

# Assessment of progress towards sustainable forest management in Croatia through usage of quantitative Improved Pan-European Criteria and Indicators

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## Abstract

### Background and purpose:

Paper analyzes the transition of forestry in Croatia from 1995 up to the situation in 2006. The comparison between these two situations is made through quantitative Improved Pan-European Criteria and Indicators (C&I) for sustainable forest management (SFM). The paper also tests the applicability of the framework on a national reporting scale, and comments on the format of the framework itself

### Material and methods:

This secondary research compiles data in the framework of quantitative Pan-European Criteria and Indicators. Data comes out of many national and international sources, out of which most important ones are the MCPFE/FAO forest assessments and the General forest management plans for Croatia. For the reasons of comparison, all respective data is equated to 2000, and all forest types have been presented through MCPFE systematization scheme.

### Results and Conclusion:

According to this framework, the forestry in Croatia has made a progress in 15 out of a total of 35 indicators while no indicator showed a negative trend, 8

showed no significant change and 12 could not be calculated. The main impediment to the calculation of the indicators was the format of the requested information, notably division of total forest area to forests and other wooded land, and division of total forest land according to availability for wood supply.

### Key words:

MCPFE's criteria and indicators, sustainable forest management, national reporting

## INTRODUCTION

After the United Nations Conference on Environment and Development (UNCED) in Rio 1992 focus of international policy came to issues of environment and sustainability, and on this wave of attention a generic criteria and indicators for sustainable management of forests have been developed, both for Europe (Helsinki process, formulated by the Ministerial Conference on the Protection of Forests in Europe – MCPFE), and for the rest of the World (Montreal process).

The starting point for MCPFE C&I was the definition of sustainability, which was agreed upon in 1993 at the second Ministerial conference in Helsinki, under H1 resolution, and it states: "Sustainable management means the stewardship and use of forests and forest lands in a way, and at a rate, that maintains their biodiversity, productivity, regeneration capacity, vitality and the potential to fulfill, now and in the future, relevant ecological, economic and social functions, at local, national, and global levels, and that does not cause damage to other ecosystems".

The MCPFE C&I were adopted on expert level in 1994, endorsed on the third Ministerial Conference in Lisbon in 1998 (L2 resolution), and subsequently improved in fourth MCPFE in Vienna in 2003 [1]. They consist out of 6 criteria, 35 quantitative and 12 qualitative indicators. The quantitative indicators cover through 122 parameter issues from all three side of sustainability – ecological, economical and social, and have been frequently used as a basis for reporting on the status of forests [2-5]. The qualitative indicators disseminate status of forest from a policy perspective, and have not been as frequently used as were the quantitative indicators. The successful usage of C&I mostly depends on wide participation on all levels; so far that acceptance has occurred among intergovernmental organizations, but not on national levels; Finland and Austrian National Forest Report are the only ones that follow MCPFE's C&I.

Paper provides an insight to the changes that occurred in forestry of Croatia in the 1995 – 2006 period through the framework of MCPFE's quantitative criteria and indicators. This time span is chosen because majority of C&I is designated for ten year periodicity of data collecting. Due to the abundance of information indicators are depicted as shortly and as precisely as possible, for it is the objective of the paper to demonstrate whether it is possible or not to cover all the aspects that are prescribed by the methodology on national level.

## MATERIAL AND METHODS

The intention of this secondary research was to report on Croatia's forest in the respective C&I framework. The usage of framework [6] implied a 10 year span of reporting, as did the data from one of the most used data sources in this paper – the General forest management plans of Croatia for 1996-2005 [7] and for the 2006-2015 period [8].

Data on annual changes of the values of indicators were mostly drawn from Annual business reports of Hrvatske šume Ltd. The same source was used for

financial parameters, which were equated to real values in the year 2000 using the official inflation rates from the annual reports of the Croatian National Bank [9]. The abundance of data also had its shortcomings; the calculation of indicators often required compiling of data from various sources, which on some instances gave equable results (defoliation data, occupational health and safety), and on some instances unequaled data (carbon stock, forest sector workforce). These effects can probably be assigned to differences in the methodologies applied in the sourced researches, and their magnitude with the respect of the context of this research is of no significant importance. The bolded text in the following chapter represents the names of the indicators of interest, and the two-number code represents the number of the respective indicator in the MCPFE C&I system (eg. Forest area 1.1. – Criterion 1, indicator 1). The analogies between different systems of classification of protected and protective forests are based on the work of Martinić [10] in Table 9.

