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The Influence of End-Users on the Temporal Consistency of an International Statistical Process: The Case of Tropical Forest Statistics

Alan Grainger[1]

Four Forest Resources Assessments (FRAs) compiled by the Department of Forestry of the United Nations (UN) Food and Agriculture Organization (FAO) are evaluated by a unified approach to statistical science that analyses technical decisions within an institutional framework. Temporal inconsistency is visible in all seven stages into which this international statistical process is divided. It is linked to a mixture of autonomous choices by FAO, and responses to the perceived needs of end-users, which are constrained by its traditional world view. The latter is characterized by, among other things, a commitment to the sovereignty of member states and to timber production as the principal objective of forest management. A composite new institutional framework is used to explain FAO's ability to sustain its autonomy in the face of civil society pressures to make the statistical process more inclusive of environmental and scientific concerns. In this framework, institutions in FAO as a whole, within the Department of Forestry, and in FAO's relations with member states, are mutually reinforcing and consolidated by the circulation of documents. Following rules to secure legitimacy within the UN system leads, as in other UN bodies, to self-defeating behaviour, evident here in overaggregated statistics that obscure tropical forest trends.

Key words: Statistical process modelling; international statistics; international organizations; deforestation; civil society; new institutionalism; discourse analysis; ontological analysis.

1. Introduction

The infrequency of systematic studies of national statistical processes is a casualty of the divide between articles by academic statisticians and those by official statisticians (Dillman 1996). The latter are mainly descriptive reports (e.g., Allen 1970; Cook 2003) or proposals for improvement (e.g., Philpotts 2002; Holt 2003). National statistics provide valuable inputs for international statistical processes, yet these and their associated sociologies are little studied as well. The same is true for the operations of United Nations (UN) and other international organizations (IOs) that coordinate many international processes (Kurian et al. 1995; Biermann and Bauer 2003). Barnett and Finnemore (1999)

[1] School of Geography, University of Leeds, Leeds LS2 9JT, UK. Email: a.grainger@leeds.ac.uk
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claim “we know very little about the internal workings of IOs or about the effects they have in the world” and blame this on biases in theories of international relations.

Environmental statistics are becoming increasingly important at the international level (El-Shaarawi and Teugels 2005). Yet tensions can arise between statistical agencies and end-users on the relative importance of the economic and environmental aspects of natural resource use, and are evident in four compilations of statistics on tropical forest resources by the UN Food and Agriculture Organization (FAO). Its Forest Resources Assessments (FRAs) have been the main source of statistical data used to justify international policies to tackle tropical deforestation (e.g., World Resources Institute et al. 1985; World Bank 2004), and quantify models of its causes (Grainger 1998). So FAO has arguably contributed as much to the social construction of this ‘environmental problem’ as climate modellers have to that of global climate change (Demeritt 2001a). Demeritt’s conception of the “mutual construction of nature, science and society” is adopted here, with statistics substituted for science[2].

Temporal consistency is a key measure of statistical quality (Polfeldt 1997) and important to FRA end-users (Matthews and Grainger 2002). Consistent time series are needed by environmentalists for effective political campaigning, and by global change scientists to (a) monitor long-term trends in world forest area (Williams 1990); (b) model national trends in terms of societal driving and controlling forces (Rudel et al. 2005); and (c) model the role in global climate change of carbon uptake by forest growth (Phillips et al. 1998) and the balance between this and carbon emissions from deforestation (Houghton 2003). Uncertainty about trends in world forest area, half of which is in the tropics, hinders carbon accounting (Houghton 2005).

This article assesses the temporal consistency of FRA statistics and how it is influenced by relations between FAO and end-users. FRA statistics are used by the many groups outside the state system which constitute what is now called ‘global civil society’ (Otto 1996), and the article focuses on two of them: global change scientists and environmental groups. Meeting end-user needs is important (Castles 1991) but rarely studied (e.g., Marsh et al. 1988; Rees 1998). As both groups only became active in this field after the first FRA was published in 1981, FAO has subsequently had to balance temporal consistency against responding to their changing needs.

The first part of the article introduces forest terminology. The second evaluates changes in FRAs using a unified approach to statistical science (Malaguerra 2005). The third discusses how FAO maintains its autonomy over FRA design in the face of civil society pressures.

2. Definitions and Categories in Forest Statistics

When defined as land cover, a forest is “a continuous tract of trees” (Whittow 1984); a threshold of 10% tree canopy cover has been used as the continuity criterion for tropical forests in all FRAs (Lanly 1981). Statistical comparisons between countries are

[2] Demeritt’s approach circumvents anti-relativist objections to social construction (see Proctor 1998) by affirming the existence of nature.

complicated when forest is defined as land use or an area over which the state has legal rights (Lund 1999), as not all such areas have tree cover.

Categories in forest statistics differentiate between forests that vary in:

- Composition, by containing (a) *coniferous* species, which have *softwoods*, or *broadleaved* species, most of which have *hardwoods*; (b) trees that are *evergreen*, retaining their leaves throughout the year, or *deciduous*, shedding leaves in cold or dry seasons; and (c) different densities of species with commercially valuable woods.
- 'Naturalness,' e.g., *natural forests* vs 'artificial' *forest plantations*.
- Maturity/disturbance, e.g., primary forest (mature and undisturbed) vs forest fallow (low secondary forest regenerating after clearance by shifting cultivators).

The wide variety of tropical forest ecosystems can be divided into closed and open forests:

Closed forests have a dense canopy. Two major types of tropical moist forest are *tropical rain forest*, consisting mainly of evergreen broadleaved trees and flourishing in the permanently humid tropics close to the Equator; and *tropical moist deciduous forest*, a mixture of evergreen and deciduous trees found where rainfall is still heavy but more seasonal. Both contain valuable hardwoods (Whitmore 1990). Closed forest also occurs in the dry tropics.

Open forests and woodlands have a more open canopy. They occur in some seasonal moist areas but are most common where rainfall is low and highly seasonal. Also known as savannas, these mixtures of trees, shrubs and grasses of varying densities are valuable for grazing and fuelwood harvesting (Eyre 1968) and are less frequently surveyed than closed forests.

Negative changes in tropical forest resources include *deforestation*, a reduction in forest area by clearance, mostly for agriculture; and *degradation*, a reduction in canopy cover, tree density, height, biodiversity, biomass etc., e.g., by selective logging, which removes a few trees per hectare. Positive changes include planting trees on cleared land (*afforestation*) and in existing forests (*reforestation*).

3. Evaluation of the Forest Resources Assessment Process

3.1. Framework for Analysis

A *statistical process* is the set of activities preceding and following publication of official statistics. It is implemented by a statistical system comprising a number of *statistical agencies*, one of which may be the *national* (or international) *statistical organization* having legal responsibility for producing official statistics. A process-based approach has been particularly recommended for the study of global environmental assessments, such as FRAs (Clark et al. 2006).

Statistical processes can be divided into seven stages (Table 1), adding Stages 1, 3, and 7 to the scheme of Simpson and Dorling (1999). As with similar frameworks for analysing public policy processes (Anderson et al. 1983), the stages do not always have to be followed in strict sequence.

Looking at each stage in turn, this section assesses the consistency of FRAs with their predecessors, and links their design to the world views of FAO and end-users. It also tests the applicability of criteria for evaluating national statistical processes (Table 1),

Table 1. A seven stage framework for analysing a statistical process with criteria for evaluation

Stage
1. Consulting end-users to determine their needs for statistics on a phenomenon
a. Inclusiveness of consultation with end-users on process design
b. Effectiveness and consistency of response to new information needs
c. Independence from political intervention
2. Designating a statistical agency to establish a suitable statistical process
a. Existence of an appropriate long-term legal framework for the agency
b. Attentiveness to implementing laws and rules on political independence
c. Availability of proper training mechanisms for staff
3. Choosing a set of statistics to portray the phenomenon
a. Choice of statistics balances meeting changing needs of end-users against temporal consistency
b. Choice of statistics is impartial and meets standards of professional and scientific integrity
c. Response burden on data providers kept to appropriate level
4. Collecting and assembling data within a given structure
a. Choice of collection methods meets professional, scientific and consistency criteria
b. Mix of data sources determined using scientific and economic criteria
c. Rights of data providers, e.g., to confidentiality, are respected
d. Data providers informed of rights and duties
e. Effectiveness of control over the quality of data collection
f. Fulfilment of international assistance obligations
5. Estimating statistics by processing and interpreting data
a. Choice of estimation methods meets professional, scientific and consistency criteria
b. Efficiency and timeliness of estimation balanced against need for accuracy
c. Effectiveness of control over the quality of estimation
d. Effectiveness of mechanisms to ensure a continuing increase in quality
6. Reporting and disseminating statistics
a. Transparency in reporting working methods
b. Transparency in explaining meaning of statistics to promote proper use
c. Effectiveness of presentation of evaluation of quality of statistical outputs
d. Equality of access for all end-users under equal conditions
e. Timeliness of reporting
f. Protection of confidentiality of data providers in reports
g. Consistency of reporting
7. Receiving feedback from end-users
a. Existence of effective feedback mechanisms to determine satisfaction of all end-users and respond consistently to these

NB. Criteria for evaluation are adapted from De Vries (1999) and amplified to include temporal consistency condensed from the thematic checklist of De Vries (1999) and amplified to include temporal consistency, which he omitted. The consultation and feedback stages are combined here for convenience.

