managed/modified natural forest	Natural forests managed or exploited for wood or non-wood forest products, wildlife or other purposes. The more intensive the use, the more that forest structure and composition is altered compared with primary forests. Ecologically, such alterations often represent shifts to earlier successional stages. Two major categories can be distinguished: managed primary forest, and **degraded** & secondary forests.
Planted forest	A forest stand established by planting or seeding. Note: this category includes both planted forests and forest plantations.
Secondary forest	Woody vegetation re-growing on land that was largely cleared from its original forest cover. Secondary forests commonly develop naturally on land abandoned after shifting cultivation, settled agriculture, pasture, and failed tree plantations.
Degraded forest	Forest that delivers a reduced supply of goods and environmental services from a given site and maintains only limited biodiversity. Degraded forest has lost its structure, function, species composition and/or productivity normally associated with the natural forest type expected at that site.
Degraded forest land	Former forest land severely damaged by excessive harvesting of wood or non-wood forest products, poor management, repeated fire, grazing or other disturbances or land uses that damage soil and vegetation to a degree that inhibits or severely delays the re-establishment of a forest after being abandoned.

List of factors leading to land degradation includes repeated over-harvesting, repeated forest fires and overgrazing. Shift to secondary forest may be induced by the clear cut without subsequent regeneration of main (climax) tree species while pioneer species are regenerating. Degraded forest may result from similar factors as degraded land, but of lower intensity.

On the contrary, both managed categories (managed forests and planted forests) result from intentional management and, therefore, they are not a priori considered as/degraded.

2.2 Developing the land degradation definition

2.2.1 Limitations of the existing concepts

The **original UNCCD concept** (considered by the Advisory Group) was very broad and process-based. It was, at least theoretically, based on almost any type of degradation (e.g. erosion, climate change, depositions of pollutants, acidification, soil compaction and nutrient exhaustion, even the changes in vegetation cover resulting from cyclic management or natural forest succession cycle); however, no thresholds for particular types of degradation were defined. Without defined thresholds, practical application of the definition would be quite subjective, depending on countries' traditions. From this viewpoint, almost all European forests/forest soils could be considered as degraded to some degree, at least by logging in the past or by deposition of pollutants, which makes the definition unsuitable for SFM indicator.

There are also several reasons why the information provided in **the World Atlas of Desertification (WAD)** is not very relevant for land degradation monitoring within the framework of the Pan-European Criteria and SFM indicators:

1. The WAD concept of land degradation (i.e. what is considered as degrading or degraded) is very complicated, quite disputable and incompatible with the concept of SFM. Within this concept, virtually all human-induced changes of ecosystems are considered to contribute to land degradation, including, for example, intentional development activities (urban development, conversion to more intensive land uses, conversion of (semi-)natural forests to plantations . These intentional activities (e.g. land use changes, establishment of plantations) are considered equally degrading as unplanned mismanagement, disasters or unfavourable natural processes. Such an approach is legitimate for monitoring trends in soil resources and biodiversity; however, it is quite incompatible with the concept of SFM that primarily focuses on management and considers some of the above mentioned processes unrelated to forestry or being a part of sustainable forestry.
2. The WAD does not contain any map of land degradation per se; it contains just a variety of information somehow related to land (and vegetation) degradation issue, including information on demography and globalisation of economy. Therefore, one single indicator of land degradation would need to be substituted by a set of "sub-indicators" describing somehow the latest development in land degradation in the signatory countries[6]. Incorporating another equal complex would complicate the actual/ already established SFM concept. The interpretation of some maps in WAD concept is unclear.

[5] *The replacement of natural forests by industrial tree plantations **may be seen** as a deterioration of forest ecosystems* (WAD, page 128)

[6] In some respect, FOREST EUROPE (and other C&I processes) is facing the same issue while monitoring SFM – no forestry sustainability map exists.

There is, for example, the Protected Areas chapter included in the atlas, in spite of having no direct link with land degradation. The land in protected areas may be both degraded/degrading and not degraded. Interpretation of this map includes sentences such as *"Human activities are a threat to more than half of the protected land"* (page 186), which may be correct from nature conservation viewpoint, however, these activities definitely do not mean the same as the land degradation (or desertification).

3. The maps for many important degradation processes explicitly mentioned in the WAD are still not included in it, for example, there are no maps for:
   - *nutrient mining* (agricultural and forestry practices resulting in negative nutrient balance),
   - *surface sealing* (the most intense form of *"land take", almost an irreversible process*),
   - *soil pollution,*
   - *soil biodiversity loss,*
   - *soil compaction,*
   - *landslides,*

   Anyway, there are some references to other atlases that may contain some related information (but definitely not all).

4. The WAD maps predominantly characterise other ecosystems rather than forests and forest land.
   a. Only a very small part of WAD maps focuses on forests (namely "Impacts on Global Forests" pages 36-37 *depicting tree loss*[7]), but even those maps do not show forest borderlines and thus complicate map's interpretation from the SFM viewpoint (e.g. the Sahara is on the map coloured as being "without tree loss").
   b. Some maps would be relevant for forests and forestry (e.g. Soil Erosion 'accelerated by human actions' pages 98-99[8], Net Primary Production pages 108-109, Land Productivity Dynamics pages 114-115[9]), however, missing forest borderlines allow just a rough estimate[10], if these degradation processes occur on forests land or only on other land types.
   c. Majority of maps depict data that are not directly linked to forestry.

[7] „Tree loss" means *decline in tree cover, if observed in any 30 m² pixel contained within each 1 km² pixel. The change in tree cover is derived from satellite observations at 30 m resolution (per year)* (WAD, page 145). This approach means that only losses are summarised and they are not compared with tree gains in other pixels.

[8] *Despite the reference to the erosion accelerated by human actions, the map provides just a rate of water erosion that does not distinguish between natural and man-accelerated erosion (e.g. large areas in the Alps are coloured as with high erosion). The scale issue is illustrated by the fact that similar areas in the Carpathians are neglected because they are smaller and so continuous.*

[9] WAD Land Productivity Dynamics categories are *Persistent severe decline in productivity, Persistent moderate decline in productivity, Stable, but stressed; persistent strong inter-annual productivity variations, Stable productivity, Persistent increase in productivity.* Major part of the pan-European region has an increasing or stable productivity, a decline was mapped only in dry regions of Spain, Hungary, Ukraine, Romania, Moldova and Russia. However, it is disputable whether these lands should be considered as degraded or they result from climate change and water deficit.

