Training Workshop on Forest Accounts

Building forest accounts

Shimla, Himachal Pradesh - September 22, 2014

Juan Pablo Castaneda

Environment and Natural Resources Global Practice, The World Bank

Outline

- The policy agendas at national and global levels
- Forest accounts in the context of NCA.
- What are forest accounts and how to do them
- A comment on data challenges

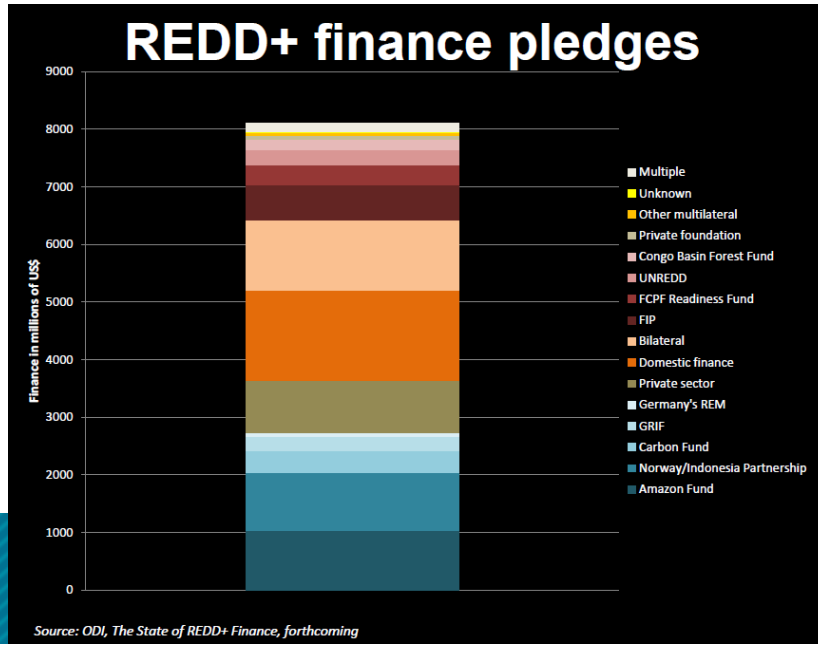
The forest policy agendas

National agenda

- Enhance revenues from forests managed as forests (REDD+)
- Include forest-based income in national income accounts
- Value forests for food security. Recognize forest-based ecosystem services as input to agriculture.
- Increase forest productivity (green infrastructure)
- Increase forest related activities productivity
- Value forests for adaptation
- Ensure that appropriation of forest resources is legal
- Ensure equitable distribution of forest resources

Global agenda

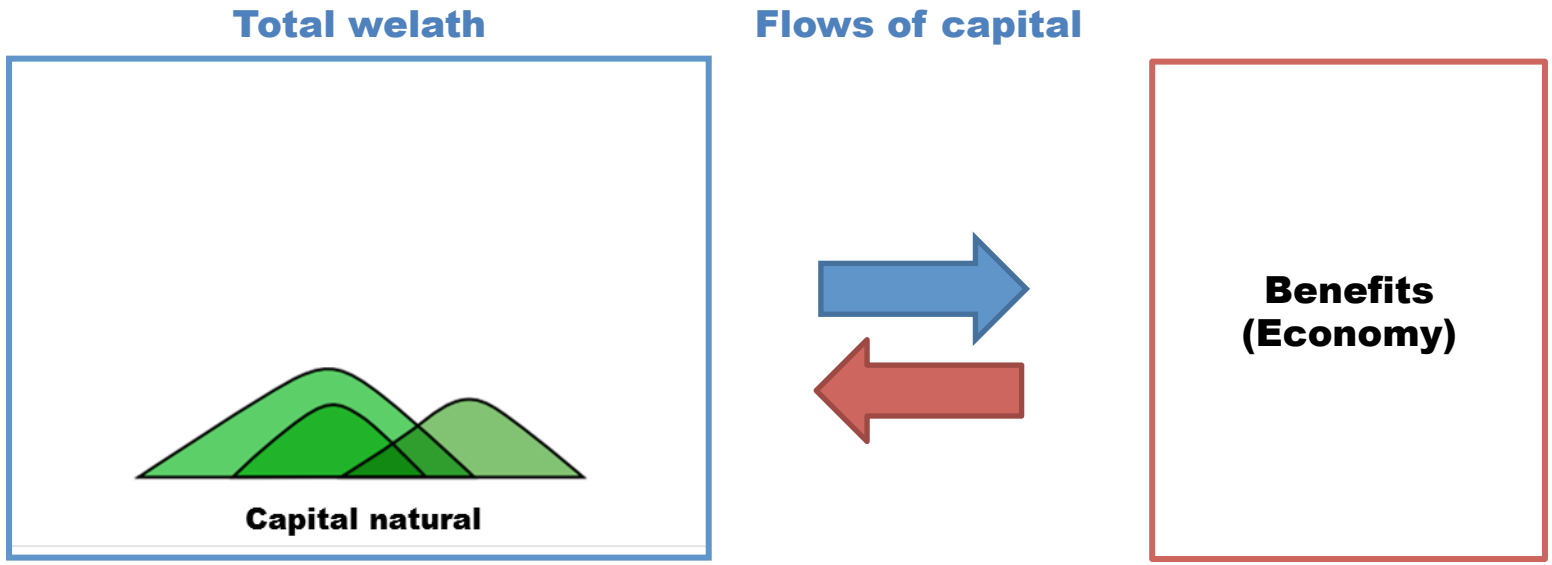
- Mobilize finance for REDD+ and adaptation
- Support voluntary private sector commitments to responsible sourcing
- Remove subsidies for unsustainable biofuels
- Implement other demand-side policies to provide incentives for legal and sustainable production
- Legality assurance initiatives
- Green procurement programs



Forest accounts in the context of NCA

What do we measure and what should we measure?

Economic development is a process of building wealth and the management of the nation's portfolio of assets.