3.2. Agency Designation

When FAO established a Forestry and Forest Products Division in 1946, a year after being founded, it was designated, by an interpretation of Article 1 of its Constitution, as the UN specialized agency responsible for reporting international forest statistics. This has led to five statistical processes.

Statistics on world trade in forest products are published annually in the FAO Forest Products Yearbook by the FAO Department of Forestry in Rome.

Statistics on land use are published annually in the FAO Production Yearbook by the Statistics Division of the FAO Department of Economic and Social Policy, also in Rome. These include: Arable Land, Permanent Crops (e.g., tree crops), Permanent Meadows and Pastures, Other Land and, until 1995 (FAO 1996), Forests and Woodland.

Statistics on global forest resources were published in the World Forest Inventory (WFI) series in 1948, 1953, 1958, and 1963 by the FAO Department of Forestry and the joint Agriculture and Timber Division of the UN Economic Commission for Europe (ECE) and FAO in Geneva. Work on WFI 5 ended prematurely in 1970 owing to poor tropical forest data (Persson 1974).

Statistics on temperate forest resources were published periodically by ECE/FAO after WFI 5 was terminated (e.g., ECE/FAO 1985).

Statistics on tropical forest resources have been published by the FAO Department of Forestry since 1981. Tropical Forest Resources Assessment 1980 ('FRA 1980') was produced jointly with the UN Environment Programme to implement Recommendation 25 of the UN Conference on the Human Environment in Stockholm in 1972 (Lanly 1981). Forest Resources Assessment 1990 (Tropical Countries) (FRA 1990; FAO 1993) was expanded to global level by adding temperate forest statistics from ECE/FAO (FAO 1995). Global Forest Resources Assessment 2000 (FRA 2000), produced by the FAO Department of Forestry and ECE/FAO, was the first to apply uniform definitions to all forests, temperate as well as tropical (FAO 2001a). Global Forest Resources Assessment 2005 (FAO 2006a) is the latest output from this process.

3.3. Choice of Statistics

3.3.1. Conceptualizing Choice

The choice of a set of statistics influences their collective meaning even before they are quantified (Poovey 1993). To portray a phenomenon coherently statistics should ideally be selected within the framework of a classification system with a clear set of rules (Bowker and Starr 1999). In geographic information science classification systems can differ (a) semantically, e.g., different names are used for the same forest type, and (b) ontologically, where there are fundamental structural differences (Hunter 2002). *Ontology* refers here to "an explicit, partial account of a conceptualization" (Guarino and Giaretta 1995), and not to a "theory. . .of what can be known," as in philosophy (Johnston 1986). Land cover mapping projects in Brazil and Great Britain, for example, have both been analysed ontologically (Fonseca et al. 2002; Comber et al. 2004). Ontological and semantic differences between national land cover classification systems result from variation in the environment and societal perceptions of this. Accommodating such differences when compiling a uniform set of global statistics is a challenge: national reports for FRA 2000 included over 600 forest definitions (FAO 2001a). However, dispensing with national ontologies could reduce the resolution of statistics (Cruz et al. 2004).

Statistical processes evolve as knowledge improves and changes occur in conditions and end-user needs. Yet the considerable variation in sets of forest statistics from one FRA to another contrasts with the occasional modifications to sets of economic statistics, their definitions and mode of estimation (Delamonthe 1989), and the care taken not to undermine long-term consistency when changing the group of indicators used to estimate a statistic (Forsyth 1978). The proportion of statistics in an FRA which appeared in its predecessor does not exceed 26%, and that remaining in its successor is at most 54% (Table 2).

Traditional claims about the independence of national statistical processes (Table 1, #1c) have been qualified by the Government Statisticians Collective (1979) and Tant (1995). For Fienberg (1989), statistics "reflect political and social perspectives and values, because data are collected in the context of a mandate that comes from the political arena." Statistics have been called a "social product" (Simpson and Dorling 1999) and "social construction" (Barnes and Hannah 2001).

The concept of *discourse*, defined as "a specific ensemble of ideas, concepts, and categorizations that are produced, reproduced and transformed in a particular set of practices and through which meaning is given to physical and social realities" (Hajer 1995), sheds light on why statistics are chosen. For the French sociologist Michel Foucault, "production of discourses is a form of power, as it constructs *categories* that . . .define what is normal and natural" (Price 1997) (author's italics). So an environmental phenomenon may be a 'problem' in one discourse but not in another (Feindt and Oels 2005). Each end-user group, and the statistical agency itself, has its own discourse. When they engage in a

Table 2. Measures of consistency between statistical categories in Forest Resources Assessments (FRAs) 1980, 1990, 2000 and 2005: the percentage of all categories in an FRA that remain in the next one (below diagonal), and the percentage of all categories in an FRA found in its predecessor (above diagonal)

% of categories in > Remaining in:	FRA 1980	FRA 1990	FRA 2000	FRA 2005	< % of categories in Previously found in:
FRA 1980	****	26	0	0	FRA 1980
FRA 1990	12	****	21	0	FRA 1990
FRA 2000	0	22	****	21	FRA 2000
FRA 2005	0	0	54	****	FRA 2005
Total No. of Statistics	50	23	24	61	

NB. This summarizes the findings of a comprehensive analysis of all statistical categories in all FRAs, using the consistency matrix method of Diamond (1999). A copy of the matrix is available from the author on request. Consistency between FRAs is overstated here since: (a) the total number of statistical categories in FRA 1980 excludes multiple forest types; and (b) restriction of estimation to certain geographical scales (e.g., regions) is ignored when calculating differences between FRAs.
Sources: FRA 1980 (Lanly 1981); FRA 1990 (FAO 1993); FRA 2000 (FAO 2001a); FRA 2005 (FAO 2006a).

dialogue each aims to influence the discourse of the statistical process, and thus the choice of statistics and the narrative represented by their time series. A *narrative* has been defined by Barton (2000) as a meaningful totality of past and future events. In group theories of policy analysis, a group's influence in the dialogue depends on its power and access (Grainger and Konteh 2007). Strong groups with preferential access to an agency may form an elite "policy community" with it (Rhodes and Marsh 1992). Other theories put more stress on the intellectual strength of a group case (e.g., Hajer 1995).

International organizations (IOs) are "associations established by governments or their representatives that are sufficiently institutionalized to require regular meetings, rules governing decision-making, a permanent staff, and a headquarters" (Shanks et al. 1996). In regime theory, IOs are merely systems of rules coordinated by their secretariats (Krasner 1983). However, Barnett and Finnemore (1999) argue from a constructivist perspective that the latter have an autonomy exceeding that which might be expected for the cluster of their member states alone (Virally 1977). IOs such as FAO, which do not threaten the interests of their most powerful member states, probably have greatest scope for this (Cox and Jacobson 1977).

3.3.2. Tropical Forest Resources Assessment 1980

The classification system in FRA 1980 separated Natural Woody Vegetation from Forest Plantations, divided the former into All Forest and Shrubs, split All Forest into Broadleaved and Coniferous, and classified Broadleaved Forest as Closed, Bamboo or Open (the latter being called "Mixed (tree) forest grassland formations" in Figure 1). Mature Closed Forest was distinguished from Forest Fallow, and classed as (commercially) Productive or Unproductive. Forest areas and deforestation rates were estimated for each category in every country.

FAO's Department of Forestry (FAODF) received few pressures from non-forestry end-users when designing FRA 1980, so four elements of its longstanding ('traditional') discourse can be inferred from the latter:

- A bureaucratic desire for order and comprehensiveness, evident in the report's many statistics, unitary hierarchical classification system (see Figure 1) and 1,500 pages. This is compatible with claims that: IOs use their autonomy to "structure knowledge by classifying the world [and] fixing meanings" (Barnett and Finnemore 1999); and forest surveys "transform heterogeneous forests into an apparently unified and calculable quantity available to new disciplinary forms of state power" (Demeritt 2001b).
- Member states have sovereignty over natural resource information, and they and their forestry departments are perceived as the main end-users. This is apparent in the separate chapter for each country, written *only* in the language in which FAO corresponds with its government. They are the most influential actors in the dialogue on FRA design, provide most FRA data and (via FAO's Forestry Committee and Ministerial Meeting on Forestry) determine FAO policies. Governments are often regarded as the primary end-users of national statistics too (Blakemore 1999).