Most of the indicators comprise out of several parameters, and they have been assessed only through the parameters for which appropriate data exists. Since data has been collected for 23 out of 35 indicators, this research cannot be used for valid assessment of progress of forestry in Croatia, rather as an introductory study to a main research. This data could be used for such an assessment only if was incorporated in a system which adequately depicts sustainable forest management [11, 12], where appropriate weights and feed-back loops have been assigned to the indicators.

## RESULTS

### Criterion 1:

### ***Maintenance and appropriate enhancement of forest resources and their contribution to global carbon cycles***

Forests area (1.1.) together with other wooded land covers 2.6 mil ha, which is about 46% of land surface of Croatia (Table 1). There are many private forest owners (estimated to 600 000) which own 21% of forests. In the period of research there has been an increase in forest cover in all types of forest ( $\approx$  65 000 ha in every group – Economic, Protective and Special purpose forests), and in every ownership category – although the increase in forest cover was mainly private forests (120 632 ha) due to the increase in abandoned agricultural land. The percentage of other wooded land in total forest area is constant ( $\approx$ 12.5%) in all ownership categories and forest types in both 1996 and 2006. Almost all state owned forests (96%) are managed by "Hrvatske šume" Ltd., which is in State ownership.

**TABLE 1**  
Forest coverage in Croatia (source [8])

Type of forest	Year	State forests - HŠ	State forests - Other	Private forests	Total
		ha			
Economic	1996	1 878 790	3 051	459 642	2 341 482
	2006	1 838 782	492	576 833	2 416 108
	Δ	-40 008	-2 558	117 191	74 625
Protective	1996	88 838	20	1 454	90 312
	2006	145 634	4 884	4 022	154 539
	Δ	56 796	4 864	2 567	64 225
Special purpose	1996	23 909	29 867	40	53 816
	2006	33 570	82 555	917	118 041
	Δ	10 661	52 690	876	64 225
Total	1996	1 991 528	32 936	461 136	2 485 611
	2006	2 018 986	87 930	581 771	2 688 688
	Δ	27 450	54 994	120 632	203 077

Similar to the area, the growing stock (1.2.) of all ownership categories has increased (Table 2). It has to be stated that according to the General forest management plan 2006-2015 the growing stock of private forests has doubled in 10 years, which has to be most probably a result in different inventorying methodologies.

Regarding the age structure (1.3.), almost half of all even-aged forests (46%) in all ownership categories fall in III and IV age class (40 – 80 years), which is a good indicator of future forest stability (no danger from over-mature stands). Similar analysis of diameter – class distribution according to land coverage could not be performed due to the lack of appropriate data.

In the line with increase in forest area and growing stock, there is also an increase in carbon stock (1.4.) of forests (Table 3).

**TABLE 2**  
Summary of growing stock distribution (source [8])

Year	State – HŠ	State – Other	Private	Total
	1 000 m <sup>3</sup>			
1996	278 324	7 905	38 028	324 256
2006	302 417	17 245	78 301	397 963
Δ	24 094	9 340	40 273	73 707

**TABLE 3**  
Carbon stock of forests (source [2, 6])

Year	Carbon stock of woody biomass total	Above ground living woody biomass	Below ground living woody biomass	Dead wood
	Mt of C			
1990	196	117.2	31	20.8
1996*	115.28	97.38	17.89	
2000	211.1	146.4	38.7	26
2005	219.4	152.2	40.2	27