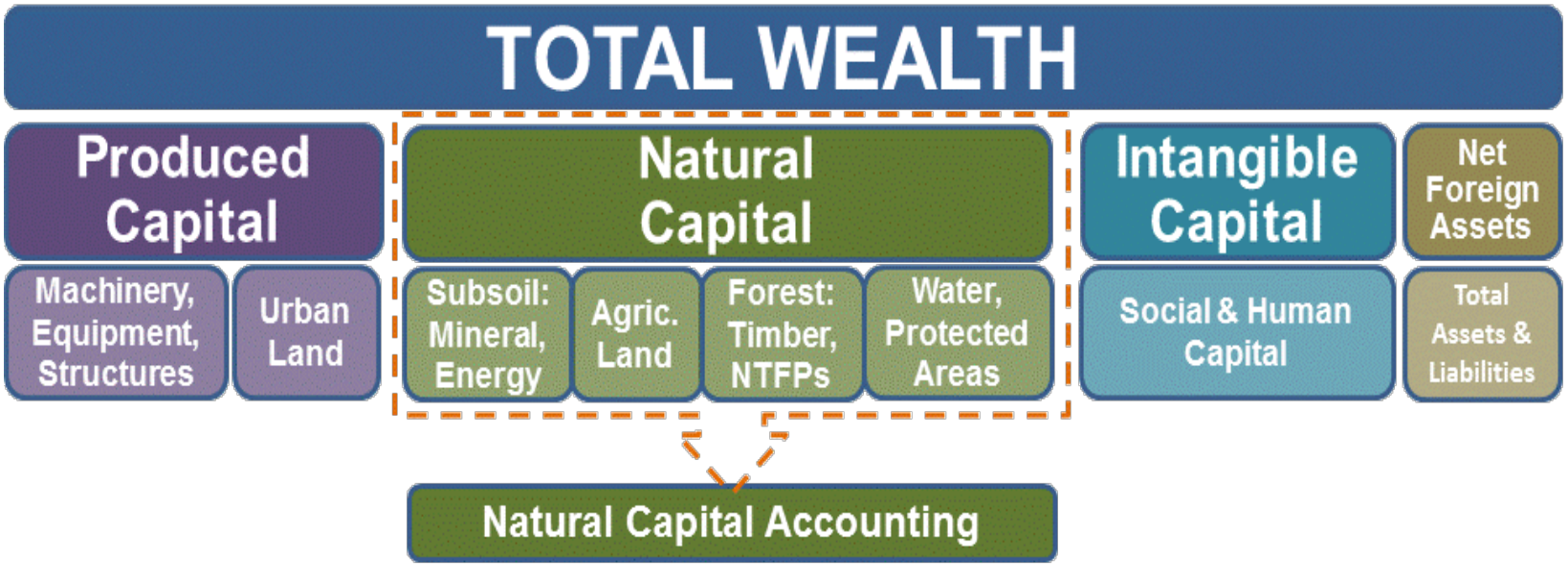
We are interested in measuring natural capital y it's relationship with the economy using Natural Capital Accounting (NCA)

Forests as part of natural capital

- The source of income and well-being is wealth, broadly defined to include: Manufactured capital, Natural capital

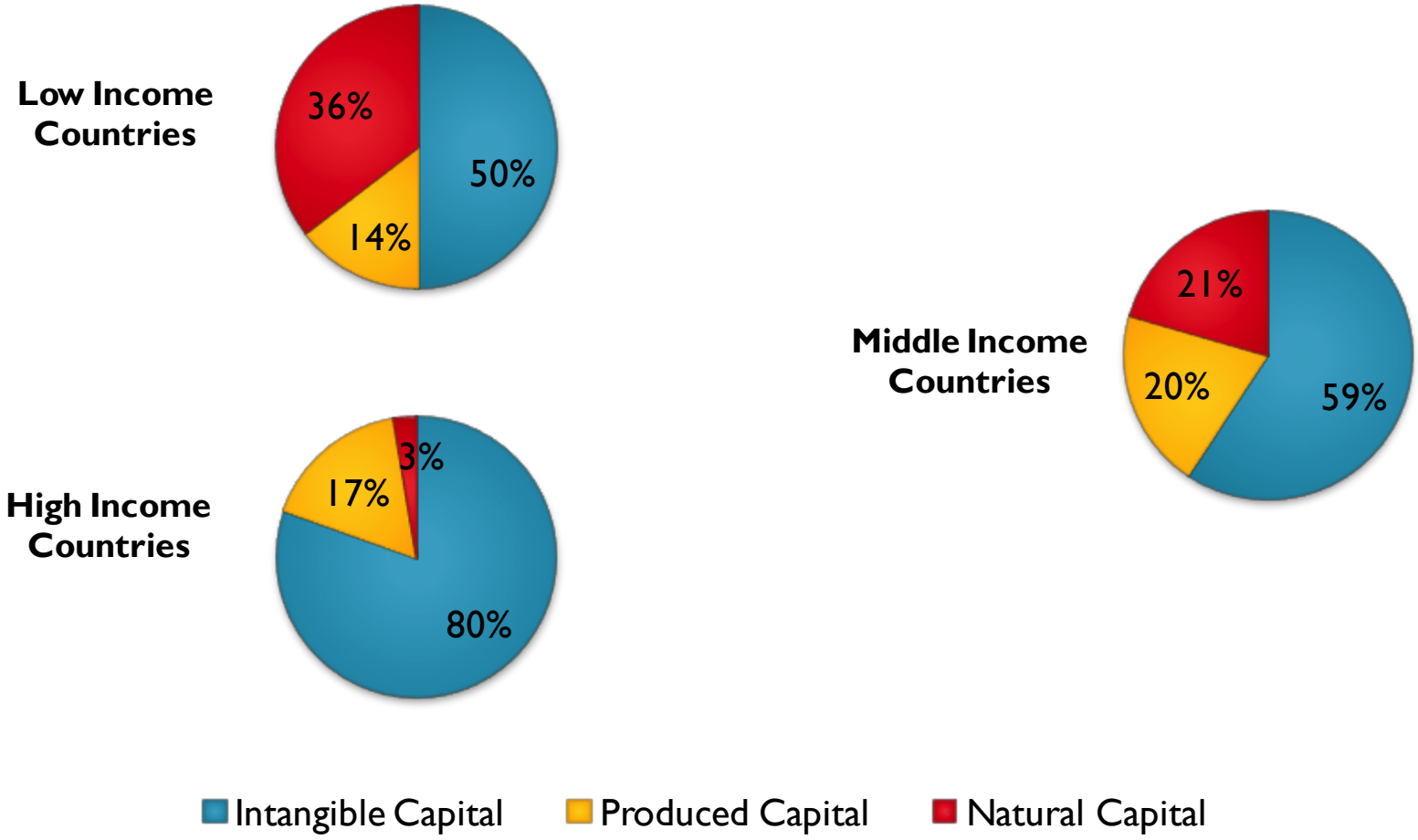
'Intangible' capital – net financial assets, human capital and social capital

- NCA focuses on the part of total wealth that comes from mineral, energy, agricultural, soil, timber, and water assets