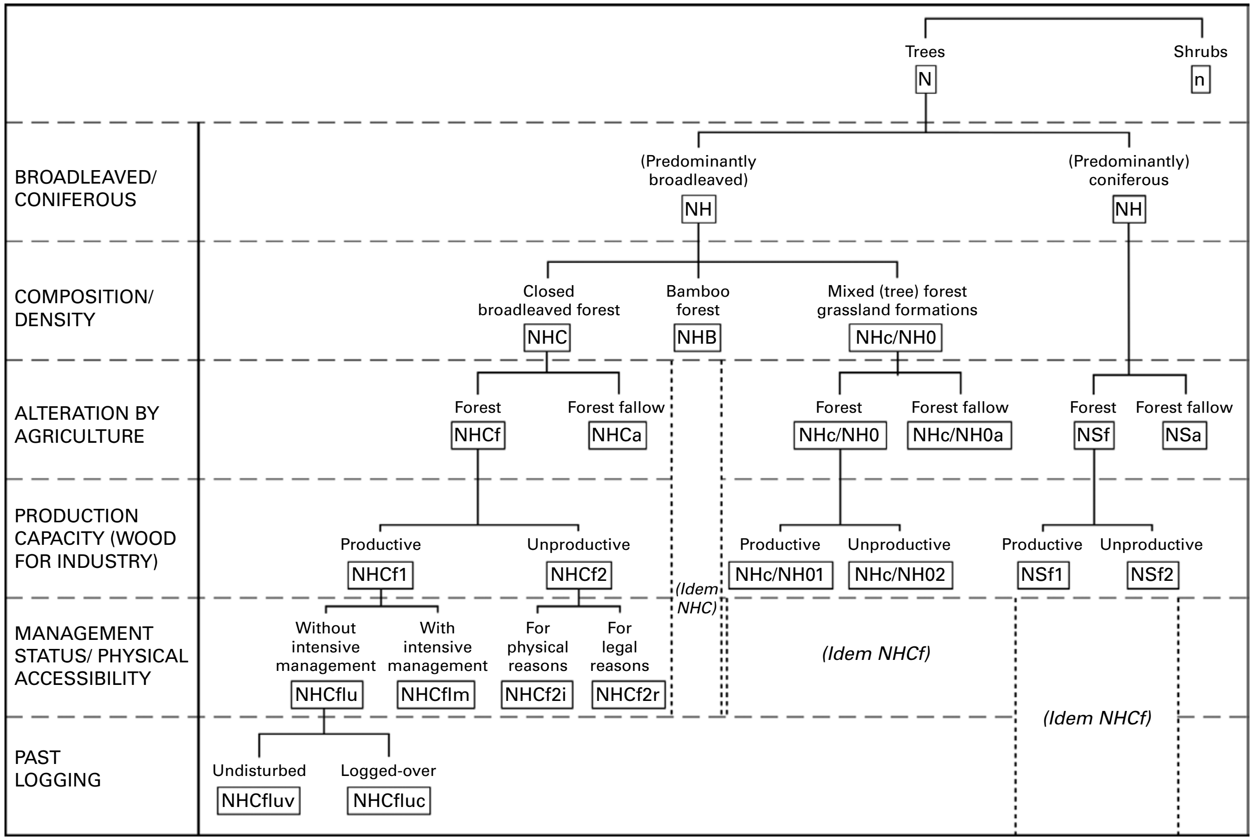

Fig. 1. Classification system for natural woody vegetation in Forest Resources Assessment 1980. Source: Lanly (1981)

- A belief in its right to use its *authority* as a UN organ to validate subjective judgments of FAO staff and consultants in filling gaps in data. According to Barnett and Finnemore (2004), the authoritativeness of IO secretariats derives from a combination of four categories of authority: rational-legal (by virtue of being bureaucracies), delegated (through the powers given them by states to carry out certain tasks), moral (as depoliticized and impartial servants of the universal conscience of all states), and expert (as concentrations of technical expertise).
- A commitment to a *productivist* ethos[3] in which timber production is the principal forest use. This is clear in the choice of statistics and orientation of the hierarchical layers below "Alteration by Agriculture" in Figure 1. Compatible with assertions by developing member states that they have the right to develop and exploit forests as they choose (Mallett 1992), it is implicit in the 'technical', management-oriented, culture of modern forestry, espoused by FAODF staff (Ness and Brechin 1988). This culture, which originated in the "scientific forestry" devised in Germany in the 18th Century and was later exported to European colonies (Lanz 2000), privileges the economic dimension of forest use. It can, with difficulty, accommodate community-based management (e.g., FAO 1978) but accepting environmental limits on production represents a greater challenge (though see Mather (2005) for a contrary opinion). While the first three discursive elements apply to FAO generally, this one is specific to FAODF.

That FRA 1980 was praised by foresters and member states is understandable, since its statistics were consistent with their discourses and they respected FAO's authority to issue them. However, 'environmental groups,' comprising environmentalist pressure groups and conservation bodies, were concerned about forestry bias in the choice of statistics (Iremonger et al. 1996).

Various approaches have been adopted to classifying the discourses of environmental groups (see for example, O'Riordan (1995) and Dryzek (1997)). Two features of these discourses are important in the present context. First, they are post-productivist (Mather 2001), in integrating the economic, social and environmental dimensions of resource use; privileging the conservation of natural ecosystems, species and other components of biological diversity (biodiversity); and challenging productivist concepts of forest stewardship (Mather and Chapman 1995), by giving equal weight to qualitative and quantitative attributes of forests and promoting their management to provide materials and environmental services. Environmentalists felt that FRA 1980 neglected degradation, particularly of primary forests by logging (Nectoux 1985), a view shared by conservation groups (IUCN 1989) and others (OTA 1984). Deforestation rates in FRA 1980 were lower than estimates by Myers (1980) of more inclusive 'conversion' rates (Sedjo and Clawson 1984).

Second, they are emancipatory, in challenging established power structures (Habermas 1981) which in this case favour human dominion over nature. Suspicions that governments

[3] The term "productivism", often defined in an agricultural context (Bowler 1985), is used for convenience in place of Dolman's (2000) "productive use value," in which the market, exploitation, utilitarianism, interventionism and progress are prominent – though this is the meaning intended here.

submitted over-optimistic statistics to FAO were justified in some cases, e.g., FAO used official figures to project national forest cover in the Philippines as 32% in 1980, though according to an independent satellite-based survey it had already fallen to 30% by 1974 (Bruce 1977).

FRA 1980 was accorded a mixed reception by global change scientists. This reflected scientific discourse, which in the present context stresses "the pursuit of systematic and formulated knowledge" (Johnston 1986), by ordering complex environmental phenomena through classification. The report's detailed forest classification (Figure 1) appealed to the comprehensive reductionism of global change scientists, and enabled them to quantify deforestation and carbon accounting models.

On the other hand, also important to scientists is the testing of alternative explanations of phenomena by empirical measurements, using instruments of known precision to obtain consistent data of determinable accuracy. Some researchers evaluated the accuracy of FRA estimates, pointing to the limited use of remote sensing surveys (e.g., Grainger 1984). This was possible because (a) FAO scrupulously listed the sources, dates and form of measurement for each country's forest area estimates, a practice continued in later FRAs (Table 1, #6c); and (b) unlike climate model outputs, many end-users are technically qualified to evaluate them, undeterred by respect for FAO's authority.

3.3.3. Forest Resources Assessment 1990

In FRA 1990 FAO relinquished some autonomy and partly responded to environmental criticisms by using a simpler and more pluralist ontology of forest types (Figure 2). Natural Forest ('All Forest' in FRA 1980) was divided into six formations (Table 3) using the ecological zone/ecosystem classification systems of Yangambi (CSA 1956) and UNESCO (1973). While more acceptable to environmental groups and global change scientists, this limited consistency with FRA 1980, confounding FAO's initial intentions (Singh 1987). National areas of Closed Broadleaved Forest were listed for many countries, providing some continuity with FRA 1980, but the ontological distinction between Closed Forest and Open Forest (central to FAO's own Land Cover Classification System (Di Gregorio and Jansen 2000)) was lost.

FRA 1990 also incorporated environmental statistics (Table 4) on: (a) biomass[4], replacing Timber Volume Overbark; (b) biodiversity; and (c) areas of forest with conservation and protection functions (a semantic change from 'unproductive' forest in FRA 1980). Yet these were only estimated for regions, not countries. This accommodation partly explained the fewer objections from environmental groups than for FRA 1980, though poor publicity contributed too (Dudley 1996).

3.3.4. Global Forest Resources Assessment 2000

Consistency between FRA 2000 and FRA 1990 was limited in a number of ways. First, Natural Forest and Forest Plantations were integrated in a new statistic of Total

[4] Biomass in FRA 2000 measures the mass (in kg) of all above-ground living and dead wood in a forest, including branches, stump, roots and litter. In FRA 2005 it included foliage and below-ground biomass too. Volume Overbark measures only the volume of harvestable wood in trunks. Carbon stock measures only the mass (in kg) of carbon in biomass.