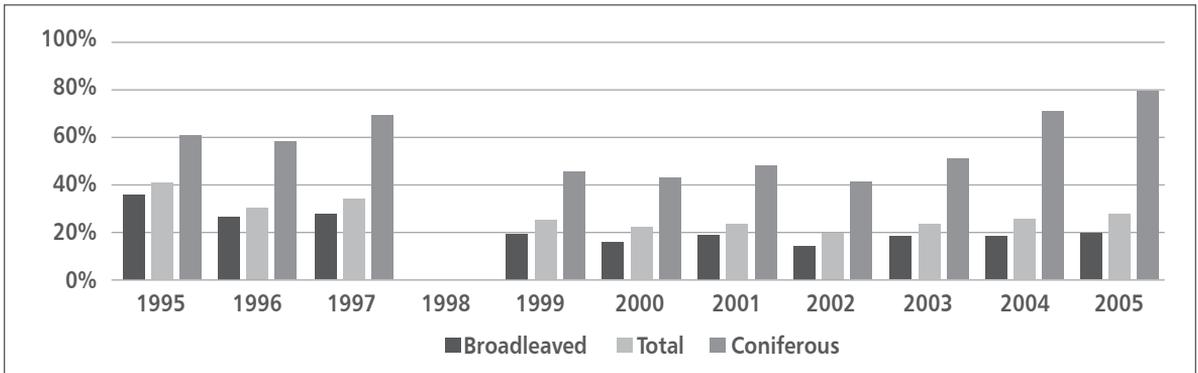


FIGURE 1  
Percentage of trees with more than 25% crown defoliation

**Criterion 2:**  
**Maintenance of forest ecosystem health and vitality**

No representative data regarding deposition of air pollutants (2.1.) and forest soil condition (2.2.) could be found. No defoliation (2.3.) trend can be observed; only that the defoliation is more strongly pronounced among coniferous trees (Figure 1 – [13, 14, 15]).

Related to forest damage (2.4.), only data regarding forest fires could be obtained. It is evident from the Table 4 that there was a peak in the number of forest fires and in the burned area in the year 2000. Although the year 2000 was very hot (+1.74 Standard deviation from mean annual temperature in 1961 – 1990 period) [16], since 90% of forest fires in Croatia are induced by man, no conclusion can be drawn regarding the management of forest and occurrence and coverage of forest fires.

TABLE 4  
Distribution of forest fires and burned area (based on [17])

Year	Number of forest fires	Burned area (ha)
1995	109	4 651
1996	305	11 214
1997	305	11 122
1998	441	32 056
1999	223	6 053
2000	706	68 171
2001	299	16 169
2002	176	4 853
2003	536	27 091
2004	204	3 378
2005	147	3 135

**Criterion 3:**  
**Maintenance and encouragement of productive functions of forests**

Unlike forest coverage, increment and fellings (3.1.) have significantly changed in the period of research; although annual gross felled timber has almost doubled from 1996 to 2006 (from 2,6 mil m<sup>3</sup> to 5,0 mil m<sup>3</sup>), it equals just to half of the annual increment (Table 5). The difference between felling and increment is smaller in state forest (fellings are 61% of increment) than in private forests (23% of increment). Although that this kind of felling policy is sustainable in the short run, it will lead the growing stock in the long run further away from the normal series of age and diameter distribution, which could be a major drawback to forest health and vitality. On European level it is expected that the growing need for wood [18] will be compensated by diminishing the difference between increment and fellings, so the current level of fellings in Croatia will probably increase. Some explanation of current levels of felling in Croatia can lie in the fact that there were 148 823 ha of suspected mined areas in 2006, and that the realized level of felling in private forests amount to 37% of planned, but further explanation of the issue would require a discussion beyond the scope of this paper.

TABLE 5  
Value and quantity of felled roundwood for "Hrvatske šume" Ltd. Real prices, equated to 2000

Year	m <sup>3</sup>	kn	kn/m <sup>3</sup>
1995	2629563	1068342047	406,2812138
1996	2934177	1050989056	358,1887038
2000	4366652	909289000	208,2348216
2005	4694727	1041391676	221,821562
2006	4200409	1101041173	262,127134

TABLE 6

Quantity and value of non-wood forest goods (source [6])

Year	Mushrooms and truffles		Resin, raw materials, medicine, aromatic products		Other plant products	
	Quantity (t)	Value (1000 €)	Quantity (t)	Value (1000 €)	Quantity (t)	Value (1000 €)
2005	400	319,1	40,0	33,2	1200,0	202,7

Despite the fact that the quantity of felled roundwood (3.2.) in forests managed by "Hrvatske šume" Ltd. has increased by 62% in the 1995-2006 period, its value has remained relatively constant; accordingly, the value of one m<sup>3</sup> has decreased by 55% in the same period. These prices are in line with the trends on European timber market, where the value of roundwood has decreased by 38% in 1995-2002 period [3].

No data regarding the value or the quantity of non-wood forest goods (3.3.) in Croatia prior to 2005 could be found, and the only information on this topic with national coverage is presented in Table 6. Similarly, no representative data regarding value of marketed services on forest and other wooded land (3.4.) could be found.