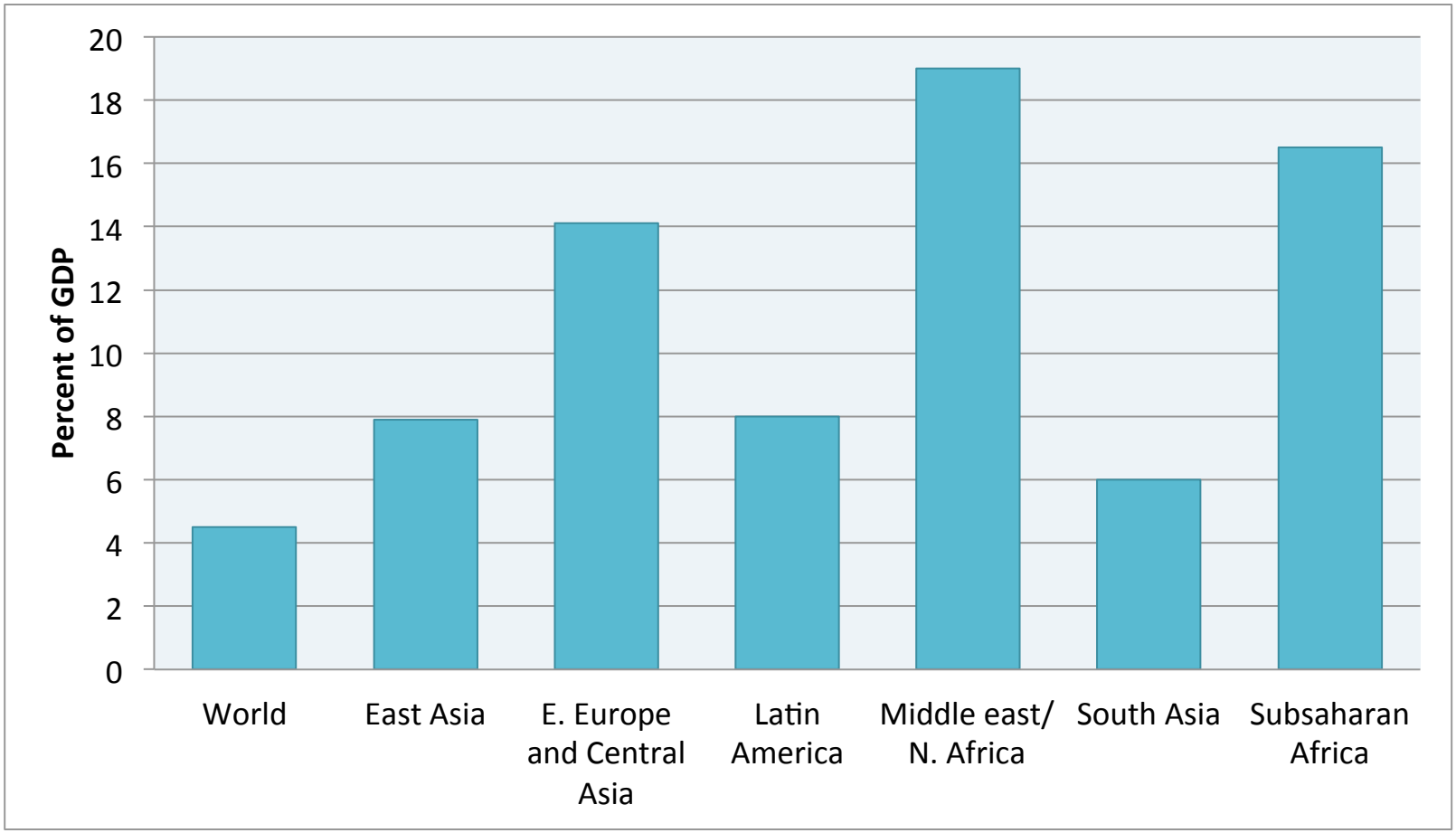
Why are the stocks of natural capital important?

Structure of comprehensive wealth by level of income, 2005

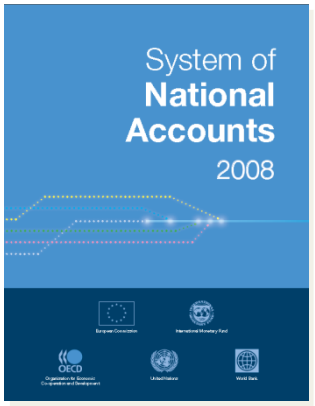


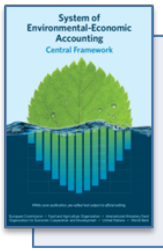
Why are the flows of NC important?

Natural resource rents are the major source of income of many countries



What is the method for Natural Capital Accounting?

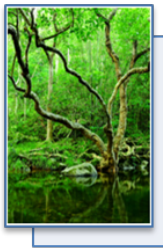




Part 1. SEEA-Central Framework

Adopted by UN Statistics Commission as International Statistical Standard in February 2012

Part 2. SEEA Experimental Ecosystem 2013



Part 3. SEEA Applications and Policy Uses

2013

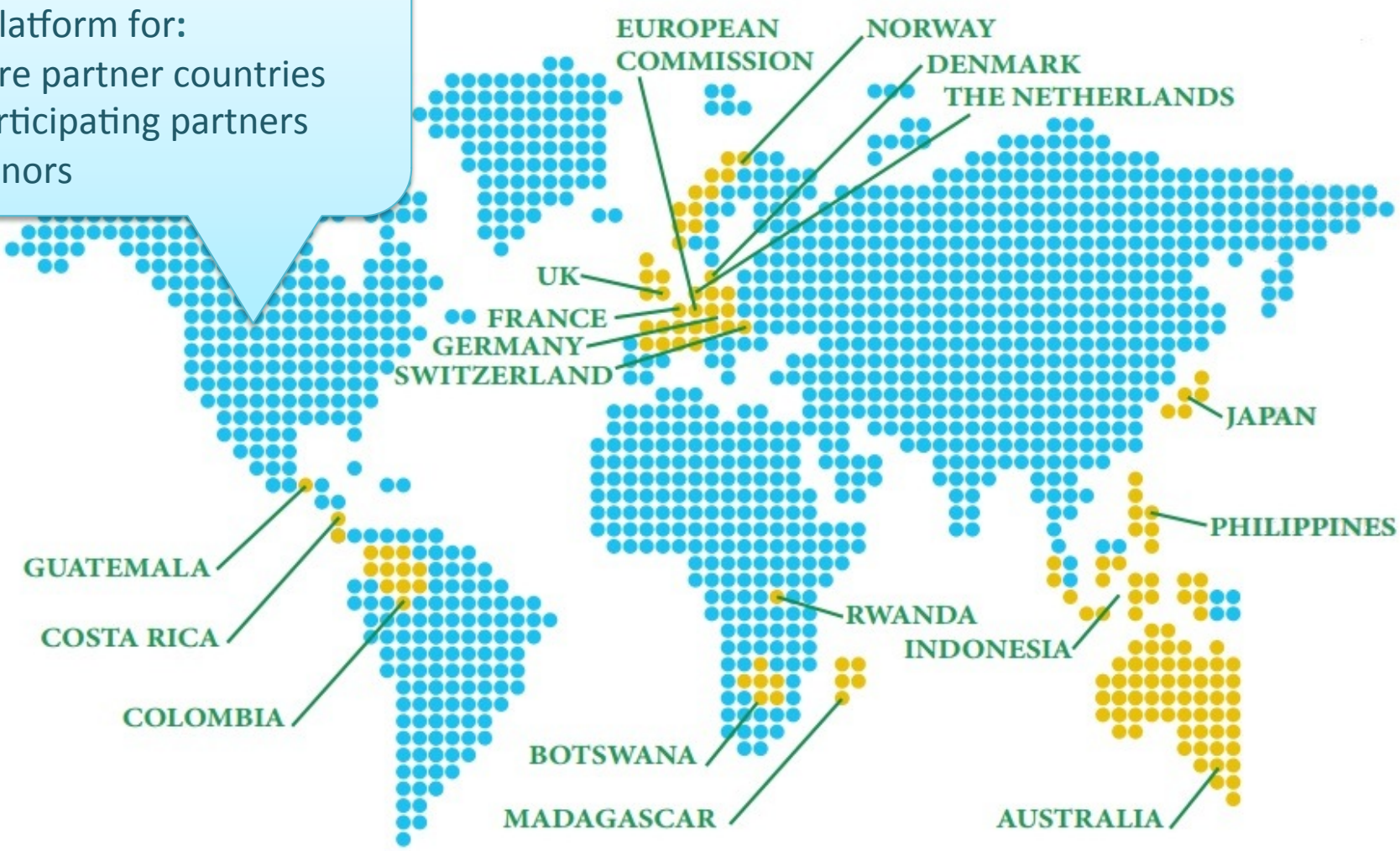
- Energy
- Land and Ecosystems
- Forest
- Fisheries
- Water

United Nations · European Commission · Food and Agriculture Organization of the United Nations · International Monetary Fund · Organisation for Economic Co-operation and Development · The World Bank

What is WAVES' role?