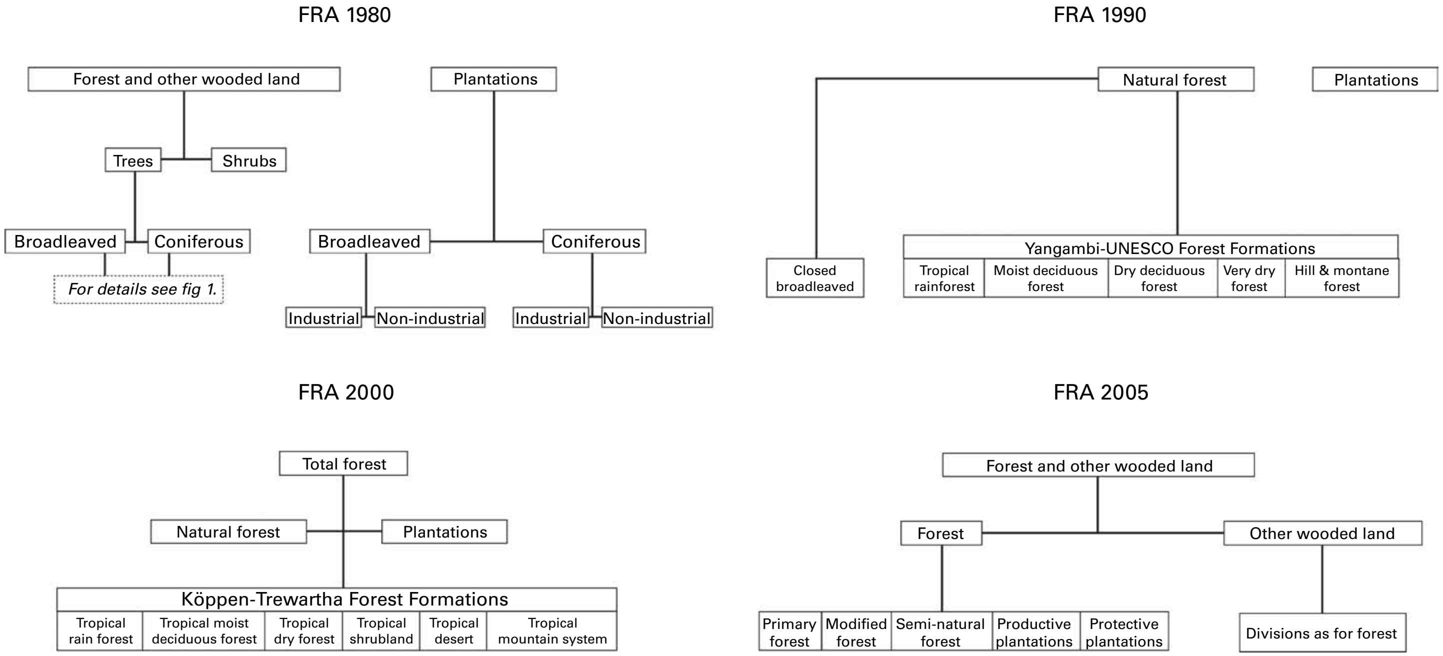

Fig. 2. Ontologies of Forest Resources Assessments 1980, 1990, 2000 and 2005. Sources: Lanly (1981), FAO (1993, 2001a, 2006a)

Table 3. Sets of forest formations used in Forest Resources Assessments (FRAs) 1990 and 2000

FRA 1990 (based on the Yangambi (CSA 1956) and UNESCO (1973) classifications)	FRA 2000 (based on the Köppen (1931) classification, modified by Trewartha (1968))
1. Tropical Rain Forest	Tropical Rain Forest
2. Moist Deciduous Forest	Tropical Moist Deciduous Forest
3. Dry Deciduous Forest	Tropical Dry Forest
4. Very Dry Forest	Tropical Shrubland
5. Desert	Tropical Desert
6. Hill and Mountain Forest	Tropical Mountain System

Sources: FAO (1993), FAO (2001a).

Forest (Figure 2). The apparent intention was to use the same framework for temperate and tropical forests (Peck 1996) – the distinction between natural forest and plantations is now questionable in temperate countries. However, the productivist connotations of this ontological shift are inescapable (Hoare 2005). Only national areas of Total Forest and Forest Plantations were included in the main tables. Direct comparisons with corresponding statistics in FRA 1990 were difficult because Forest Plantations area was inflated by including non-forest tree species (e.g., rubber) harvested for wood; FAO revised its 1990 area estimates but only issued new national figures for Total Forest. National areas of Natural Forest for 2000 were, however, listed in the text.

Second, Natural Forest was divided into forest formations by a different classification system (Köppen 1931; Trewartha 1968) (Table 3). This followed a reevaluation by FAO (1999; 2001c) and an expert panel (FAO 2000d). The switch led to spatial inconsistency with FRA 1990 since the two systems differ ontologically, e.g., in FRA 2000 the zone in which tropical rain forest can potentially occur was 36% larger in size than in FRA 1990 (author's calculations). However, the area of each formation was not listed, only its percentage of overall forest area.

Finally, Deforestation Rate was replaced by Rate of Forest Area Change (RFAC), a "net deforestation" statistic (FAO 2001a) that aggregates (gross) deforestation and afforestation rates. No national gross deforestation rates were listed. By measuring change in Total Forest, not Natural Forest, RFAC neglects ecological differences and can decline if deforestation rates fall *or* afforestation rates rise (Stokstad 2001). These drawbacks had been predicted (Singh 1996).

More environmental statistics were included (Table 4) to cover: (a) non-wood forest products, though only the main types in each country were indicated; (b) biodiversity, with national values now estimated for statistics focusing on two key concerns of environmental groups – protection of major ecosystem types and the threat to certain species; and (c) sustainability of management, using the Area of Forest Under Management Plans and the Area of Forest Certified as sustainable by groups accredited by an internationally recognized body (Rametsteiner and Simula 2003). However, FAO regarded the first of these sustainability statistics as inadequate since often plans are not implemented, and for many countries no values were listed for either statistic.

Table 4. Changes in environmental statistics categories for forest and other wooded land (OWL) in Forest Resources Assessments (FRAs) 1980, 1990, 2000 and 2005 (units of area unless otherwise stated)

	FRA 1980	FRA 1990	FRA 2000	FRA 2005
1.	**Degradation by Logging** (ha/an) Unlogged Closed Forest[f] (Broadleaved/Coniferous)	Total Closed Broadleaved Forest Unlogged Closed Broadleaved Forest Logged Closed Broadleaved Forest	Total Forest Area[f]	Change in Growing Stock (m^3/an) Change in Growing Stock (m^3/ha/an) Change in Growing Stock (%/an)
2.	**Degradation by Other Disturbances**		Forest Fires in Total Forest (no. /an)[f] Forest Fires in Total Forest (ha/an)[f]	Fires (ha/an) (Total Forest/OWL) Insects(ha/an) (Total Forest/OWL)[f] Diseases (ha/an) (Total Forest/OWL)[f]
3.	**Biomass**	Biomass Natural Forest (t) Biomass Density Natural Forest (t/ha)	Biomass Total Forest (t) Biomass Density Total Forest (t/ha)	Biomass and Carbon Stocks (separate), listed for: (Total) Forest and OWL (separate) (t) Above-Ground (t)[n] Below-Ground (t)[n] Dead Wood (t)[n] Litter (Carbon only) (t)[f] Soil (Carbon only) (t)[f]
4.	**Biodiversity (Species Numbers)**	By Yangambi Forest Formation[r] % Species Lost (by formation)[r]	Total Forest Species Endangered Forest Species (By Group)	Native Trees[n] Endangered Trees (By Threat) Percent Total Growing Stock In 3/10 Leading Species[f]

Table 4. Continued

	FRA 1980	FRA 1990	FRA 2000	FRA 2005
5.	**Biodiversity (Protected Areas)**	Natural Forest in Protected Areas[sr] Environmental Protection Forest[sr]	Total Forest in Protected Areas[f]	Area and % Total Forest for Conservation[n] Area and % Total Forest for Protection[n] Area and % Total Forest in Multiple Uses Area and % Total Forest for Social Services[n]
6	**Non-Wood Forest Products**		List by Main Groups[f]	Removals by Main Groups[f] Value of Removals (US$)[f]
7.	**Sustainable Forest Management**			
	Productive Forest		Area under management plans[n] Areas certified sustainable[n]	

Sources: FRA 1980 (Lanly 1981); FRA 1990 (FAO 1993); FRA 2000 (FAO 2001a); FRA 2005 (FAO 2006a)
Bracketed symbols, e.g., (Total Forest/OWL), mean that the statistic is estimated separately for each symbolized class.
[n] not for all countries
[f] estimated for a few countries only
[r]estimated for main continental regions (e.g., Africa) only, [sr]estimated for sub-regions (e.g., West Africa) only

3.3.5. Global Forest Resources Assessment 2005

Publication of FRA 2005 followed the FAO Committee on Forestry's decision to switch to quinquennial reports after FRA 2000 (FAO 2001b; 2003b). Its two highest area categories are Forest and Other Wooded Land. The latter, included in global FRA 1990 (FAO 1995) but omitted from FRA 2000, corresponds to 'Shrubs' in FRA 1980 plus other areas with tree cover. The layer of categories below 'Forest' (a confusing semantic shift from Total Forest in FRA 2000) is divided by 'naturalness' into Primary Forest ('undisturbed forest' in FRA 1980), Modified Forest (e.g., logged forest and forest fallow), Semi-Natural (intensively managed) Forest, Productive Plantations, and Protective Plantations. There are no national, regional or pan-tropical estimates of Natural Forest area.