[10] The absence of forest borderlines influenced also the elaboration of particular maps (e.g., in majority of maps, particular 1 km² pixels were calculated regardless the proportion of forest in them), which cannot be solved by simple cropping a map by the countries' forest borderline.

5. The WAD concept is incompatible with relevant definitions used in the SFM concept, for example:
    a. Instead of the FRA forest definition, the WAD introduces its own forest definition: *"the term 'forest' is used to indicate the 'tree cover extent' mapped in the dataset"* (page 144) and *"forests are areas where more than 40 % of each grid cell (1 km2) is covered with trees"* (page 182). See also the scale issue (chapter 2.2.8).
    b. WAD maps do not distinguish between permanent deforestation and forest regeneration. For example, in the map "Impacts on Global Forests" pages 36-37, majority of *tree loss*[7] in Europe is just temporary, resulting from felling and regeneration. This is, for example, easily visible in North American and Scandinavian countries.
    c. WAD suggests that the replacement of natural forests by plantations or managed forests can be understood as degradation.
    d. The term "ecosystem services" is used as a synonym of non-provisioning ecosystem services and there is a dichotomy between timber production and non-provisioning services, while SFM concept considers timber production to be an important ecosystem service.
6. In spite of declaring WAD's focus not only on desertification but any land degradation instead, there is still some bias towards droughts, dryland and other characteristics linked with desertification.
7. Reliability of data and scale of maps is mostly not comparable with forest data from NFIs or forest stand inventories, and therefore insufficient, especially for small countries.

A possible pan-European land degradation indicator based on Land degradation neutrality concept (LDN) would be a complex indicator, partially based on qualitative/descriptive or even missing data. Only a small part of its components would be strictly quantitative. The calculation of such an indicator would be quite subjective and complicated.

To make land degradation concept applicable to practical forestry and forest certification of forest management, the indicator needs to be applicable on a single forest stand. However, some of the LDN processes are applicable (or monitored) just at the country/regional level, without direct relevance for forestry and its sustainability. Some of these processes are of low relevance in the context of forest management practices in Europe.

ITTO approach is fully compliant with the concept of SFM (both global and Pan-European). Intentional changes made in order of timber (or non-wood goods) production is not considered as degradation unless they include unsustainable practices. Degradation results from unintentional side effects of (mis)management or from natural degradation processes.

There are several ways of defining land, land degradation and trend in (land) degradation. We need to choose the most suitable definition to be used within the set of Pan-European C&I of SFM.

The definitions of degradation and trends in degradation may be based on the assessment of degradation processes affecting the respective piece of land or on the assessment of the land pattern resulting from these processes. In the first case, various measurement units characterising the intensity of processes would be used, in the second case, the area of degraded pieces of land would serve as the only measure of degradation (in this case, characterising of degraded lands would be crucial).

The definition of land may include only soil (at most together with water regime) or it may include also vegetation cover on the respective land. Assessment may be conducted at various scales, and put to various contexts.

The following subchapters provide analyses of these options.

2.2.2 Intensity of degradation processes versus the extent of degraded areas

The full-text of the indicator (trends in land degradation[11]) can be interpreted in two ways. Land degradation can be assessed through the assessment of a number and intensity of relevant land degradation processes (as, at least partially, suggested in UNCCD Land Degradation Neutrality Concept), or through monitoring degraded land area resulting from these processes, either still continuing or finished (as suggested in ITTO and WAD concepts). Both these methods have some advantages and disadvantages.

The **assessment of particular degradation processes** acting upon the land (whatever it is/may be) represents more direct method of assessment. It is (theoretically, if our knowledge and data are sufficient) a sensitive method, allowing identification of a progressing degradation long before its results are apparent.

On the other hand, any assessment of this type would require having defined a reasonable threshold for the intensity of each particular process. Many of the well-known degradation processes occur almost inevitably at any piece of land but, without such thresholds, it would only be possible to count them. Assessing the number of degradation processes, however, would not be a sufficient measure of land degradation because it is indisputable that one intensive important process may outweigh many less important or less intensive processes. On top of that, defining the *acceptable intensity* of certain process may be more a matter of political agreement than of science. In some cases, identifying the balance between degradation and (progressive) evolution of some characteristics of ecosystem may provide basis for defining such a threshold but, in many others, this approach would be misleading. For example, sustainable soil erosion should not exceed the creation of new soil by weathering or depositing.

[11] *See Background information for the updated pan-European indicators for sustainable forest management at https://foresteurope.org/wp-content/uploads/2016/10/3AG_UPI_Updated_Backgr_Info.pdf*

However, in the case of, for example, soil acidification, there is no such a reasonable basis[12] and balancing between "degradation" of some soil properties by timber removals and environmentally positive impacts of timber use would be even more complicated.

Majority of **degradation processes are very difficult to be monitored** and, therefore, the data available for large-scale level (for whole countries and pan-European region) are usually insufficient. Compared to relative rarity of severely degraded plots, the surveys such as ICP Forest, with just several plots for a smaller country, have only a limited chance to record all important degradation processes occurring in a particular country. NFIs usually do not monitor this aspect of forests' state and even their grids would be for this purpose insufficient.

The assessment of **trends in the area of** (severely) **degraded forest land** allows focusing on the undisputable results of degradation processes. In forestry practice (e.g. national forest inventories, stand inventories), monitoring of the area of degraded land should be more feasible/less complicated than monitoring of "invisible processes". However, as degradation processes are usually slow, the five-year-changes in the area of degraded land will also be very small and difficult to monitor and interpret. This type of assessment requires a proper definition of the degraded land.

In many countries, the forest land degraded in the past (e.g. by overgrazing or mining) may be now considered as non-forest land.

Gradually, the UNCCD concept has developed to **Land Degradation Neutrality Concept**, in which land degradation neutrality (LDN) is defined as *"a state whereby the* ***amount and quality*** *of land resources necessary to support ecosystem functions and services and enhance food security to remain stable or increase"*. This definition suggests assessing the state of particular pieces of land rather than assessing the processes acting on them.