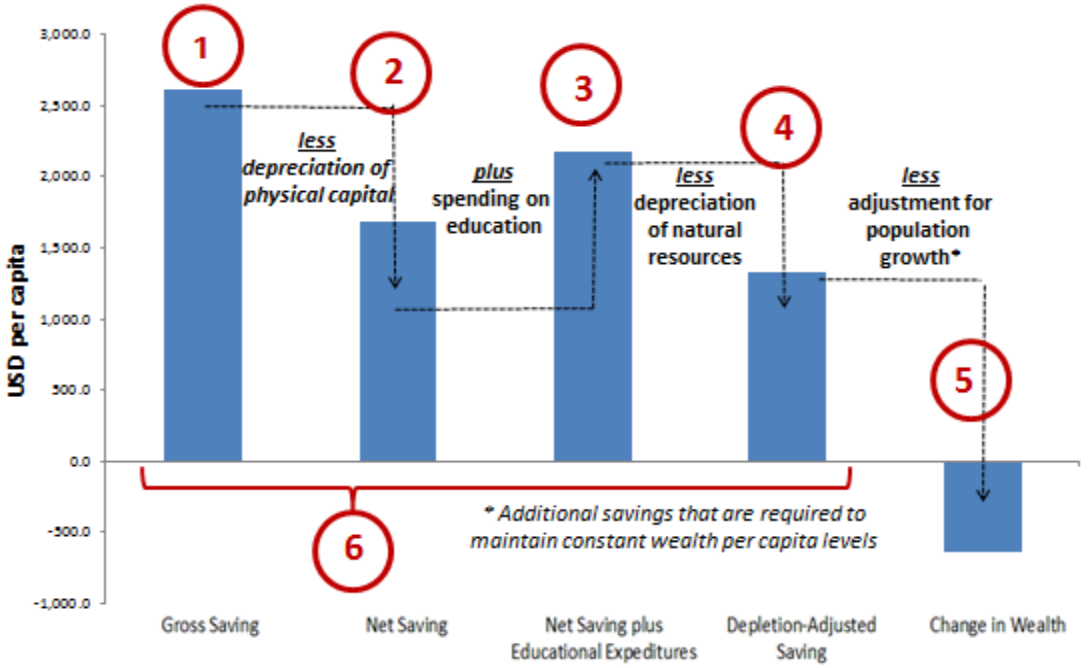
Global partnership, WAVES as a platform for:

- Core partner countries
- Participating partners
- Donors



Why is it useful to do forest accounts in the context NCA?

1. Increase savings levels
2. Enhance quality of produced capital
3. Increase expenditures in health and education
4. 4a. Enhance quantity of natural capital
   4b. Enhance quality of natural capital
5. Serve the demands of a growing population
6. Increase factor productivity



What are forest accounts and how to do them?

The relevance of forest accounts?