Existing groups of environmental statistics in FRA 2000 are expanded (Table 4), with two matching tables on Biomass and Carbon Stock[3], and new statistics on the Volume and Value of Removals of Non-Wood Forest Products (though for many countries no estimates are given).

The two sustainability statistics in FRA 2000 are excluded, but each table of national statistics is now linked to one of six 'thematic areas' (TAs), out of seven recognized by a conference of nine regional inter-governmental processes that promote the development of systems of criteria and indicators for sustainable management (FAO 2003a):

- Extent of forest resources
- Biological diversity
- Forest health and vitality
- Productive functions of forest resources
- Protective functions of forest resources
- Socio-economic functions
- Legal, policy and institutional framework

FAO uses this framework to evaluate regional trends in sustainability but admits "it [is] difficult to say anything definite about the level of progress" (FAO 2006a). This is understandable, for while the TAs cover all dimensions of post-productivist sustainability FRA statistics focus on forest extent and production, not quality of forest management. The TAs correspond to the International Tropical Timber Organization's seven sustainability criteria (ITTO 2005); Poore (2003) was also unimpressed by criteria and indicator systems, calling them "a good idea that has lost its way." The TA that is arguably most critical for national sustainability – sound policies and a national capacity to implement them – is the one FAO omits.

3.4. Data Collection

Views differ on the optimal degree of centralization for statistical processes (Øien 1991). More centralized collection may bring greater uniformity in data quality but at the expense of mean quality. Data collection is decentralized in the FRA process, with FAO requesting the latest estimates from governments, as it does for FAO Production Yearbooks. Estimates come mainly from 'national correspondents' in the state forestry department (or equivalent).

Reliance on country reports reflects a key tenet of FAO's traditional discourse: respect for member state sovereignty. Long dominated by colonial powers, developing countries, in particular, now assert their sovereignty and resist threats to it from globalization. They challenge a common assumption of international civil society groups, representing a cosmopolitan ('world citizenship') discourse, that everyone is a stakeholder in tropical forests (Nath 1992). Information is central to every dimension of globalization, including the environmental one (Grainger 2005); many states regard information on natural resources as within the ambit of national sovereignty and controlling statistics as a legitimate defensive tool (though see Trutzel (2005) for a contrary opinion). Others have argued that governments shape the content of national statistics (cf. Table 1, #1c) to maintain their internal power (Simpson and Dorling 1999; Persson 1979), or inhibit criticism of their commitment to fulfilling international obligations (Kpedekpo and Arya 1981). Myers (1980, 1989) tried when making his estimates to counter government bias through participatory interrogation of 'official' figures and drawing on nongovernmental data sources.

FAO responded to scientists' concerns about FRA 1980 (see Section 3.3.2) by changing the original design of FRA 1990 to include regional estimates of forest areas and deforestation rates for Africa based on a parallel centralized satellite survey. Such elaborations probably explain why the report was less detailed than FRA 1980. The entire tropics was surveyed in FRA 2000, though again no national estimates were produced, as FAO (2000a) claimed it had "no mandate to monitor member states." FRA 2005 was more decentralized than ever before, using national statistics as the sole data source for the first time. FAO had stated on a number of occasions that it was considering switching to a more satellite-based system (FAO 2000a, 2000b; Tomppo et al. 2002; Tomppo and Czaplewski 2002a, 2002b). Yet it appears that it only ever envisaged "coordinating and facilitating," not implementing this (FAO 2000e). As many countries have insufficient resources to survey their forests regularly, enthusiasm for decentralization is more political than technical in origin (though good ground data are essential for satellite surveys). FAO (2006b) wants to extend the parallel survey to global level in FRA 2010, but only to validate regional estimates.

3.5. Estimating Statistics

FAO has (until FRA 2005) corrected to a common base year estimates of forest area that have been mainly supplied by governments, usually based on their latest national forest surveys. Although this is technically *editing* (Granquist 1997), when the latest survey was 20-30 years ago it is closer to *imputation*, which supplies plausible values for missing ones to complete a dataset (Charlton 2004). FAO respects national sovereignty by often listing the uncorrected figures too.

Consistency between FRAs is limited by the use of different correction methods. Forest areas in FRA 1980 were adjusted to the base year of 1980 by linear projections, or imputed by experts. Deforestation rates for 1976-80 were estimated using inventory information when this was available, and by modelling when it was not.

In FRA 1990 FAO intentionally took "a more scientific" approach to estimation (Holmgren and Persson 2002). Each country's forest area was projected to 1990 using regional deforestation models that simulate the non-linear decline in Percentage National Forest Cover as a function of Population Density revealed in cross-sectional regression models (e.g., Palo et al. 1987). Yet for 33% of 90 tropical countries in 1980 forest areas and 1990 were both extrapolated from data outside the period, as the last national forest survey was before 1980 (Table 5).

Some scientists were impressed by FRA 1990, e.g., Brown and Czaplewski (1997). Others had reservations about errors in (a) regional correction models resulting from variation between countries; and (b) Natural Forest area values, since estimates are less accurate for open forest than closed forest. Using deterministic, rather than stochastic, imputation also underestimates a variable's variance (Nielsen 2003). So if deforestation rates are estimated as a function of population growth (as they were in FRA 1980), misleading correlations will result between these variables if the statistics are used in cross-sectional analysis of factors causing and controlling deforestation (Rudel and Roper 1997). This happened, for example, in Rudel (1994). The same would apply if tests for non-linear relationships between national forest area and population density used forest areas in FRA 1990 corrected by the non-linear method.

FAO dispensed with non-linear models in FRA 2000, on the advice of an expert panel that reflected some of these concerns (FAO 2000c). Instead it corrected forest areas to 2000 by linear projections and (for a third of all tropical countries) expert judgments, much as in FRA 1980. Rate of Forest Area Change was estimated by evaluating national forest area statistics in the light of information from the parallel remote sensing survey, and for 90 tropical countries was 12.2 million ha per annum in the 1990s. The gross Deforestation Rate was 13.4 million ha per annum, compared with 15.4 million ha per annum in the 1980s (according to FRA 1990). Satellite-based estimates for the 1990s were smaller: 9.2 million ha per annum for all tropical forest (in the parallel FRA study) and 5.8 million ha per annum for tropical moist forest only (by the TREES Programme (Achard et al. 2002)). But the merits of their sampling designs, which were random for the FRA survey and clustered by deforestation 'hot spots' for the TREES study, have been debated (Tucker and Townshend 2000; Czaplewski 2002; Kaiser 2002).

In FRA 2005 FAO asked member states to fit data structured within their own forest ontologies into FRA's global ontology *and* correct them to 1990, 2000 and 2005 (usually by linear projection), effectively restricting FAO's role to quality control (cf Table 1, # 5c). This was surprising, as FAO admitted that the accuracy of FRA 2000 statistics was compromised by lack of reliable data for many countries (FAO 2001a; Tomppo et al. 2002), a qualification repeated in FRA 2005. FAO (2005a) also

Table 5. Length of period since the last national forest survey, for 90 tropical countries in Forest Resources Assessments (FRAs) 1990, 2000 and 2005 (the number based on expert estimates, not contemporary mapping, is shown in brackets)

Period Since Survey (Years)	Number of countries		
	FRA 1990	FRA 2000	FRA 2005
>10	30	16(5)	31(15)
≤ 10	60	74(25)	59(20)

Sources: FRA 1990 (FAO 1993); FRA 2000 (FAO 2001a); FRA 2005 (FAO 2006a) warned that "many countries are reporting forest area estimates for 1990 and 2000 which differ from those . . . in . . . FRA 2000 . . .". Hopefully, the new approach will not make domestic ontologies redundant: Gold et al. (2006) relied on original national statistics to correct for temporal inconsistency in the ECE/FAO statistical process for European forest resources.

3.6. Reporting and Dissemination

A statistical agency is usually established to publish statistics on an ongoing basis, so its continuity should promote temporal consistency. FAO Production Yearbooks are produced in a permanent office in FAO's Department of Economic and Social Policy. Often assumed to provide an authoritative annual time series for Forests and Woodland (e.g., Lomborg 2001), their statistics – until listing ceased in the mid-1990s – were only those *reported* (not measured) every year.

FRA statistics appear discontinuous by comparison, but have usually been more accurate and disaggregated. Although the Assistant Director General for Forestry committed FAO in 1990 to continuously monitor the world's forests (Murray 1990), each FRA has been treated as a self-contained project, giving scope for varying process design. FAO's own hindsight narrative assigns every FRA a theme: deforestation (FRA 1980); deforestation and biodiversity (FRA 1990); multiple forest benefits (FRA 2000); and sustainable management (FRA 2005) (FAO 2006a). The chapter structure of FRA 2005 matched six of the seven thematic areas of post-productivist sustainable management listed in Section 3.3.5, in contrast to the productivist "forest inventory" structure of earlier reports (Holmgren 2002). FAO's preference for 'snapshots' is not unique (see Clarke and Doel 2005), but other international statistical processes vary reporting themes without being inconsistent (e.g., World Resources Institute 2000).