2.2.3 Forest land as a subject of degradation monitoring

When the Advisory Group was discussing this indicator, the participating experts suggested that the proposed indicator was intended only to monitor forest land degradation, not forest degradation. The reason was that it was expected to assess/monitor this easier than to conduct a complex assessment of degradation of all forest ecosystem components (e.g. productivity of tree component expressed in yield classes, log grades, biodiversity, etc.). (Possible) Degradation of a tree component and biodiversity was considered being already monitored with the use of many other Pan-European indicators. However, the Advisory Group suggested no definition of "land" for the purpose of this indicator. Blum (in Jones, Montanarella (eds.), 2003) says that *"Land is more than soil and comprises topography (landscape), soil cover[13], as well as aquatic elements such as for example small lakes and rivers, which exist on land"*.

[12] Soil development naturally has some degradative aspects. Long evolution of soils necessarily leads to less productive acid soils.

[13] Soil cover does not mean vegetation cover as a whole, it can be understood as a part of vegetation and/or litter directly covering soil surface.

Soil represents an important component of land but it is not equal to land. According to this source, within a framework of the land degradation concept, land and soil can be considered to be almost synonyms.

UNCCD definition in the Article 1 (e) says: *"land" means the terrestrial bio-productive system that comprises soil, vegetation, other biota, and the ecological and hydrological processes that operate within the system"*. This understanding does not distinguish between forest and forest land and thus it is too broad for the C&I purposes as it overlaps with many already existing pan-European indicators. The UNCCD concept includes not only the degradation of soil but also the degradation of vegetation cover and much more (see also Orr et al 2017).

All definitions exceeding the scope of soil and soil water are, for the purpose of this indicator, too complex and thus incompatible with the actual concept of SFM indicators. We need to define this indicator properly to make it compatible with the entire already existing pan-European set. A new indicator should not be based on the synthesis of many existing pan-European indicators (see the chapter 2.1.3) and even of few new ones.

Despite all the above-mentioned ambiguities, it is usually possible to identify degraded land. However, as the most-degraded (forest) land is actually without any tree cover (see the chapters 2.1.4 and 2.2.4), it may be far more complicated to identify, which part of it is the former forest land and which part should be considered as forest land (e.g. because of the planned afforestation).

2.2.4 Legal status of forest land and land use change

Many degraded areas result from, for example, unsustainable agriculture in the past and thus they may still be considered as agricultural land or, depending on national legislation, they may be assigned for afforestation/restoration and considered to be forest land.

In general, national legislation on land categories may allow considering as forest land:

1. any degraded land that could potentially host a forest, or
2. any degraded land officially assigned for afforestation and degraded land that has to be reforested (i.e. "permanent forest estate" as defined by FAO FRA).

UNCCD concepts and WAD maps consider the entire Earth surface to be land (there is no special focus on forests and forest land), including areas being covered by buildings or infrastructure for a long time. This approach results in considering all these areas as "degraded".

If the country's land should be categorised to be both a forest and a non-forest land, (as it is the case of all other pan-European indicators), it becomes unclear, which category of the degraded land without any tree cover for many years should belong into the category of degraded forest land. Especially in case if this land was degraded when used as non-forested land (e.g. due to overgrazing of grasslands).

Forest sector organisations and institutions, which are usually involved in pan-European

reporting on C&I of SFM, do not necessarily have the access to sufficient information on degraded pieces of land outside forests and/or of official forest land. Only if systematically collected for a specific purpose, information may be available, e.g. information on degraded land officially designated for afforestation.

Even if the maps are produced for the entire land, these overlap with some official forestland map, the pixels used for the production of the WAD maps would still not be identical with forest pixels and the methods of their analyses would not be tailored for forests.

2.2.5 Forest land degradation vs. forest degradation

In forestry, the terms forest and forest land are usually not considered as synonyms, whereas in the UNCCD and WAD concepts they are (according to the definitions used in both these concepts). Whether the difference between forest and forest land is clearly defined or not, degraded forest and degraded forest land traditionally mean principally different categories.

These categories may overlap (e.g. soil may be considered as a part of forest ecosystem) but, in that case, forest degradation is a broader term than land degradation. Forest degradation includes changes in tree component that are traditionally not considered to be land degradation, such as adverse change in tree species composition, coppicing, poor tending practices, etc. In the context of traditional forestry terminology, the term "land degradation" should refer rather to site conditions than to forest stand quality. This concept would fit the purpose of new SFM indicator in the Pan-European set.

The difference between these two types of degradation should be unambiguous from the definitions of forest and forest land. Both ITTO definitions[14], those of degraded forest and degraded forest land, match this criterion.

2.2.6 Need for restoration as a criterion defining degraded land

ITTO defines degraded forest land as former forest land without tree cover, restoration of which is significantly hampered. In other words, this means that, instead of common afforestation practices, more intensive measures are required. Such measures are traditionally called restoration, reclamation or rehabilitation. Therefore, it is possible to say that the need for such measures means (helps to identify) that the land was degraded.

The terminology of restoration activities used by UNCCD is explained in the following paragraphs.

[14] ITTO: **Degraded forest:** Forest that delivers a reduced supply of goods and environmental services from a given site and maintains only limited biodiversity. Degraded forest has lost its structure, function, species composition and/or productivity normally associated with the natural forest type expected at that site.

ITTO: **Degraded forest land:** Former forest land severely damaged by the excessive harvesting of wood or non-wood forest products, poor management, repeated fire, grazing or other disturbances or land uses that damage soil and vegetation to a degree that inhibits or severely delays the re-establishment of forest after abandonment.

The Society for Ecological Restoration defines ecological restoration *as the process of assisting the recovery of an ecosystem that has been degraded, damaged or destroyed.*

Restoration represents *a way of reversing degradation processes* and increasing the contributions of ecosystems and landscapes to livelihoods, land productivity, environmental services and resilience of human and natural systems. The term "restoration" covers a wide range of conservation, sustainable management and **active restoration practices** that increase the quality and diversity of land resources, thus enhancing ecological integrity and human well-being (FAO, 2015).