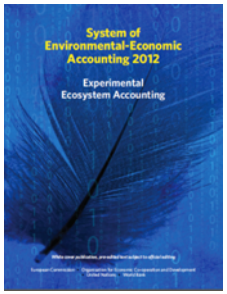
Marco central del SCAE

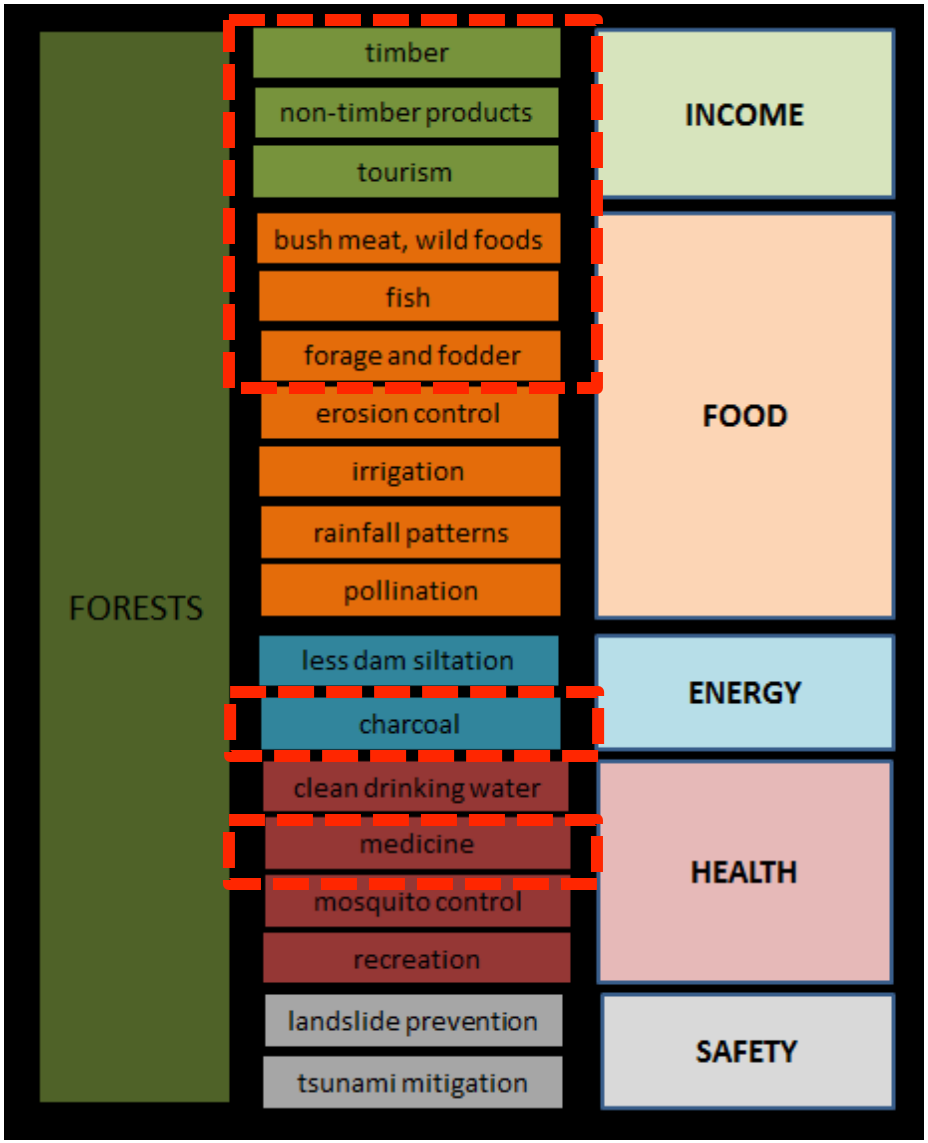
Mayor concenso

Dos perspectivas complementarias

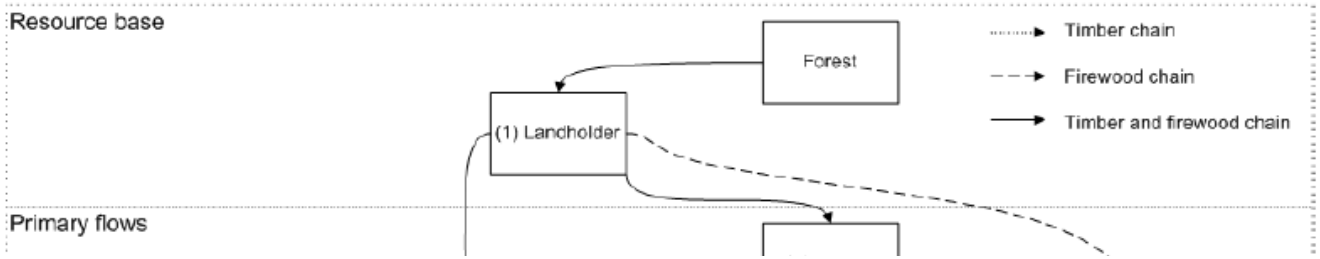
Menor concenso

Ecosistemas del SCAE





Complexity reduced to relationships (identities)



	Control type, variables, data type and sources								
Type of logging and primary extraction	Controlled (c)			Non-controlled (n)			Total logging (t) variables, data types and sources		
Clearcutting									
Firewood	FCc	D	INAB data	FCn	R	INAB reports ratio	FC	E	Sum of the parts

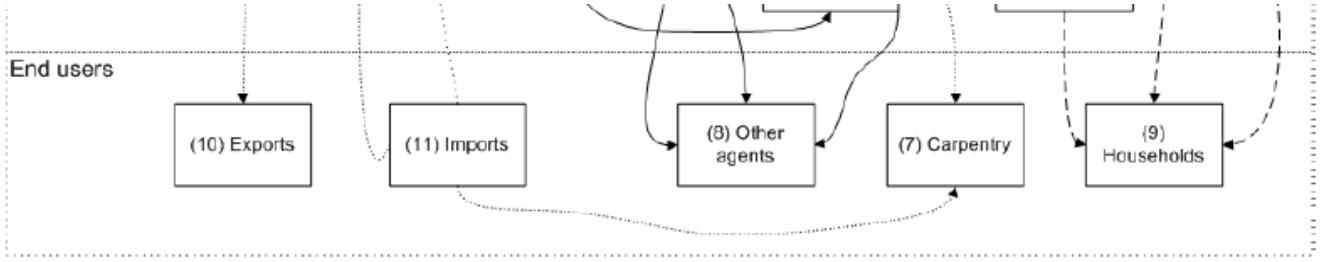
$$\mathbf{Ln = L - Lc} \tag{a}$$

$$\mathbf{(Cn + Sn) = (Ct + St) - (Cc + Sc)} \tag{b}$$

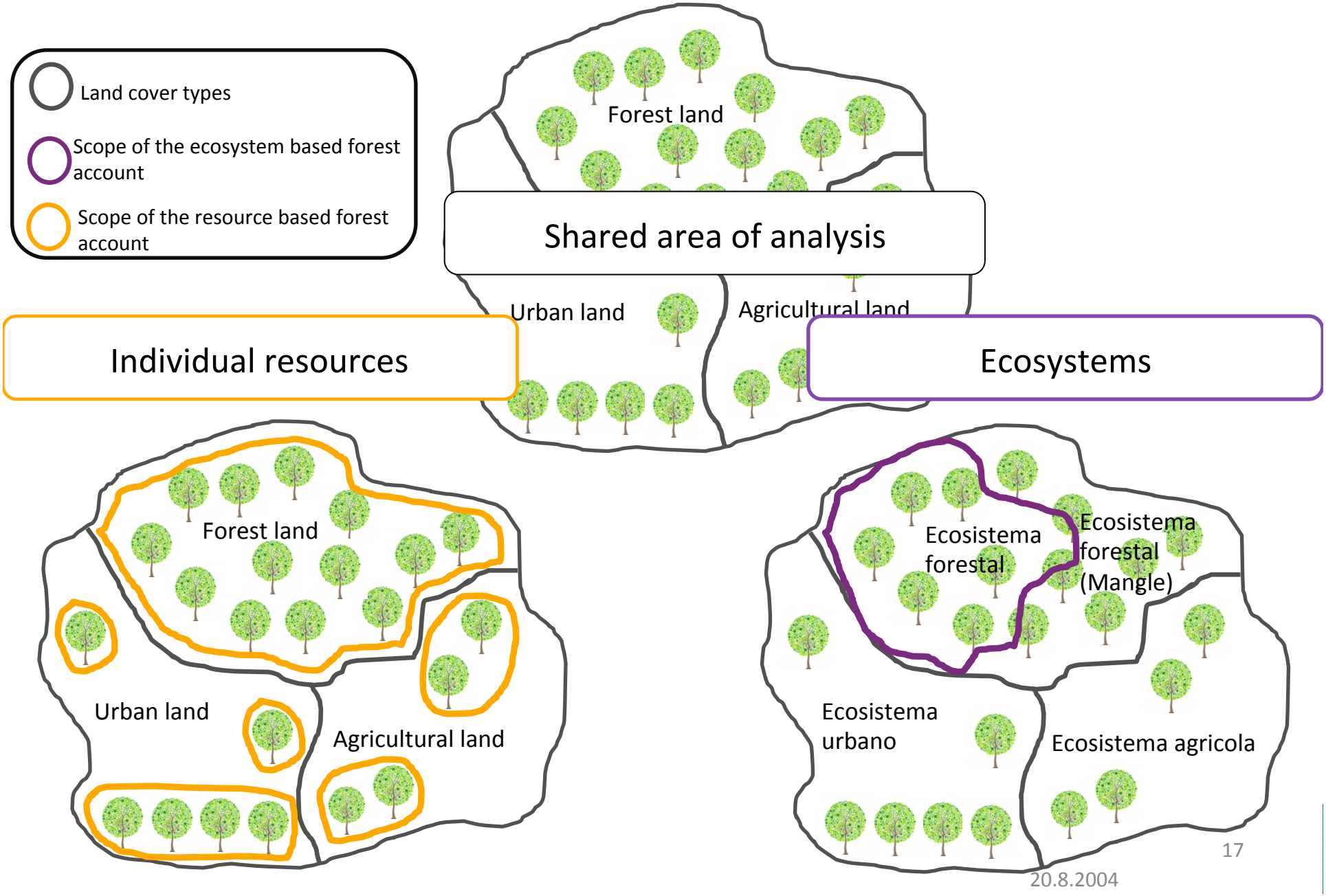
$$\mathbf{[(FCn + TCn) + (FSn + TSn)] = [(FCt + TCt) + (FSt + TSt)] - [(FCc + TCc) + (FSc + TSc)]} \tag{c}$$

$$\mathbf{Fn + Tn = Ft + Tt - Fc + Tc} \tag{d}$$

D = Direct source, O = Own estimations (survey, enterview or gis), E = Estimated as residual from identity or as the sum of the parts, R = Ratios obtained from direct sources