When it comes to proportion of forest and other wooded under a management plan or equivalent (3.5.), the situation is almost dichotomous; nearly all state owned forests in Croatia are covered by forest management plans (95%). The situation is inverse in private forests, due to a number of reasons [19] out of which the prevailing one is the high degree of plot dissemination (average size 0,42 ha). Although it was prescribed that the annual coverage of private forests with forest management plans should be 60 000 ha per year [7], Table 7 shows a deviation from that plan. It also has to be noted that in 2005, 32.6% of private forests had expired management plans. The low percentage of private forest with forest management plan can be explained by a fact that in 2005 "Hrvatske šume" Ltd., who at that time were managing private forests, had a total of 222 out of approximately 9500 employees designated to deal with issues of private forestry. The situation is even more evident in the

fact that in the same year the employees of "Hrvatske šume" Ltd. reported 63 247 working hours related to private forests, which is equivalent to full time occupation of just 31 employee [20].

#### **Criterion 4:**

#### **Maintenance, conservation and appropriate enhancement of biological diversity in forest ecosystems**

According to different sources, Croatia has around 250 tree species, out of which 50-60 have economic values. Although no comparable data could be found that would show the trend in tree species composition (4.1.), based on the trends from the linked indicators 1.1 and 4.3. it can be said that the tree species composition in Croatia is relatively constant.

Compared with the planned forest regeneration (4.2.) activities of the following decade (2005 – 2015), the area of natural regeneration is expanding (1.57 mil ha to 1.83 mil ha), while the area of natural regeneration enhanced by planting (33 492 ha to 13 730 ha) and the area of regeneration by seeding (28 350 ha to 16 894 ha) is contracting. The area designated for coppice sprouting (504 901 ha to 533 828 ha) has remained relatively constant.

The naturalness (4.3) of forests in Croatia in the period of interest has not changed – almost all of the forests and OWL are modified natural forests (2.02 – 2.06 mil ha), while the share of forests undisturbed by man (10 000 ha) and plantations (56 000 – 61 000 ha) is not significant.

There is no data regarding the area of forests under introduced tree species (4.4.).

TABLE 7

Annual coverage of forest by forest management plans (source [8])

Year	Annual coverage of forest by forest management plans										Coverage by management plans	
	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	1996 - 2005	
	ha										ha	%
State-HŠ	43455	112899	185123	243086	210541	253707	782025	234255	162334	272974	1900399	95
Private	0	6726	3682	7708	2120	5756	3153	0	3521	1862	34528	7

Under FSC certification scheme for state forests managed by "Hrvatske šume" Ltd. there was an obligation (minor non-compliance) in 2002 that was fulfilled in 2003 regarding the deadwood (4.5.) in forests; it is an observed practice that 3 – 5 fallen or standing trees are left in the forest after the final cut. A similar obligation was prescribed by the General forest management plan of Croatia 1996 – 2005 [8]. It can be stated that the situation regarding deadwood in forest has remained unchanged in the time period of interest.

Areas managed for in situ (5162 ha – 4997 ha) and ex situ (75 – 80 ha) genetic resources (4.6.) preservation have remained relatively constant, while the area managed for seed production has grown from 23 ha to 75 ha in the time period of interest

There is no usable data regarding landscape patterns (4.7.) of forest cover.

There is a total of 32 flora threatened forest species (4.8.) in Croatia, out of which 2 are trees (*Betula pubescens* – critical; *Taxus baccata* – vulnerable) and

one is a shrub (*Ilex aquifolium*). According to different sources, there are from 813 [21] up to 1198 [2] forest flora species. And although no such information could be found for the year 1996, it can be presumed that the situation has remained relatively unchanged.

It can be observed that the extent of protected forests (4.9.) under MCPFE classification has changed in the period of interest mostly in the class 3, which represents protective forests under national classification (Tables 8 and 9). Further dissemination of MCPFE class 3 represents in fact Indicators 5.1. and 5.2. of the Criterion 5.

**Criterion 5:**

***Maintenance and appropriate enhancement of protective functions in forest management***

Since no such data could be found for the beginning of the period of interest, such analysis could not be performed – it can be only states that in 2006, 97% of protective forests were managed protection of soil, water and ecosystem functions, and that such ratio was similar in 1996.