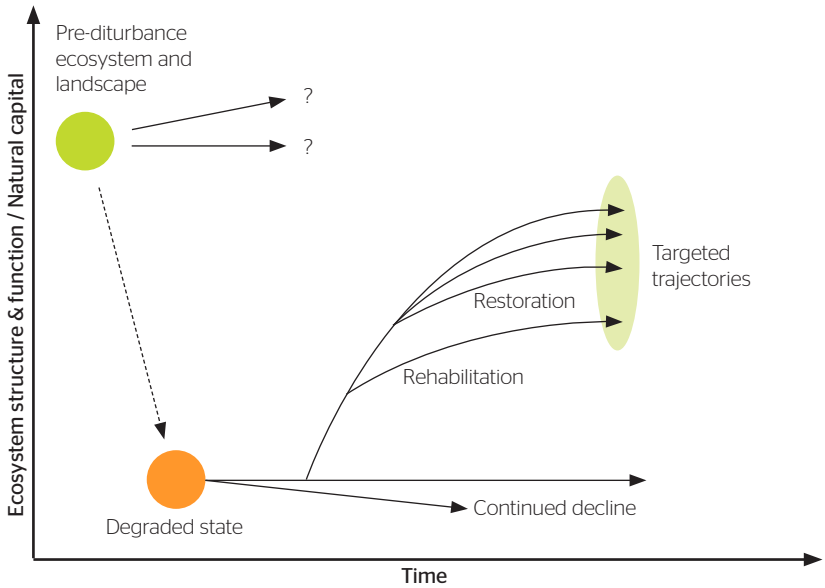
According to UNCCD (Orr et al 2017), **restoration** means *"the process of assisting the recovery of an ecosystem that has been degraded* (Society for Ecological Restoration International Science and Policy Working Group, 2004 & McDonald et al., 2016). *Restoration seeks to re-establish the pre-existing ecological structure and function, including biotic integrity.*

According to UNCCD (Orr et al 2017), **reclamation** means *"actions undertaken with the aim of returning degraded land to a useful state. While not all reclamation projects enhance natural capital, those that are more ecologically-based can qualify as rehabilitation or even restoration"* (adapted from Society for Ecological Restoration International Science and Policy Working Group, 2004).

In the same source (Orr et al 2017), **rehabilitation** means *"actions undertaken with the aim of reinstating ecosystem functionality, where the focus is on provision of goods and services rather than restoration"* (adapted from McDonald et al., 2016).

Figure 2-2

Options for reversing land degradation



Adapted by Orr et al. (2017) from: McDonald et al., (2016); Society for Ecological Restoration International Science and Policy Working Group, (2004); Hobbs & Norton, (1996); Aronson et al., (2007).

2.2.7 Intentional versus unintentional changes of land

According to some land degradation definitions (such as those by UNCCD and WAD), any "negative change" accompanied by a loss or a reduction of biological productivity and complexity can be considered as land degradation. The list of such changes includes, for example, soil sealing resulting from road or buildings constructions, land use change from forestry to agriculture, conversion of semi-natural forest to forest plantation, forest regeneration (i.e. the change from mature forest to clearing), etc. forest management and, therefore, it could not be adopted for SFM indicator. Forest land degradation definition for the purpose of SFM indicator should distinguish between intentional and unintentional changes in forest ecosystems. For example, temporary reduction of woody biomass and changes in biodiversity due to felling should not be considered degradation equally to, for example, unintentional adverse change of site conditions due (mis) management or resulting from climate change, air pollution, etc.

The need for restoration can be also be used to distinguish between degradation and sustainable management practices (plantations or young forest stands do not need restoration, at least not from the viewpoint of forestry; see also the chapter 2.2.6).

From this viewpoint, the ITTO concept (see above) is applicable to SFM better than other concepts of land degradation. In this concept, conversion to (sustainably) managed forests and establishment of plantations is not considered as degradation (though these forest stands can be degraded by other factors such as climate change, air pollution, mismanagement). Accordingly, this concept does not focus on built-up areas or conversion of forest to other land uses.

2.2.8 Scale issue – inventory plot level vs. whole-country level

If degraded areas are too small and scattered compared to the grid of forest inventory plots of feasible density, these cannot be inventoried by the standard NFI method. In such case, the area of degraded land can be calculated only as the sum of each known degraded area in the country. If degraded land in the given country is rare (degraded area represents just a small part of country's land), direct measuring (e.g. by forest managers or forest stand inventory crews) would be feasible. Remote sensing (in case of small degraded areas especially aerial photography) can be employed as well.

Statistical inventory of degraded land becomes effective only when detectable by inventory grids with sufficient statistical precision. In majority of countries in the pan-European region (probably except for Southern parts of Europe), degraded forest land is too rare to be monitored, within a framework of the existing national forest inventories. The same principle applies to the extent of annual change. The larger differences between two years (or two reporting cycles), the smaller density of inventory plots is required.

Using both the above-mentioned methods, signatory countries could report the total area of degraded plots (using predefined thresholds for their size and level of degradation) without measuring of ongoing degradation processes.

Monitoring of degradation processes (necessary for the UNCCD approach) would be much more demanding. Theoretically, these processes could be monitored through specialised monitoring plots and their combination with remote sensing. It is necessary to realise that degradation processes identified on these plots could never result in any degraded piece of land (due to their low intensity). Sampling design could cover the entire country's territory or only areas prone to degradation, which could increase effectiveness. However, even such monitoring may be almost unfeasible due to lack of suitable methods (and low accuracy of methods in place) for monitoring particular processes.

2.2.9 Time framework

From the policy viewpoint it may be important to decide if all degraded land regardless the date of degradation, or only recently degraded land should be reported. Both options have some political connotations. In some countries, due to their long history of land use, the area of old degraded pieces of land may be rather large.

Even the approximate information on the time when the area was degraded would extend our knowledge on land degradation and it should be understandable from the reported time series, e.g. all degraded forest areas occurring before the first reporting year and remaining degraded in that year to be included in reported figures. Similarly, recovered forest land should be reported cumulatively.

Considering all degraded areas regardless their age may bring an additional problem. Some degraded pieces of land being without human influence for a long time may be very difficult to distinguish from the areas with *naturally* shallow or stony soils, natural screes, etc.

The Expert Group discussed the possibility to report only the areas degraded during the last reporting cycle; however, as the degradation processes are usually very slow, this approach was found to be unrealistic.

2.2.10 Degradation versus damage

The Advisory Group suggested that the difference between forest (land) damage and degradation could be unclear and definitions of these terms required to be further developed.