How to do forest accounting - Setting up a framework for forest accounts



General structure of the forest accounts – ASSET ACCOUNTS

❖ resource by resource

	Type of timber resource		
		Natural timber resources	
	Cultivated timber resources	Available for wood supply	Not available for wood supply
Opening stock of timber resources			
Additions to stock			
Natural growth			
Reclassifications			
Total additions to stock			
Reductions in stock			
Removals			
Natural losses			
Catastrophic losses			
Reclassifications			
Total reductions in stock			
Closing stock of timber resources			

Monetary units

Type of timber resources	
Cultivated timber resources	Natural timber resources Available for wood supply

❖ Cultivated: management practices constitute a process of economic production

❖ Natural: where the previous doesn't apply.

❖ Not AFWS: due to physical, economic or regulatory reasons

❖ forest asset (forest ecosystem unit)

	Changes of ecosystem condition				
	Vegetation	Biodiversity	Soil	Water	Carbon
Opening condition					
Improvements in conditions					
Reduction in condition					
Closing condition					

Monetary units

	EAU or LCEU
Opening stock	
Additions to stock	
Regeneration-natural	
Regeneration. human	
Total additions to stock	
Reductions in stock	
Extraction and harvest	
Catastrophic losses	
Total reductions in stock	
Revaluations	
Closing stock of ecosystem assets	

General structure of the forest accounts – FLOW ACCOUNTS

Table 6.9: Physical supply and use table for wood products, France, 1999
(timber, logs and wood in 1000 cubic metres; pulp, paper and waste in 1000 tons)

SUPPLY

Economic activities: suppliers

Products

95920							95920		95920
23162							23162	1451	24613
31200									
11869									
						x	x		x

- ❖ PHYSICAL UNITS: flow of materials and products / flow of ES
- ❖ MONETARY UNITS: aggregated value .

USE

Economic activities: intermediate and final consumers

Products

	23337						23337			1276	24613
						2423	2423	28429		375	31227
		10944					10944			1624	12568
	7736					6076	13812			2695	16507
			4372				4372			431	4803
						4465	4465			4167	8632
	2265	2162				3431	7858			980	8838
			5276				5276			1028	6304

Services

suppliers

Consumers

What are the steps to fill-in the accounting tables?

DEFINITION OF THE POLICY QUESTION THAT THE ACCOUNTS HAVE TO ANSWER

MAPPING AND ASSESSING THE **FOREST AREA** AT THE COUNTRY LEVEL

FOREST ASSETS/ RESOURCES

- Location
- Extent
- Condition

FLOW OF FOREST ECOSYSTEM SERVICES

- Provisioning
- Regulating
- Cultural

BENEFITS PROVIDED BY FORESTS

- MARKET forest benefits
- CONTRIBUTION to other sectors
- NON-MARKET benefits

Characterization of the forest resources/ forest asset and creation of forest ecosystem classes

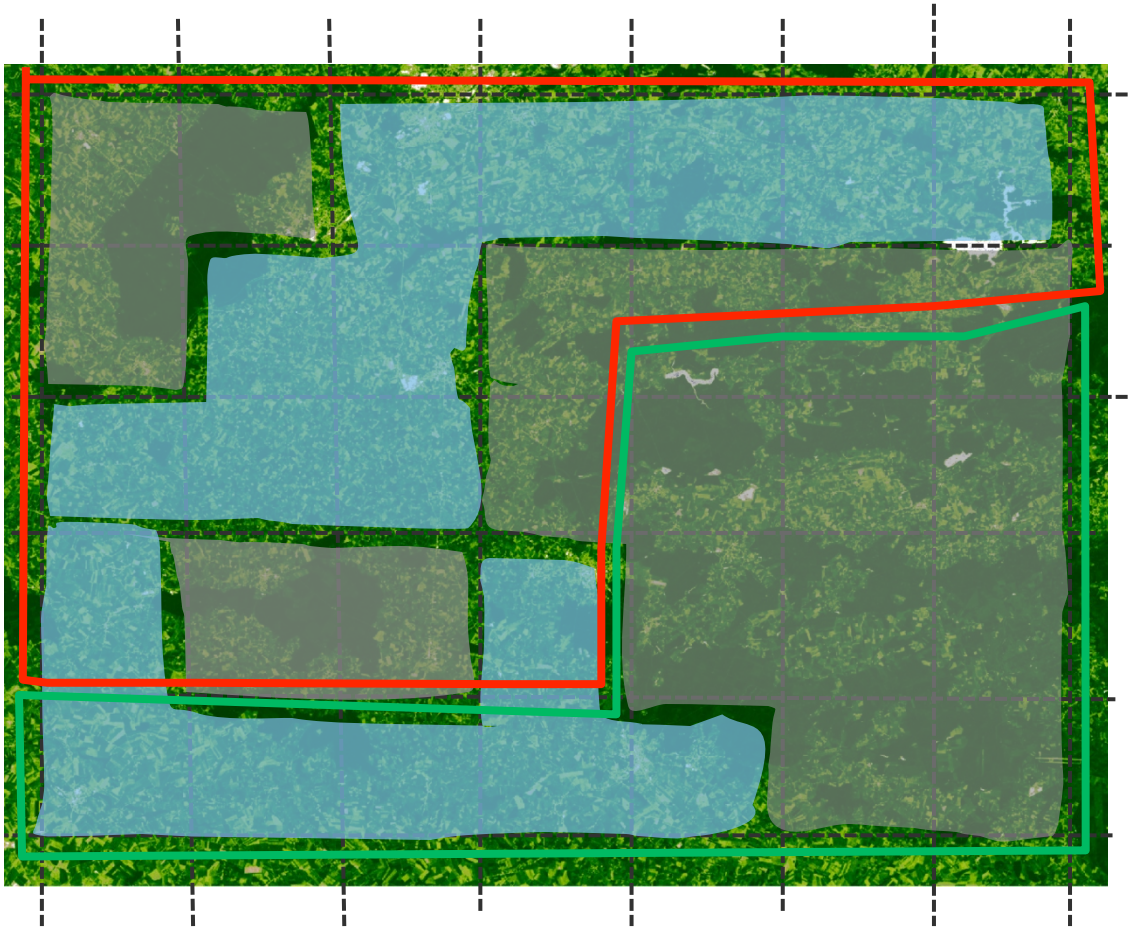
Flow of ecosystem services from the forest asset

Benefits from forest ecosystem services

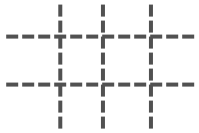
Steps to fill-in the accounting tables – Mapping of the forest area & ecosystems