In each FRA FAO has revised estimates in its predecessor(s) to ensure consistency with current ones. The total area of Natural Forest in the tropics in 1980, given as 1,970 million hectares for 76 countries in FRA 1980 (Lanly 1981), was later corrected to 1,935 million ha (FAO 1982), then revised to 1,910 million ha for 90 countries in FRA 1990 (Table 6). The estimate of 1,756 million ha for 1990 in FRA 1990 was raised to 1,932 million ha for the same 90 countries in FRA 2000, falling to 1,799 million ha in 2000. FRA 2005 raised both the 1990 and 2000 estimates and gave the 2005 area as 1,768 million ha (these figures were calculated by subtracting Forest Plantations Area from Total Forest Area). Adding the areas of the 32 and 42 other tropical countries included in FRAs 2000 and 2005, respectively, only raises these totals by 0.3%.

Later *vintages* of statistics are generally considered more reliable, for if measurement errors decline then estimates should progressively approach the actual value (Patterson and Heravi 2004). Yet while estimates for over half of the 90 countries in FRAs 2000 and 2005 were based on remote sensing surveys, for more than a third of countries estimates relied on subjective expert assessments (Table 5).

Internal consistency within each FRA was obtained at the cost of inconsistency between the tropical forest area narratives of different FRAs (Table 6). The FRA 2000 narrative resembles that in FRA 1990 displaced by ten years, following increases in the 1990 estimates for half of the 90 countries (Figure 3). A further net rise in estimates in FRA

Table 6. Estimates of areas of Natural Forest in tropical countries in 1980, 1990, 2000 and 2005, showing different vintages of statistics in Forest Resources Assessments (FRAs) 1980, 1990, 2000 and 2005 (million ha)

	FRA 1980	FRA 1982	FRA 1990		FRA 2000		FRA 2005		
	1980	1980	1980	1990	1990	2000	1990	2000	2005
Africa	703	703	569	528	684	629	672	628	607
Asia-Pacific	337	337	350	311	313	265	342	312	296
Latin America & Cbn.	931	896	992	918	936	905	934	889	865
Totals*	1,970	1,935	1,910	1,756	1,932	1,799	1,949	1,829	1,768
No. of countries	76	76	90	90	90	90	90	90	90
Original Totals*	1,970	1,935	1,910	1,756	1,938	1,804	1,955	1,834	1,773
No. of countries	76	76	90	90	122	122	132	132	132

NB. *Totals may not match sub-totals due to rounding. ‘Original Totals’ refer to all tropical countries listed in the FRA concerned. ‘Totals’ refer to our standard set of 90 countries or, for FRA 1980, only the 76 countries it included.

Sources by column: (1) Lanly (1981); (2) FRA 1982 = FRA 1980 updated for Latin America (FAO 1982); (3–4) (FAO 1993); (5) Calculations by this author from statistics in FRA 1990 and FRA 2000 (FAO 2001a); (6) FAO (2001a); (7-9) Calculations by this author from statistics in FRA 2005 (FAO 2006a).

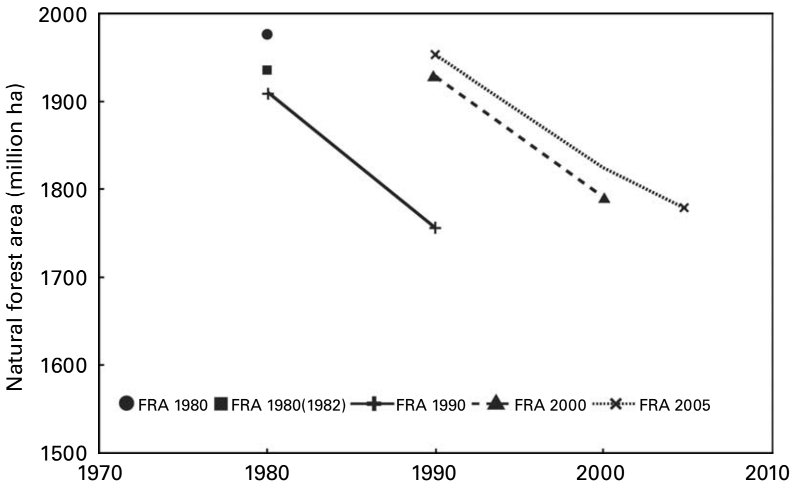

Fig. 3. Alternative narratives of trends in Natural Forest area in tropical countries from 1980 to 2005 (million ha), from Forest Resources Assessments (FRAs) 1980, 1990, 2000 and 2005. Sources: Grainger (2007), based on Lanly (1981), FAO (1982, 1993, 2001a, 2006a)

2005 led to an upward shift in the narrative for 1990 to 2000. According to FAO (2001d), for 70% of the countries whose 1990 estimates were raised in FRA 2000 the adjustments took advantage of 'better' data; the remainder were attributable to changes in classification. Such rises in successive estimates seem to resemble 'reserves appreciation' in oil reserves (Odell and Rosing 1983), but the parallel is weak as they do not necessarily reflect comparable regional and national adjustments (Grainger 2007).

3.7. Consultation and Feedback

FAO seeks advice and feedback from end-users in "expert consultations," the most comprehensive of which are held at the Kotka College of Forestry and Forest Industry in Finland. FAO's traditional discourse is not greatly challenged as most participants are forest inventory and forestry specialists employed by state forestry departments (Table 7).

Nevertheless, the sole environmental group at 'Kotka I' in 1987, the World Conservation Union (IUCN), won support for including environmental statistics in FRA 1990 (Collins 1987). Similar proposals for FRA 2000 at a meeting in Nairobi in 1992 and at Kotkas II (1993) and III (1996) lacked focus: at Kotka III IUCN identified no fewer than 18 "top priority" environmental statistics (Iremonger et al. 1996).

Global change scientists advised on using remote sensing techniques in FRAs at meetings in Rome in 1990 (for FRA 1990) and Washington in 1996 (for FRA 2000). Yet increasing aggregation of area statistics suggests that FAO still does not fully understand their needs, as does a comment on responses to FRA 2000: "Users and media still appeared to be primarily interested in forest area and area change" (FAO 2006a).

Urged by Kotka III and the Rome 2000 meeting to become more accessible and transparent (Table 1, #6a/b), FAO now places on its website drafts of FRAs and working papers describing its methods. An evaluation of the draft FRA 2000, published on the World Resources Institute website, identified the drawbacks of the new Rate of Forest Area Change

Table 7. Forest Resources Assessment expert consultations and Advisory Group meetings: aggregate attendance by external experts by speciality and percent all recommendations implemented by 2006

	Participants by Category[a]							
	Forest Inventory	Forestry Miscellaneous	Other UN Bodies[b]	International Agreements[c]	Environmental	Global Change Science	Percent Experts at Previous Kotka Meeting	Percent Recommendations Implemented by 2006[d]
Expert Consultations								
Total No.	119	78	7	11	11	15	na	na
Mean (%)	49	32	3	5	5	6	25	68
Advisory Group Meetings								
Total No.	65	29	18	5	8	5	na	na
Mean (%)	45	28	8	12	8	0	na	33

Sources. Expert Consultations held at the Kotka College of Forestry and Forest Industry: (I) FAO (1987), Nyyssönen (1987); (II) Nyyssönen (1993); (III) Nyyssönen and Ahti (1996); (IV) FAO (2002a); (V) FAO (2006d). Other consultations: FAO (1990); UNEP (1993); Lund and Blue (1996), Paivinen et al. (1996); FAO (2000c). Advisory Group Meetings: FAO (2002b); FAO (2003c); FAO (2003d); FAO (2005a); FAO (2006c).

NB. [a]Totals and means refer to participants in the seven expert consultations held between 1987 and 2006 for which data are available (excludes Nairobi (1992) and Washington (1996)) and all five Advisory Group meetings 2002-2006. Advisers are categorized by this author by primary interest/affiliation. [b]Excludes staff of UN Economic Commission for Europe. [c]Agreements include: UN Conventions on Biodiversity and Climate Change, International Tropical Timber Agreements etc. [d]Refers to the percentage of substantive (as opposed to procedural) recommendations implemented partly or wholly in at least one FRA by 2006 (means of 59 recommendations (in 9 consultations) and 15 recommendations (in 5 AGs)). na = not applicable.