In English, *degradation* and *damage* can be understood almost as synonyms. Degradation refers more to a (long-term) trend; damage refers more to an event. A series of damages can cause a long-term degradation. However, many times the results (i.e. degraded forest or degraded land) of one serious damage or gradual long-lasting degradation may be the same.

In forestry, understanding both terms is related to the already developed terminology:

- Damage can be attributed both to a single tree (it is usually related with tree health condition) and to the area (e.g. a damaged forest stand), while degradation is always assigned to an area (some trees within a degraded area of forest can be even healthy).
- A forest with all trees killed by wind or pests is traditionally considered to be damaged, not degraded.
- A forest with bark-stripped trees is usually considered as damaged, not degraded, despite long-term (at least mid-term) consequences of such damage.
- Damaged forests can recover without any measures exceeding the "normal forestry" (such as tending or regeneration). In the worst cases, regeneration of premature forest stand is sufficient. Degraded forests naturally recover very slowly and special restoration measures (e.g. technical measures, repeated planting, planting combined with suppression of undesirable vegetation) can speed up this process.
- Eroded soils designated for afforestation, many times resulting from unsustainable agriculture practices (especially overgrazing), are traditionally considered as degraded (forest) land.
- As apparent from the FAO FRA 2020 reporting, official definitions of degraded forest (stand) are quite rare among FOREST EUROPE signatories. However, based on discussions in the Expert Group, some countries considered coppice stands and stands of "less valuable" tree species degraded.

Note: FAO (2016) suggests (with a question mark) to use the area of forests with "partial canopy cover loss" as a proxy for forest degradation (i.e. not land degradation). This area would be identified via remote sensing. However, it is often unclear whether the canopy cover loss represents degradation or only damage. Canopy cover loss may result from the degradation of soil, but it can also be caused directly by damaging agents such as windstorms that are traditionally considered to be damage, not degradation. In addition, forests in certain stages of forest regeneration have necessarily reduced canopy for certain time (several years, exceptionally decades) to enable natural regeneration, though this reduction is considered as positive (neutral, at most).

2.2.11 FOREST EUROPE definition of land degradation

The definition of land degradation suitable for pan-European C&I purposes should meet several criteria:

- it should be pattern based (due to feasibility reasons, see chapter 2.2.2), "trend in degradation" should mean the trend in area of degraded land;
- it should focus only on the characteristics of land (e.g. soil and soil water regime), not on vegetation-cover characteristics;
- as for degraded land matching the definition should be related to forest management or, at least, degraded areas (including those degraded by external factor or by other land uses) should be designated for reforestation (afforestation);

- it should include all the processes and/or land characteristics resulting from forest mismanagement and/or from adverse impacts of the changing environment (e.g. climate change, deposition of pollutants, etc.);
- intentional forestry activities, such as forest regeneration, establishment of plantations and development of forest road network should not be considered as degradation, unless they generate evidently degraded soil/land;
- intentional changes such as land use changes, urban and infrastructure development should not be considered as degradation[15].

The very first attempt to formulate the definition of forest land degradation was made in the document "**Background information for the updated pan-European indicators for sustainable forest management"**. This preliminary definition was based on the UNCCD Article 1 (f):

"According to the definition of land degradation as established in the text (article 1) of the UNCCD, "forest land degradation" can be understood as a ***reduction or a loss of biological or economic productivity and complexity of forest and other wooded lands resulting from land use or from a process or combination of processes, including processes arising from human activities and habitation patterns such as:***

1. ***soil erosion caused by wind and/or water;***
2. ***deterioration of the physical, chemical and biological or economic properties of soil and***
3. ***long term loss of natural vegetation".***

As apparent from the comparison at the footnote[16], the entire adaption consisted only of dropping all the references to climatic aridity (because these references restricted the geographical scope of the definition) and to ecosystems other than forests from the original UNCCD definition. However, this did not create definition compatible with the pan-European set of C&I, because:

- The UNCCD definition is too broad. As degradation, it considers not only changes in soil (land) properties but also (undefined) changes in "natural vegetation" and (undefined) "biological productivity and complexity". In other words, according to this, any change of ecosystem towards a less natural state would be considered as "land degradation". On top of that, these changes are being monitored via other SFM indicators, such as indicators of the criterion 1 (forest resources), 2 (forest health and vitality) and 4 (biodiversity).
- The UNCCD definition is process-based; however, it is quite disputable whether this approach is suitable for C&I purposes. The assessment of degradation processes would require reasonably defined thresholds for the intensity of particular processes. Otherwise, degradation would be "identified" in almost all forests.

[15] Of course, this type of information (e.g. land transition matrix) would be desirable to improve the knowledge on trends in land management, but it should not be interpreted as land degradation.

[16] UNCCD, Article 1 (f): "land degradation" means reduction or loss, **in arid, semi-arid and dry sub-humid areas**, of the biological or economic productivity and complexity of **rainfed cropland, irrigated cropland, or range, pasture**, forest and woodlands resulting from land uses or from a process or combination of processes, including processes arising from human activities and habitation patterns, such as: (i) soil erosion caused by wind and/or water; (ii) deterioration of physical, chemical and biological or economic properties of soil; and (iii) long-term loss of natural vegetation.

In the World Atlas of Desertification (JRC, 2018), even a broader definition of land degradation (as given by the Millennium Ecosystem Assessment) is used:

Land degradation leads to a long-term failure to balance demand for and supply of ecosystem goods and services. Essential goods and services include food, forage, fuel, building materials, fresh water (for humans and livestock, for irrigation, sanitation), control of agricultural pests, nutrient cycling, purification of air and water, the moderation of extreme weather, biodiversity and cultural and recreational benefits.

Again, this definition was too broad in scope, trying to cover almost all aspects of negative changes in vegetation cover and/or land use, not only changes in the quality of land. Some of the listed ecosystem services can be considered as competing one another, and their realistic evaluation should be based on the concept of an "ideal balance". However, the methods assessing the balance between, for example, changes in biodiversity and timber production are far from being developed and generally accepted.

For the above mentioned reasons, the Expert Group on Implementation of the Updated pan-European Indicators for SFM agreed to develop a FOREST EUROPE's own definition of Forest land degradation, that would be more suitable for the Pan-European set. LUB suggested to employ and further develop the ITTO concept of forest and land degradation, in which "*degraded forest land means* ***former*** *forest land severely damaged by excessive harvesting of forest products, poor management, repeated fires, grazing, etc., with soil and vegetation damaged to a degree that severely delays the re-establishment of forest after being abandoned*". This concept was (though with some reservations) accepted and the wording further developed.