Steps proposed by the EEA to define units to account for forest assets

- Basic Statistical Units



BSUs: Basic Statistical Units
Min grid resolution info



LCEUs Closest to ecosystems

Broadleaved primary forest

Broadleaved secondary forest

EAUs Long-term monitoring

Not protected forest

Natural park (protected forest)

Steps to fill-in the accounting tables- Indicators to characterize the forest ASSET

Forest land

Opening stock of forest and other wooded land	
Additions to stock	
• Afforestation	• Afforested area (m^2) • Density (trees/ha)
• Natural expansion	• Area (m^2)
• Reforestation	• Reforested area (m^2) • Density (trees/ha)
Reductions in stock	
• Deforestation	• Deforested area (m^2)
• Natural regression	• Area (m^2)
Closing stock of forest and other wooded land	

Standing timber

Additions to stock	
• Growth	• Natural growth of timber volume (m^3)
• Timber in young trees (not considered in previous accounting period)	• Volume in trees recently classified as timber (m^3)
Reductions to stock	
• Tree harvest	• Havested timber during the period (m^3)
• Tree losses	• Losses in timber volume due to fires, disease, catastrophic events, etc (m^3)
Closing stock of standing timber	

Condition of forest ecosystems

Defoliation	• Litter fall measurements (kg) • LAI-based indicator
Forest health	• Presence of pathogens and plagues • Status of bark • Mortality rate
Forest fires	• Burnt area
Fragmentation	• % of forest area in categories (core, interior, connected, patchy) • Effective mesh size • Size of forest fragments • Length of fragment edge
Aerosol pollutants	• Ozone concentration • Nitrogen deposition • Sulfur deposition

Steps to fill-in the accounting tables Indicators to characterize the forest FLOWS

Provisioning services

• Timber	• Harvested timber (m^3; m^3/ha)
• Firewood/charcoal	• Volume (m^3)
• NTFP	• Volume (m^3); Weight (kg; ton); Number of units
• Genetic material	• Composition • Diversity
• Grazing	• Number of animals in silvo-pastoral system • Weight units of produced animal product • Energy uptake

Regulating services

• Atmospheric/climate regulation	• Net carbon storage (gains-losses)
• Water flow regulation	• Canopy cover fraction in recharge areas • Average daily and annual water flow in rivers • Cover in strategic locations (floodplains, steep slopes, wetlands, etc)
• Water cycle regulation	• BOD • Turbidity in waterways
• Pollination	• Abundance and variety of pollinator species
• Soil retention and formation	• Erosion rates • Cover (or bare soil) fraction in vulnerable areas • Turbidity in waterways

Cultural services

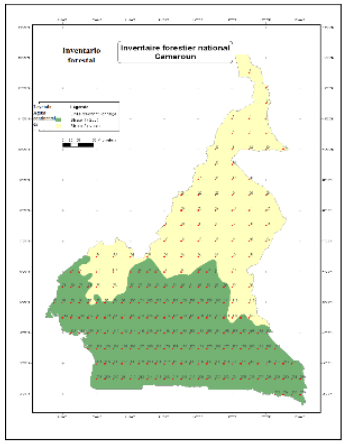
Division	Group	Class	Indicators
Physical and intellectual interactions with biota, ecosystems, and land-/seascapes	Physical and experiential interactions	Experiential use of plants, animals and land-/seascapes in different environmental settings. And physical use of land-/seascapes in different environmental settings	• Distribution of wildlife/emblematic species associated with forest • Important bird areas associated with forest • Area of forest accessible for recreation • Number of visitors • Number of hunters • Ecotourism operators • Area of forests accessible for hunting
	Intellectual and representative interactions	Scientific, educational, heritage, cultural, entertainment and aesthetic	• Citations, distribution of research projects, educational projects, number of historic records • Number/value of publications sold
Spiritual, symbolic and other interactions with biota, ecosystems, and land-/seascapes	Spiritual and/or emblematic	Symbolic and sacred and/or religious	• Distribution of sites of emblematic plants/forest • Number of sites with recognised cultural & spiritual value • Number of visitors
	Other cultural outputs	Existence and bequest	• Distribution of important areas for forest biodiversity and their conservation status • Condition of forest-associated priority species on habitat and birds directives • Distribution of sites with forest designated as having cultural values • Number of visitors

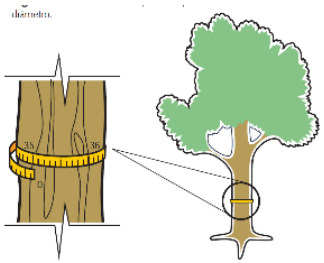
Where do we get the data from?

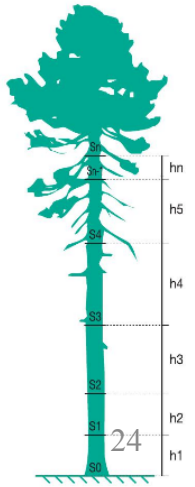
Forest inventories/forest statistics

Main features:

- The primary source of quantitative information on forest resources
- Based on statistical sampling
- Based on field surveying techniques
- Basis for planning and assessments at country, regional or global level (e.g. Forest Resources Assessment – FRA)





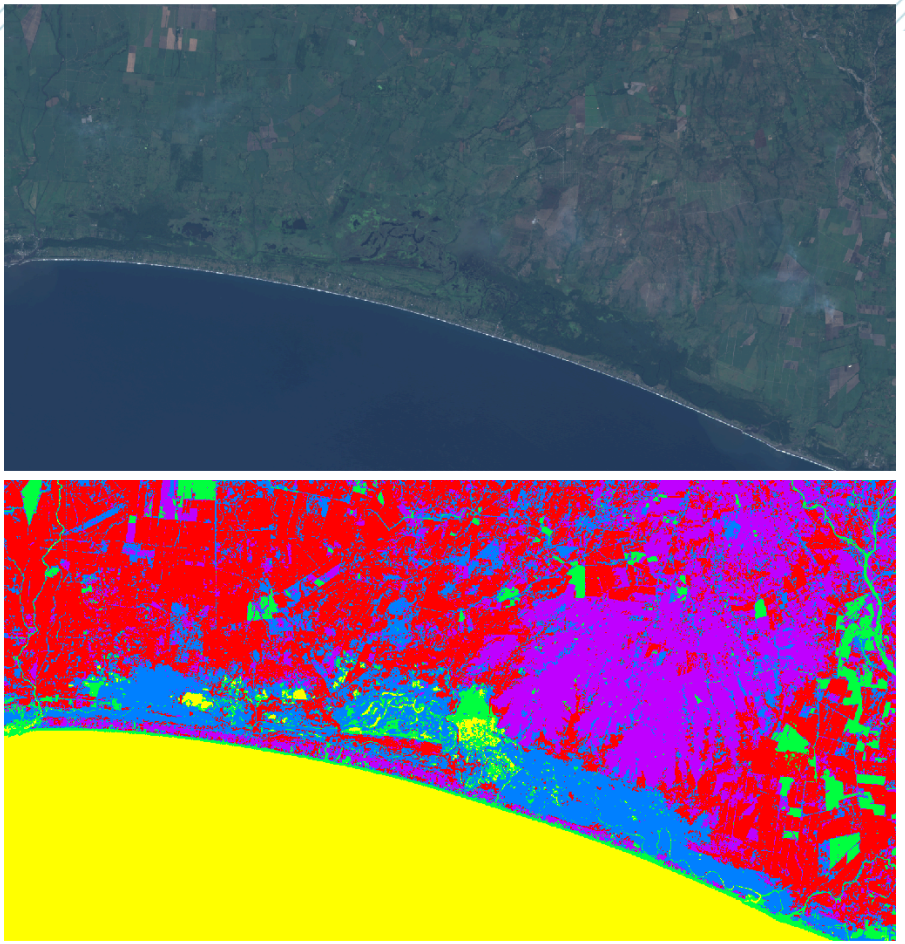


Where do we get the data from?