TABLE 8

*Extent of protected forests according to MCPFE classification system*

MCPFE* class	MCPFE objective	Year		
		1996	2006	
		ha		
1.	1.1.	No active intervention	6 003	5 685
	1.2.	Minimum intervention	20 235	41 279
	1.3.	Conservation through active management.	312 668	317 502
2.	Protection of Landscapes and Specific Natural Elements		1 557	11 396
3.	Protective Functions		47 624	81 530
Total			388 087	457 392

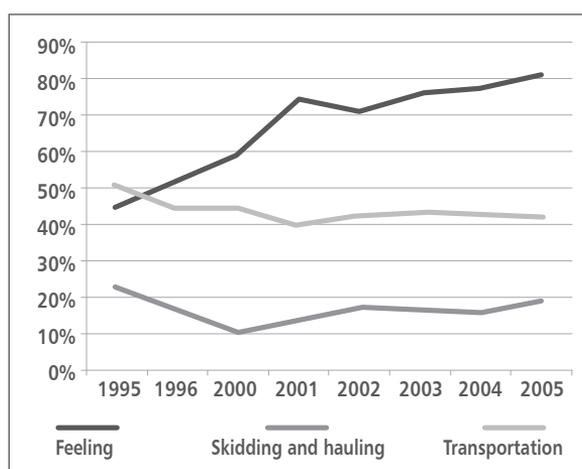
TABLE 9

*Analogies between different classification systems of protected and protective forests (modified on the basis of [10])*

EEA	MCPFE*	IUCN	National classification of Croatia	
A	1.	1.1.	I	Strict reserve
		1.2.	II	National park
		1.3	III	Nature monument
B	2.	IV	Special reserve	
		V	Significant landscape, Park forest, Nature park	
		VI	Regional park	
			Monument of park architecture	
-	3.	-	Protective forests	

**Criterion 6:****Maintenance of other socio-economic functions and conditions**

In the period of interest almost all of the forests, both state and private, were managed by "Hrvatske šume" Ltd. a predominant forest holding (6.1.); the exception were the 4.3% of state forests that were managed by other legal entities (total of 11), out of which the largest one is the Ministry of defense. However, there has also been a strong activity of private entrepreneurs, who have in the same period doubled their share in timber transportation niche, while their share in felling and skidding and hauling (Figure 2).



**FIGURE 2**  
*Trend in entrepreneurial activities in forestry in Croatia*

Contribution of forestry sector to GDP (6.2.) has moved slightly downscale (1995 – 1.6%; 2005 – 1.3%.; [22]).

Although no data regarding net revenue (6.3.) of forestry in total could be found, a good indicator of economic viability of forestry in Croatia is the annual net revenue of "Hrvatske šume" Ltd., whose profits have decreased from 32 million Kuna's (4.32 mil €) in 1996 to 19 million Kuna's (2.57 mil €) in 2006 (real values, equated to year 2000, [23]). The net revenue figures actually represent a stabile 1.5% of all revenues, indicating planned financial results of the company.

Expenditures for services (6.4.) that are publically available and that forests in Croatia provide can be seen through a "green tax" prescribed by the Law on forests, by which all subjects in the economy are obliged to pay 0.07% of their annual revenues for the "Publically useful functions of the forests", which are as follows [24]:

Protection of soil, roads and other objects from erosion and flood; influence of forests on water regime and hydropower system; influence of forests on soil fertility and agricultural production; influence of forests on climate; protection and improvement for environment; creation of oxygen and atmosphere cleansing; recreative, touristic and health function; influence on fauna and hunting; protective and special purpose forests. The amount of the "green tax" has increased from 150 million Kuna's in 1996 to 268 million Kuna's in 2006 (real prices, equated to year 2000).

No data on national level that would show the forest sector workforce (6.5.) in the years 1996 and 2006 could be found; however, the most reliable source on the sectors' workforce is the National Forest Policy and Strategy (25), which states the forestry and logging activities employ 19500 people (9500 in "Hrvatske šume" Ltd., 6000 employed by private entrepreneurs and 4000 of part time employees), that wood industry employs 23100, and that pulp and paper industry employees 6250 people, which sums up to a total of 49000 of people. Since the number of employees in "Hrvatske šume" Ltd. has remained constant, that there is an increase in the activities of private entrepreneurs and that the annual fellings have increased, it can be said that the employment in forestry and logging in Croatia has slightly increased in the period of interest.

Number of non-fatal occupational accidents has steadily decreased from 736 in 1995 to 505 in 2005. The number of fatal injuries in forestry has grown from 1 to 5 in the same period, but this information should not be treated as a trend, since the annual number of fatal injuries in forestry varies in the period of interest from none (in 1999) to seven (in 1998) in a way from which no conclusions can be drawn. With this information, it can be concluded that the situation regarding occupational safety and health (6.6.) has improved [26, 27].