FOREST EUROPE definition of degraded forest land used for the pan-European reporting 2020:

Forest land severely damaged, e.g. by the desertification, fires, grazing, air pollution, erosion, unsustainable management, etc., that lost tree cover and with soil damaged to such a degree, that severely hampers or delays the re-establishment of stocking.

Note: **After stocking is re-established, the area can still be considered as a degraded forest, but not degraded forest land.**

This proposed definition is area-based (not process-based) and restricted to worst cases of land degradation. It does not include any land with forest cover, regardless of the fact whether soil productivity is decreased or not.

3 Questionnaire Survey

To check data availability and to collect comments on implementation of the indicator at national level, a new sheet for the indicator was added to the Joint FOREST EUROPE / UNECE / FAO Questionnaire on Pan-European Indicators for Sustainable Forest Management. The definition of degraded land linked to the table was the same as in chapter 2.2.11 (footnote 1 shows the shortened version of the definition, full text is available at the link given in the upper-left cell). The structure of the required data was as follows:

Total area of degraded land[1]	Area primarily degraded by								Former degraded land restored[2]
	Grazing	Repeated fires	Air pollution	Desertification	Other 1	Other 2	Other 3	Unknown	
1000 ha									

[1] Area with soils degraded to a degree that severely hampers re-establishment of the stocking
[2] Restored by afforestation/reforestation

In addition to the total area of degraded land, signatories could split the area by seven main causes of degradation (three of which were not predefined and countries were free to suggests their own categories), the rest could be reported as unknown. Additionally, we asked also for the area of restored former degraded land (i.e. successfully afforested degraded land).

The questionnaire also inquired some additional information:

Country comments:

Criteria applied to reporting damage
Minimum size of degraded FOWL reported, ha:
Other criteria and minimum thresholds used to determine an area as *"degraded"*:
Criteria used to determine the primary type of degradation:
Are degraded areas originating from land uses other than forestry included in the figures you reported?
In your country, are recently degraded forest areas legally considered as non-forest land?
In your country, are degraded non-forest areas re-categorised to forest land with the aim to reforest them?
Does your country have a national methodology for land degradation assessment?

Signatories were also asked for any relevant **comments** related to national data, definitions, trend(s), etc.

Reporting notes:

1. *Connection with FRA/CFRQ 2020:* global reporting covers degraded forests in Table T5c. Please refer to the corresponding FRA/CFRQ guidelines at http://fra-platform.herokuapp.com/ and terms and definitions at http://fra-platform.herokuapp.com/definitions/en/tad#1a
2. *Prefilling:* This table has not been prefilled;
3. *Reference years:* The figures for the reporting years refer to the situation in a reference year (1990, 2000, 2005, 2010, 2015) noted in the Table, or in the nearest year for which data is available, not the averages of annually affected areas for the 5-year periods, e.g. 1988-1992 for 1990. National Correspondents are asked for degraded area present in a reference year. If for example degradation occurred in 2001, the area affected should be included in the reporting for 2005, only if the area remains degraded also in 2005, as well as in the subsequent year(s) (2010) if relevant.
4. Data sources: please specify sources separately for forest, other wooded land and total FOWL if the sources differ.
5. It is up to the countries to define the thresholds for the minimum size of degraded forest land and other wooded land to be reported as well as the criteria and detailed thresholds used to determine area as "degraded". However, it is recommended to report only degradation that results in significantly hampered re-establishment of the area stocking (it does not have to be actually planned, but it has to be obvious that, if the case, it would be hampered). If the stocking is re-established, the area is considered to be restored.
6. *"Primarily degraded"* is mainly related to the severity of the influence on degradation. The area degraded by various agents (no matter which kind of agent and how many subsequent agents) should be counted just once.
7. Sub-class *"Primarily degraded by grazing"*: this category usually includes land degraded (eroded and poor in humus) by various domestic animals (degradation by wild animals is expected to be rare). This type of degradation typically takes place on non-forest land; however, the affected plots are many times left for forest expansion or decided to be afforested. Please use "Country comments" to specify if these plots are considered to be degraded forest land in your country, and if you have sufficient information for their monitoring and reporting.
8. Sub-class "*Primarily degraded by repeated fires"*: this sub-class is expected to be more common on forest land; however, degraded regularly burned pastures also belong to this sub-class. Please use *"Country comments"* to specify if these plots are considered to be degraded forest land in your country, and if you have sufficient information for their monitoring and reporting.
9. Sub-class *"Primarily degraded by air pollution"*: air pollution can cause changes in pH, leaching of nutrients, crusts on soil surface, etc. Please use *"Country comments"* to specify if these plots are considered to be degraded forest land in your country, and if you have sufficient information for their monitoring and reporting.
10. Sub-class *"Primarily degraded by desertification"*: this type of degradation is mostly related to climate/weather influence possibly combined with fires, grazing, deforestation and other agents. Please use *"Country comments"* to specify if these plots are considered to be degraded forest land in your country, and if you have sufficient information for their monitoring and reporting.
11. Sub-class *"Primarily degraded by other agent(s)"* comprises: repeated damage to forest stands, poor forest management, landslides, long-term changes in water table, etc. The agent(s), if relevant, has (have) to be named in the blank field in the table 2.5 header. Please use *"Country comments"* to characterise the agent that caused degradation, and if these plots are considered to be degraded forest land in your country and if you have sufficient information for their monitoring and reporting.
12. Total area degraded should be the sum of degradation by individual sub-classes.
13. A clear determination of a moment, when a degraded area is reversed to a normal situation is complex, difficult and can vary depending on a type of degradation. However, successful re-establishment of (nearly) full stocking should be considered a successful reclamation also in such cases when a normal productivity has not been restored yet. Please use *"Country comments"* to specify in which point these plots start to be considered reclaimed in your country, providing you have sufficient information for their monitoring and reporting, and when they start to be considered successfully reclaimed.

4 Data Availability

At present, according to the results of the questionnaire survey, the availability of national data is poor. Only 4 of 46 signatory countries reported some areas of degraded land, none of them reported all the required figures. Croatia and Switzerland reported the areas degraded or damaged by repeated fires, Poland and Romania reported restored areas of formerly degraded land. 15 countries provided at least some qualitative information and/or comments related to the issue.