Table 8. *End-user perceptions of Global Forest Resources Assessment 2000*

Positive	Negative
1. Comprehensive coverage	1. Forest area/deforestation rate estimates inaccurate
2. Data sources and methods transparent	2. Reliance on member state statistics leads to (1)
3. Original national statistics listed	3. Carbon/biodiversity statistics inaccurate
4. Adjustment methods simpler than in FRA 1990	4. Inconsistency between successive FRAs
5. First global maps of forest by ecological zones	5. Forest and plantation areas aggregated
6. Collaboration with outside organizations	6. Deforestation/afforestation rates aggregated
	7. Forest definitions unacceptable to all end-users
	8. Statistics less reliable than implied in report

NB. Based on replies to a questionnaire from representatives of four types of end-user groups (number of groups in brackets): environmental (6), global change research (4), forestry research (2), international organization (1). Source: Matthews and Grainger (2002)

and Total Forest statistics (Matthews 2001), and publicity given to it in a Centre for International Forest Research (CIFOR) email newsletter generated responses from other critics. However, informal feedback to FAO had limited impact: no national estimates for gross Deforestation Rate were included, and those for Natural Forest areas for 2000 (only) were listed in the text, not the main tables.

Kotka IV, held in 2002, urged FAO to recognize the diversity of FRA end-users; study their needs more deeply than in a survey commissioned for Kotka IV (Table 8); and introduce a smaller, multi-disciplinary Advisory Group that could meet more frequently than consultations. The latter was established, and held four meetings between 2002 and 2005 to advise on FRA 2005. The inclusion of representatives of the Worldwide Fund for Nature and World Resources Institute embedded environmental groups in the FRA policy community. Continuity of membership should ensure more consistent advice than provided by Kotka meetings – only a quarter of external advisors have attended the previous event (Table 7) – *and* more consistent responses from FAO.

FRA design is now influenced by international forest-related agreements too, e.g., 'thematic areas' for sustainable management are used to group statistics and structure chapters in FRA 2005 (see Section 3.3.5). A representative of the Ministerial Conference for the Protection of Forests in Europe attends Kotka meetings and, with one from the International Tropical Timber Organization, those of the Advisory Group too. The Secretariat of the Framework Convention on Climate Change was also represented at Kotka IV, and is a member of the Collaborative Partnership for Forests which FAO coordinates (FAO 2005b). Climate change needs are acknowledged by the inclusion of more detailed biomass statistics in FRA 2005. The latter was reviewed at Kotka V in 2006.

It is difficult to position these end-user consultations on Pateman's (1970) continuum of participation. This stretches from true participation to 'pseudo-participation', a term used to describe "a consultative process [by which they] are merely kept informed of developments . . . and expected to accept decisions already made" (Rose 2003). Since Kotka I the emphasis has switched from top-down briefings to collegial discussions, and environmental and global change issues are well represented. Yet FAO has the final word in the FRA dialogue. Over two thirds of recommendations were implemented in a later FRA (Table 7), but a third of changes were partial, inconsistent (omitted in later FRAs), or symbolic (Matten 2003), e.g., overaggregated or only estimated for a few countries. The Advisory Group has made fewer substantive recommendations than have expert consultations, with only a third implemented so far. Thus, biodiversity statistics in FRA 2005 conformed to specifications recommended by the Advisory Group's first meeting, but FRA 2005 did not resemble FRA 2000 in design, as its second meeting suggested, probably because of decisions taken earlier at Kotkas III and IV.

4. Searching for Meaning in the FRA Process

Two key themes emerge from this analysis: temporal inconsistency (visible at every stage in the FRA process) and the continued hegemony of FAO's traditional discourse. Temporal inconsistency is not unique to forest statistics, appearing in decennial population censuses too (e.g., Diamond 1999). So instead of questioning it, and clinging to modernist expectations of continued improvement in the quality and accuracy of statistics, it seems more appropriate to offer a post-modern interpretation of the FRA process which, "rather than trying to find truth, seeks to highlight the practices involved in constructing representations of truth" (Schram 1993).

4.1. Temporal Inconsistency

Temporal inconsistency in FRA design may be linked to two main factors. First, autonomous decisions by FAO in areas where it has perceived expert authority and its traditional discourse can dominate, e.g., choosing forest area statistics. Second, partial reciprocity in construction, where FAO is more sensitive to truth as perceived by civil society but is constrained by:

- The first three elements of its discourse. So well-tried methods are retained when new ones are adopted, e.g., expert imputation backed by FAO's authority continues, despite engagement with 'scientific' estimation; and unresolved conflict between scientific discourse and FAO's commitment to member state sovereignty compartmentalizes remote sensing surveys from the main studies.
- Conflicts between its discourse and those of environmental groups. This leads to variation in the choice of environmental statistics that may reflect its:
    - Preference for 'snapshot' monitoring. This, together with poor organizational learning,[5] and changes in staff, consultation participants and end-user demands,

[5] Organizational learning is defined (after Crossan et al. 1999) as identifying patterns in experiences, explaining these to colleagues, integrating them into shared understandings throughout an organization and institutionalizing these as modified rules and procedures. (In a more restricted view (Haas and Haas 1995) it occurs when an organization questions its basic beliefs, in contrast to non-reflective 'adaptation.')

encourages a contextual approach to FRA design, as a result of which FRAs change in character from one report to the next.

- Symbolic responses to idea-based (non-market) environmental concerns, compared with more substantive responses to material- (e.g., timber) and interest-based (e.g., member states') issues. So including a statistic may seem more important to FAO than whether it is quantified for many countries or retained in later FRAs.
- Uneasiness with statistics not 'anchored' in its discourse. These statistics, which in the language of Lévi-Strauss (1950) can be termed "free floating", are more meaningful to environmental groups than to FAO. Such difficulties may reflect its inability to devise an acceptable post-productivist ontology as universal as that of FRA 1980 (see Figure 1). Environmental groups lack the power to insist on a new ontology – unlike end-users of the Land Cover Map of Great Britain 2000 who restricted scientific autonomy in its design (Comber et al. 2003).

4.2. Maintaining FAO Autonomy

FAO's continued control over the FRA process typifies the generic political phenomenon of hegemony (Gramsci 1971) and resonates with Barnett and Finnemore's (2004) idea of "undemocratic liberalism" in international organizations (IOs). Their constructivist, bureaucracy-centred analysis of IO autonomy counters some of the limitations of Principal-Agent Theory (PAT) explanations of how the autonomy of the secretariat (or 'agent') is constrained by member states (the 'principal') (Nielson and Tierney 2003). Yet neither approach fully displays the tensions involved, for while IO secretariats have autonomy, it is limited since they must continually acknowledge the sovereignty of member states from which it derives. So they are just as entangled in their member states as member states are in them (Jacobson et al. 1986). Constructivism and PAT are also unable to provide a comprehensive explanation of the interface between IOs and global civil society.

This section therefore offers an alternative framework for understanding the longevity of an IO's "structure of meaning-in-use," as Milliken (1999) perceptively calls discourse. It involves linking the reproduction of discourse to the reproduction of institutions through regular practices in networks of actors both within and outside IOs (after Giddens 1984). Institutions are conceived differently by the various schools of 'new institutionalism' (Hall and Taylor 1996). Yet none of the schools would object to a definition of institutions as "enduring regularities of human action" (Crawford and Ostrom 1995), and all would agree that institutions should not be equated solely with organizations, a usage that still persists in some quarters (Philo 2001). Instead, institutions pervade organizations. Adopting a new institutionalist approach, in my view, sheds more light on the internal functioning of IO secretariats than either constructivism or PAT, overcomes the structural bias of the former and the agency bias of the latter and, equally importantly, links internal functioning to external relationships.

In this framework, institutions are portrayed as sustaining FAO discourse at multiple inter-related levels (Scott 1994):

- Organizational level. Decision-making by actors within FAO is guided by *formal institutions*. For historical institutionalists,[6] these formal rules create a "logic of appropriateness" (March and Olsen 1989) that filters out – or compartmentalizes – contrary views and promotes path-dependency (Thelen 1999). But when following rules becomes an end in itself the result can be bureaucratic dysfunctionality (Merton 1940) and "self-defeating behaviour" (Barnett and Finnemore 1999). Overaggregation, for instance, is making FRA statistics less relevant to some end-users.
- Sub-organizational level. *Informal institutions* arise in bureaucracies from what De Certeau (1984) has called the "everyday practices" of their personnel. These become "rules in use" through regular reproduction and undermine effectiveness (Hill 1972).[6] So for sociological institutionalists institutions include not just rules but "symbolic and behavioural systems" that transcend organizations and create meaning and identities for staff (Scott 1994). Informal institutions linked to professional discourses strengthen IO autonomy against external pressures, e.g., environmental reform has been impeded at the World Bank by its economic/engineering culture (Nielson and Tierney 2003), and in FAO's Department of Forestry (FAODF) by its focus on timber production. Symbolic and contextual responses to civil society discourses therefore come as no surprise.
- Global level. From a sociological institutionalism perspective, IOs are legitimized externally by complying with the myths and symbols of their environment (the UN system), not by their efficiency (Scott 1994). So ritualistic observance of formal rules in FAO reproduces and legitimizes its discourse in daily interactions in the cohesive network linking it to member states and other UN bodies. Privileging communications in this network insulates FAO from civil society – a formal consultation with a small group of NGOs before the FAO Ministerial Meeting on Forestry in 2005 was apparently the first of its kind (Kneeland and Vahanen 2005). Member states, on the other hand, may see the FRA process as yet another multilateral meeting place, or "node," for reproducing their sovereignty (Ansell and Weber 1999). FAODF's productivism is also entrenched, and its authority enhanced, by interactions with foresters in state forestry departments. Indeed, FAO is a beacon for propagating modern forestry culture, strongly influencing forestry departments in different countries to adopt similar cultures and practices, a phenomenon known as institutional isomorphism (DiMaggio and Powell 1983).