No comparative data on wood consumption (6.7.) could be found; only that annual wood consumption in 2007 was 0.8m<sup>3</sup>/capita [28].

Trade in wood (6.8.) has made a strong turn in the period of research: imports of roundwood have downsized from 135 000 m<sup>3</sup> in 1996 to 70 000 m<sup>3</sup> in 2006, while exports have grown from 281 000 m<sup>3</sup> in 1996 to 907 000 m<sup>3</sup> in 2006, which amounts to one third of annual felling.

Share of energy from wood resources (6.9.) in total energy consumption has approximately stayed on the same level from 1996 (3.8%) to 2006 (4.08%), while the intermediate values have randomly fluxed no more than a half of a percent around the ending value [29].

With some minor exceptions (like forests owned by the Ministry of defense), all forests in Croatia have accessibility for recreation (6.10.). Recreation as a primary function of forest is present in protected areas that fall into IUCN's categories II (National Park), III (Natural Monument) and V (Protected landscape), which amounts to 334 412 ha in 1996 and 370 148 ha in 2006.

No viable data regarding number of forest sites with cultural and spiritual values (6.11.) in the period of research could be found.

## DISCUSSION AND CONCLUSIONS

The evaluation summary of the former section reveals that forestry in Croatia has made a progress in the 1995 – 2006 period; 15 out of 35 indicators show a positive trend, no indicator shows a negative trend, 12 have unknown values, and 8 have recorded no significant change. This result were obtained by having sufficient data for calculating at least basic parameters for 23 indicator, while out of a total of 122 parameters 42 were calculated.

The main impediments in the calculation of parameters related to the indicators were:

### Division to forests and other wooded land

When reporting on forests, few international data sources (like UNECE and FAO) use this demarcation. On national level this kind of demarcation exists just for basic information like forest cover, thus excluding a large number of parameters.

### Division of parameters related to availability for wood supply

No data exists for forests in Croatia that would disseminate the information of a parameter related to availability for wood supply. Such division is not used in national reporting, and the authors have not found a clear definition what the availability for wood supply means in the respective literature. This impediment has also excluded many parameters.

## COMPLEXITY OF INDICATORS

Some indicators (notably 4.8 - Threatened forest species; 4.9- Protected forests and 6.10. - Accessibility for recreation) have many parameters, whose level of detail and related comment is adequate for a separate report

### Weak reporting on forestry on national level

Very small percentage of data required for the calculation of indicators that came from national

sources showed information on national level; Data related to state forests, especially those managed by Hrvatske šume Ltd. was very abundant, unlike information related to private forest. Many parameters (notably 1.4.; 2.3.; 3.1.; 4.8.; 4.9.; 6.5. and 6.6.) required compiling different data sources, which introduces an issue of data credibility due to the differences in methodologies of data calculating.

### No separate reporting on forestry by the Central Bureau of Statistics

Central Bureau of Statistics keeps much of the information that is required for the calculation of indicators; unfortunately majority of information is presented in statistical data bases jointly for agriculture, forestry and hunting, thus disabling the usage of information

MCPFE's quantitative indicators represent a comprehensive framework for reporting on forestry, a framework whose application can be simply evaluated and just as easily compared to any other application regardless of the scale. However, as any theoretical framework, it has its weak sides, one of which is the format of the data. This paper could not provide the figures on most of the parameters simply because the data sources do not show information in such formats that would enable the calculation of the parameters. This could be the prevailing reason for the lack of broad support to this reporting framework.

One of the ways to deal with this issue would be to make on international level a data base of national forestry reporting system, and to modify the parameters of indicators to a format which suits national reporting systems most fittingly. Another issue is the volume of information that the parameters of the indicators cover; if it would be possible to calculate all the parameters on a national level and to comment on them, the paper would fit a volume of a standalone report. Compiling this information on an international level requires compression and selection of data, which is evident from the respective documentation [2, 6], and this process introduces the issue of data viability.

Due to the nature of the policy cycle, this framework will most probably be revised in the same manner it was improved previously, and to become more and more closer to its full potential of operability.

Aside from these shortcomings, quantitative C&I for sustainable management of forest are a clear, though-through and internationally agreed upon system for reporting on forests that covers all the aspects of the sector, and whose logic and outputs are easily understandable to a broad filed of audience.

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