FOREST EUROPE signatories	Related area(s)	Reported comments	Degraded forest monitoring (FRA)
Albania	No	No	N/A
Andorra	No	No	No
Austria	No	Yes	Yes
Belarus	No	Yes	No
Belgium	No	No	No
Bosnia and Herzegovina	No	No	No
Bulgaria	No	No	No
Croatia	No	Yes	No
Cyprus	No	No	No
Czech Republic	No	No	Yes
Denmark	No	Yes	No
Estonia	No	No	No
European Union	N/A	N/A	N/A
Finland	No	Yes	No
France	No	No	No
Georgia	No	Yes	Yes
Germany	No	No	No
Greece	No	No	N/A
Holy See	N/A	N/A	N/A
Hungary	No	Partially	No
Iceland	No	Partially	No
Ireland	No	Partially	No
Italy	No	No	No
Latvia	No	Partially	No
Liechtenstein	No	No	Yes
Lithuania	No	Yes	No
Luxembourg	No	No	No
Malta	No	No	No
Monaco	No	No	No
Montenegro	No	No	No
Netherlands	No	No	No
North Macedonia	No	No	Yes

FOREST EUROPE signatories	Related area(s)	Reported comments	Degraded forest monitoring (FRA)
Norway	No	No	No
Poland	Partially (restored land)	Partially	No
Portugal	No	No	No
Republic of Moldova	No	No	No
Romania	Partially (restored land)	Partially	Yes
Russian Federation	No	No	No
Serbia	No	No	Yes
Slovak Republic	No	Yes	No
Slovenia	No	No	No
Spain	No	No	Yes
Sweden	No	Yes	No
Switzerland	Partially (repeated fires)	No	No
Turkey	No	No	No
Ukraine	No	No	No
United Kingdom	No	No	No

Austria:

- recently degraded forest areas are considered as forest land
- there is no national methodology for land degradation assessment
- the definition of degraded forest (destroyed forest) reported to FRA overlaps with the definition of degraded forest land mentioned in this pilot study (it includes areas with significantly hampered reforestation, eroded soils but also areas with weakened productivity and damaged forests)
- there is a legal obligation to report "destroyed" areas, however, the figures reported are almost negligible

Belarus:

- recently degraded forest areas are considered to be non-forest land
- recently degraded non-forest areas are not re-categorised to forest land to afforest them
- there is no national methodology for land degradation assessment

Bosnia and Herzegovina:

- neither the definition of degraded forest land nor the definition of degraded forest reported, however, degraded forests growing stock is reported (FRA table 2a)

Croatia:

- degraded areas originating from land uses other than forestry are not included in the report
- recently degraded forest areas are considered to be forest land
- recently degraded non-forest areas are partially re-categorised to forest land to afforest them
- there is no national methodology for land degradation assessment
- national register of forest fires is the data source

Czech Republic:

- Forests that declined in the past due to industrial air pollution (acid depositions) are considered to be degraded and still monitored. They do not match the definition of degraded forests land as the soils were restored in 1980s.

Denmark:

- recently degraded forest areas are considered to be forest land
- recently degraded non-forest areas are not re-categorised as forest land to be afforested
- there is no national methodology for land degradation assessment
- Denmark suggests to adopt the concept of land degradation that would be based on productivity/nutrient changes, however, it considers this concept quite ambiguous

Finland:

- recently degraded forest areas are considered to be forest land
- recently degraded non-forest areas are not re-categorised to forest land to be afforested
- there is no national methodology for land degradation assessment

Georgia:

- recently degraded forest areas are considered to be forest land
- recently degraded non-forest areas are not re-categorised to forest land to be afforested
- there is no national methodology for land degradation assessment
- there are plans to start monitoring of forest degradation in 2018 within NFI framework
- degraded forest is defined as forest with "negatively affected forest structure and functions"
- forest degradation has been monitored within a framework of the NFI since 2018

Germany:

- the monitoring of forest degradation is considered to be unnecessary

Hungary:

- there is no national methodology for land degradation assessment

Iceland:

- there is no national methodology for land degradation assessment

Ireland:

- land degradation is unimportant in this country, there are some areas, but quite negligible

Lithuania:

- recently degraded forest areas are considered to be forest land
- recently degraded non-forest areas are not re-categorised to forest land to be afforested
- there is no national methodology for land degradation assessment

Latvia:

- there is no national methodology for land degradation assessment

Liechtenstein:

- damaged forest is understood as degraded forest (degradation: severe weather conditions, stones, insects, harvesting, humans, animals)

North Macedonia:

- degraded forest is a forest, which has, to a considerable extent, lost its quality and increment due to the adverse impact of biotic, abiotic and anthropogenic factors
- this definition probably includes degraded forest, degraded forest land and damaged forest

Poland:

- recently degraded non-forest areas are partially re-categorised to forest land to be afforested
- there is no national methodology for land degradation assessment
- information on restored former degraded land are available in Central Statistical Office's Yearbook Environment 2005 and Environment 2016 pro

Romania:

- recently degraded forest areas are considered to be forest land
- recently degraded non-forest areas are partially re-categorised to forest land to be afforested
- there is a national methodology for land degradation assessment and funding for restoration
- Degraded forests: forests with compromised production capacity, due to stocking density, tree species composition and no satisfactory fulfilment of the protection functions. There is some overlap with the restored degraded land.

Serbia:

- Degraded forest: a forest, which has significantly lost the quality, vitality, and the capacity of increment and natural regeneration (includes large areas of shrubs, maquis, etc.)

Slovak Republic:

- recently degraded forest areas are considered to be forest land
- recently degraded non-forest areas may be re-categorised to forest land to be afforested
- there is no national methodology for land degradation assessment

Sweden:

- recently degraded forest areas are considered to be forest land
- recently degraded non-forest areas are partially re-categorised to forest land to be afforested (the most degraded areas are not designated for afforestation)
- there is no national methodology for land degradation assessment
- and degradation is unimportant in Sweden

Note: None of the signatory countries reported desertification (e.g. loss of forest area which became deserts). It does not necessarily mean that this process would be unimportant in the Pan-European region. Maybe just the data or proper guidelines are missing.