Material flows in IO networks are also important, however. According to Phillips et al. (2004), in the "mutually constitutive relationship among action, texts, discourse and institutions. . .institutions [are] constructed primarily through the production of texts, rather than directly through actions." This differs from the new institutionalist approach

[6] Historical institutionalists do recognize informal institutions too (Thelen and Steinmo 1992).

presented here so far, in which texts are effectively assumed to include actions, and institutions are formed by actors interacting together on a regular basis, called “reciprocal typification of habitualized actions” by Berger and Luckmann (1967).[7] But it does apply to IOs, which transact formal practices by circulating texts. Thus the report of FRA 1980 began, like most UN documents, by citing the decision that authorized it.

Yet circulating texts does not have to be treated as an alternative to the mutually reinforcing effects of human behaviour. Viewed from a “heterogeneous” perspective (Murdoch 1997), it consolidates them. Through the lens of Actor Network Theory (ANT), for example, which allows both humans *and* material things to be members of networks, the flow of national statistics from member states to FAO and their translation into international statistics create a powerful network (Latour 1986). This would be weakened if satellite images substituted fully for national estimates by member states, but is strengthened when civil society groups ‘enrol’ themselves into the network by using FRA statistics. The latter, and foresters’ respect for FAO authority, may help to explain how consent from global civil society can (as Gramsci argued) maintain FAO hegemony.

5. Discussion and Conclusions

FAO’s Forest Resources Assessments (FRAs) are tremendous accomplishments and a tribute to the hard work of many people. Their temporal inconsistency, it is argued here, results from autonomous decisions by FAO, and partial reciprocity – responses to perceived civil society end-user needs constrained by FAO’s traditional discourse. The latter, and FAO autonomy, is sustained by mutually reinforcing symbolic, formal and informal institutions and the circulation of texts. Analysing technical decisions within an institutional framework shows the value of Malaguerra’s (2005) idea of a unified approach to statistical science that is relevant to both academic and official statisticians.

This reading of the FRA process resonates with end-user perceptions of its pros and cons (Table 8). But it does have limitations, for while Kotka and Advisory Group meetings and FRA methods are well-documented, many FAO operations remain hidden from outsiders. Different readings are possible, as FAO’s own narrative shows. The FRA process scores well on the evaluation criteria in Table 1 (Table 9). Most of these apply at international level, yet protecting statistical agencies from government intervention (#1c) is less relevant since IOs derive power from producing information, and privileging member states over civil society replaces respect for data provider confidentiality (#4c/d,#6f).

Might FRAs become more consistent in future? FAO is currently, I would argue, in the first of a sequence of three waves of environmental reform.[8] This initial ‘symbolic’

[7] Phillips et al. (2004) adopt a more restrictive approach to institutions than others (e.g., Fairclough 2003) who treat actions as equivalent to texts.
[8] Nielson and Tierney (2003) have proposed the idea of “waves of reform” but not explicitly a three-wave sequence.

Table 9. Evaluation criteria in Table 1 applied to the Forest Resources Assessment process

	Yes	Partial/Not Applicable	No
1. Consultation			
a. Inclusiveness	Y		
b. Effective and consistent response to needs		P	
c. Political independence			N
2. Agency designation			
a. Appropriate legal framework	Y		
b. Political independence		NA	
c. Adequate staff training			Y
3. Choice of statistics			
a. Meets end-user needs and maintains consistency		P	
b. Impartiality and integrity		P	
c. Optimizes data provider burden			N
4. Data collection			
a. Professional, scientific and consistent methods		P	
b. Justifiable and consistent mix of data sources		P	
c. Rights of data providers respected		NA	
d. Data providers informed of rights/duties		NA	
e. Effective quality control	Y		
f. International assistance	Y		
5. Estimating statistics			
a. Professional, scientific and consistent methods		P	
b. Efficiency, timeliness and accuracy	Y		
c. Effective quality control		P	
d. Effective quality improvement mechanisms			N
6. Reporting and dissemination			
a. Working methods transparent	Y		
b. Meaning of statistics transparent	Y		
c. Quality evaluation transparent	Y		
d. Equality of access	Y		
e. Timeliness	Y		
f. Confidentiality of data providers protected		NA	
g. Consistency of reporting		N	
7. Feedback			
a. Effective feedback mechanisms	Y		

Key: Y = Yes, N = No, P = Partial, NA = Not Applicable
NB. "Partial" scores may result if not all requirements in a criterion are met

wave, characterized by a gap between words and deeds, could last indefinitely. New institutionalism theories offer few insights into institutional change (Gorges 2001), but all bureaucracies adapt poorly to social change (Burns and Stalker 1961), and ritualistic rule following and the lack of a learning culture inhibit organizational learning from responses to outside pressures (Lipshitz and Popper 2000). At the World Bank the symbolic wave lasted from 1987 to 1994, when exasperated member states launched the second wave by changing its formal rule system to integrate the environment into operations (Nielson and

Tierney 2003). In the third wave, changes must be made to the more tenacious informal institutions (Weaver and Leiteritz 2005). At the World Bank this wave is still ongoing (Gutner 2005).

Reforming FAO will be more difficult, as it has greater autonomy from member states and civil society than the World Bank (Beigbeder 1987) and is more integrated into the UN system. The U.S. government, for example, traditionally appoints the World Bank's President, and so can insert a 'change entrepreneur' if it wishes. Developing member states also have more power in FAO to resist environmental reforms they perceive will threaten their development. Adopting a comprehensive post-productivist set of forest statistics might, extending Demeritt's (2001b) argument, impose a new political order of global environmental governance that developing countries would oppose (Mather 2005). The potential for outside professionals to expedite reform has, in my view, been overstated.[9] But if FAO did become more open to outsiders then organizational learning would be facilitated by research into links between: (a) the four institutional mechanisms identified here and how FAO staff perceive them; and (b) systems of rules in the FRA process and in FAO as a whole.

Transferring responsibility for global forest monitoring, e.g., to a new World Environment Organization more powerful than the UN Environment Programme (UNEP) (Biermann 2001) would probably not improve matters. Constraints from FAO's informal institutions would disappear but not those from UN institutions generally.

Civil society groups might, however, fill the 'information gap' themselves. Like IOs, they want to establish their autonomy and political space (Bayart 1986), and are now more willing to 'cross the border' with the state system. For example, by imitating the latter's use of symbolism to enhance legitimacy and power (Tsoukas 1999), and assuming IO roles by establishing transnational networks to tackle environmental problems of low priority to the state system, thereby "transfiguring transnational political space" (Lipschutz 2000).

Such networks already exist in forest monitoring, but have a hybrid character, as is commonly found in the field of international development (Brinkerhoff 1996). IUCN's World Conservation Monitoring Centre, for example, formed a global network to make the first atlas-based estimates of tropical forest area (Collins et al. 1991), and then became part of UNEP. The first alternative estimates of tropical forest area and deforestation rates to be based wholly on satellite imagery came from global change scientists at the European Commission's Joint Research Centre (Achard and Estreguil 1995; Achard et al. 2002). Global change networks have also enrolled remote sensing agencies, e.g., a new satellite will improve estimates of carbon stocks by monitoring forests in three dimensions (Hese et al. 2005). If these trends continue international statistical processes will become more complex, and environmental statistics could become a medium for constructing not just our view of nature but, indirectly, society itself.

[9] Haas (1990) and Haas and Haas (1995) suggested that external "epistemic communities" of professionals could help IOs discover their dysfunctionality and how to overcome it. However, they viewed IOs as mainly consisting of groups of member states and took an idealistic view of information. Of all IOs, the World Bank has long been the most open to two-way academic interchange, but this did not prevent its initial symbolic responses to calls for environmental reform.

6. References

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Statistics is a crucial process behind how we make discoveries in science, make decisions based on data, and make predictions. Statistics allows you to understand a subject much more deeply. In this post, I cover two main reasons why studying the field of statistics is crucial in modern society.Â Using statistical analyses to produce findings for a study is the culmination of a long process. This process includes constructing the study design, selecting and measuring the variables, devising the sampling technique and sample size, cleaning the data, and determining the analysis methodology among numerous other issues. The overall quality of the results depends on the entire chain of events. A single weak link might produce unreliable results. Statistical process control (SPC) is a set of tools that is widely used in production industry. The main elements of SPC are control charts for monitoring the stability of processes and process capability evaluations.Â On an international level, there is currently no standard or guideline available describing the application of SPC for SBJP.Â These influences on the process along with their parameter space need to be recorded for each group of potentially similar processes. There are several methods available to identify influences on a process, e.g. the Ishikawa diagram [19] and the IDEF0 diagram [20]. The process influences can be extracted directly from the diagrams and become factors by which the features are categorized.