5 Data Reliability

As data availability is, at the moment, very poor across the countries, it is quite difficult to analyse their reliability or potential reliability.

Amongst FOREST EUROPE signatories, there is just a limited willingness to report land degradation resulting from unintentional side effects of forest (mis)management, especially if these "accidents" are economically and environmentally unimportant. This particularly applies on small-scale degradation, the identification of which may be disputable (e.g. small areas temporarily compacted by heavy machinery). Theoretically, some independent monitoring could help but this would be probably unfeasible.

In case of areas degraded by natural disasters, climate change or anthropogenic factors external to forestry, the willingness to report them correctly should not be questionable.

Understanding of land degradation issue in some countries is insufficient or considered to be unimportant, which also may compromise the reliability of the data. For example, many countries admit they have some degraded areas but, due to low significance, they have no proper monitoring of the state of and trends in them. This may change in rapidly changing climate and related adverse effects (higher frequency of forest fires, landslides, avalanches, spreading of invasive species, etc.) and the awareness of the issue may improve. These changes may then improve the quality of the implementation of systematic measures in data collection and recording at national level.

6 Indicator Feasibility

Though not available now, monitoring and reporting of the data asked for by the questionnaire would be quite feasible. Degraded land, as defined in this study, can be identified quite easily and thus it could be feasibly monitored either directly (e.g. through remote sensing, tailored monitoring schemes) or indirectly within the framework of national forest inventories (if their grids are dense enough).

Tailored monitoring of degraded land seems to be a more feasible option for countries where degraded land is rare and in smaller countries where monitoring through NFIs would not be effective. There are several possible approaches to such monitoring. For example, the pieces of land that are probably degraded can be preliminary identified via remote sensing (orthophotomaps).

If resolution is high enough, eroded soils are usually quite visible even in normal colour spectrum. Subsequently, the identified plots would be visited by field staff, verified and the method of their future monitoring would be decided. If their remote identification were found precise enough, the monitoring could be based purely on remote sensing. Otherwise, the degraded

pieces of land would have to be measured precisely and future monitoring would be based on repeated measuring (in this case, also remote identification of possible newly degraded areas would have to be conducted regularly, e.g. every ten years). If the degraded pieces of land are large, they can be monitored using a grid of sample plots on degraded land and its vicinity (combined with remote identification of unexpected enlargement of the areas and new degraded areas).

Additionally, other data sources such as managerial records from forestry and other sectors or questionnaires can be used, especially for preliminary identification.

Monitoring land degradation through national forest inventories would be feasible in countries where degraded land is quite widespread and in countries with larger numbers of inventory plots. Feasibility depends on confidence limits in which the total area of degraded land is identified by NFI in a particular country (which depends on the country's area and forest area, total area and pattern of degraded land and NFI grid.

In the countries where forest land is not legally designated (i.e. the concept of a "permanent forest estate" is not employed), it may be quite difficult to decide whether the identified degraded land without tree cover (e.g. severely eroded areas) should be considered as forest land or not (see chapter 2.2.4 on legal status of degraded land). This should be considered in the designs of national forest inventories or special monitoring of degraded land in a country and in the interpretation of the countries' reports, as they may not be comparable in this respect.

Land use and/or activities that caused degradation should be also considered carefully. Many degraded pieces of land originate from agriculture practices, mining, air pollution and other factors external to forestry. Though the role of forestry in restoration of such areas is essential, if not properly interpreted, this would compromise the meaningfulness of the land degradation indicator and its significance for monitoring sustainability of forest management.

By definition, SFM should prevent land (soil) degradation resulting from forest management. If the trends in other significant SFM indicators are within their "allowed ranges", the degradation of forest land should not be progressing. From this viewpoint, the land degradation indicator may be of low importance. On the other hand, degraded areas may result also from climate change, air pollution and other factors external to forestry, monitoring of which is necessary.

Reliability of the data may be compromised by unwillingness of foresters to measure and report new cases of degradation by forest management (especially those small-scale and temporal), the elimination of which may be unfeasible.

7 Conclusion

Increasing population and appropriation of natural resources increases also the pressure on natural resources, including forest areas. Forests undisturbed by humans are very scarce in Europe and vast majority of forests is managed, which puts them at risk of degradation. There is an overall interest to manage land in sustainable manner and in this context also the process of the Ministerial Conference on the Protection of Forests in Europe (MCPFE) develops the concept of SFM at the regional level. Implementation of SFM in the region is monitored by SFM indicators, a set of which is regularly revised to cover relevant issues. The issue of land degradation and maintaining soil fertility cannot be overlooked, in contrast, active measures should be taken to restore degraded areas. In this framework also the indicator on Forest Land Degradation was adopted in 2015.

Within the process of developing the basic definition for the indicator it became clear, that the existing UNCCD concept was too broad for direct implementation of SFM indicator, which should not be too complex and overlapping a great number of other related indicators from the present C&I set. As a result of discussions within the FOREST EUROPE Advisory Group on Updating the Pan-European Indicators and the FOREST EUROPE Expert Group on Implementation of the Updated pan-European Indicators for SFM, forest stand characteristics were left aside and following definition of forest land degradation (degraded forest land), was recommended: *Forest land severely damaged by e.g. desertification, fires, grazing, air pollution, erosion, unsustainable management, etc., that lost tree cover and with soil damaged to a degree, that severely hampers or delays the re-establishment of stocking.* This definition is in line also with ITTO definition of degraded forest land and the whole concept of forest degradation.

The initial survey on data for this indicator revealed poor data availability and low significance of forest land degradation issue in the majority of FOREST EUROPE signatory countries. There are also persisting problems with the interpretation of land degradation within the concept of SFM.

Because of poor data availability in the most recent pan-European reporting, the indicator 2.5 (Forest Land Degradation) will not be quantitatively analysed in the report State of Europe's forests 2020. Having the indicator introduced to the set and the degraded land properly defined, the interest in information on degraded forest areas and their restoration may gradually improve, resulting in better availability of data in future reporting cycles.

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Ministerial Conference on the Protection of Forests in Europe - FOREST EUROPE
Liaison Unit Bratislava
T.G. Masaryka 22, 960 01 Zvolen, Slovak Republic
liaison.unit.bratislava@foresteurope.org
www.foresteurope.org

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