Spaceborne remote sensing

Why remote sensing?

- Dynamic data source of area covered by vegetation
- Identification of different vegetation types
- Upgrade forest inventories
- Information forest condition
- Geographical reference
- Constant technological development



Example: Land cover classification based on Landsat 8 imagery. Pacific coast; Guatemala

Where do we get the data from?

Forest Modeling

Why modeling ?

❖ Various indicators of forest assets and flows can not be measured directly.

❖ Particularly useful for deriving indicators of environmental services.

❖ Some examples are:

- Wild fauna population
- Erosion protection
- Surface discharge
- Carbon sequestration
- Green area deficit in urban areas

ARIES
ARtificial Intelligence for Ecosystem Services

InVEST Integrated Valuation of Ecosystem Services and Tradeoffs
natural capital PROJECT

USGS
science for a changing world

Social Values for Ecosystem Services (SolVES)—Using GIS to Include Social Values Information in Ecosystem Services Assessments

Where do we get the data from?

Other sources

- Livelihood surveys
- Population census
- Other statistics, reports, spatial databases
- etc.
- SNA → validate
- Global forest

watch poograms (?)

Table 6. Number of households in survey consuming each type of renewable energy.

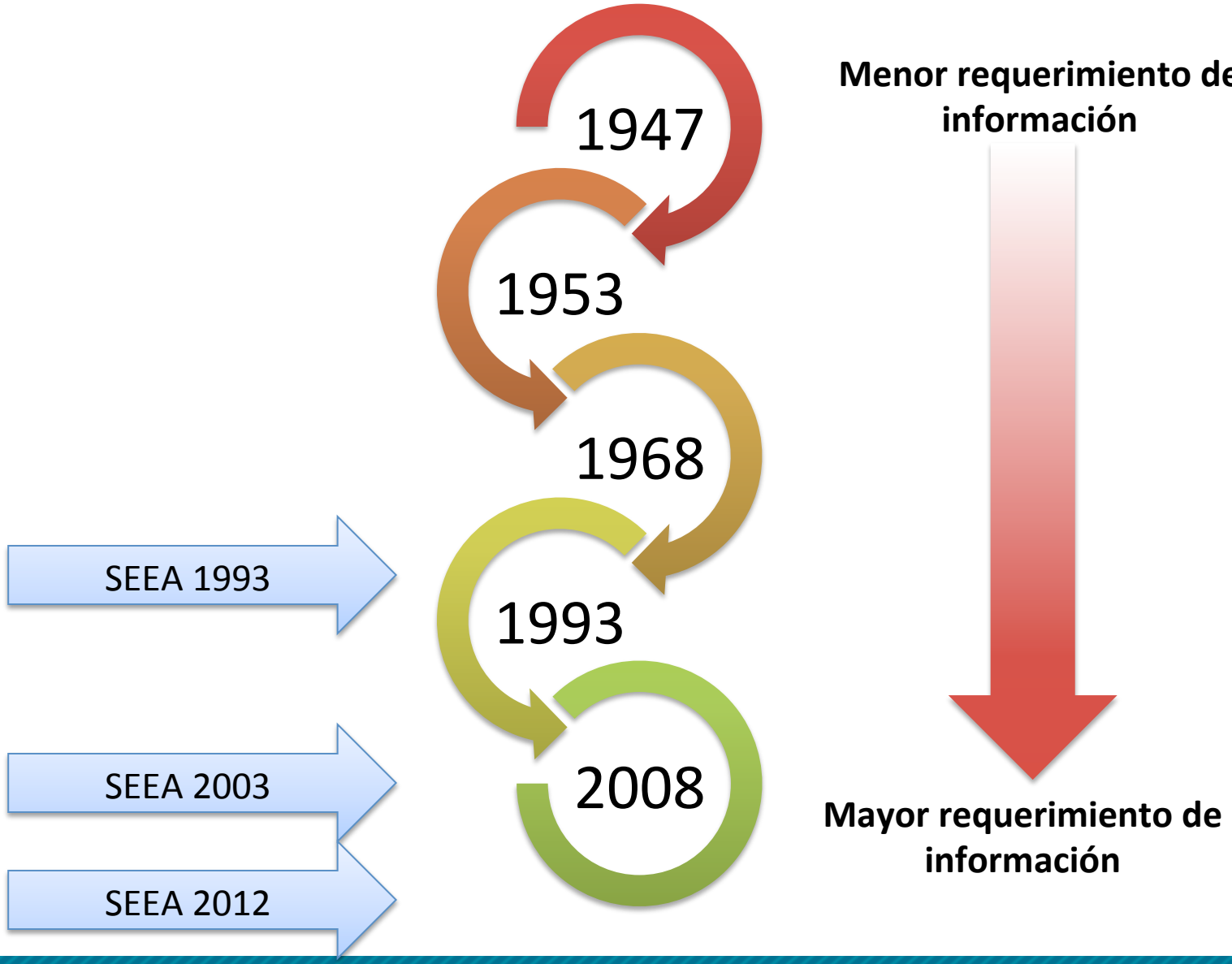
Village class	Sample size	Fire-wood	Char-coal	Plant residues	Animal dung	Biogas	Solar panel
LOA	406	395	35	250	40	0	0
LOF	276	275	29	192	10	0	1
RAF	29	29	5	25	1	0	0
UPA	37	37	7	22	0	0	0
LOG	162	147	83	115	5	1	0
UG	351	202	248	324	3	0	0
National total	1261	1085	407	928	59	1	1

Source: Mustonen, S.; Raiko, R.; Luukkanen, J. Bionergy consumption and biogas potential in Cambodian households. Sustainability. 2013 (5) 1875-1892 doi:10.3390/su5051875

A comment on data challenges

From Seymour, 2014

Give time to development…



Information on forests has never been better…

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Acknowledgments: This work was funded by NIH grants (R01GM076007 and R01GM093182) and a Packard Fellowship to D.B. and a NIH postdoctoral fellowship to C.E.E. All DNA-sequencing reads generated in this study are deposited at the National Center for Biotechnology Information Short Reads Archive (www.ncbi.nlm.nih.gov/sra) under the accession no. SRS402821. The genome assemblies are available at the National Center for Biotechnology Information under BioProject PRJNA77213. We thank Z. Walton and A. Gorchakov for technical assistance.

Supplementary Materials
www.sciencemag.org/content/342/6160/846/suppl/DC1
Materials and Methods
Supplementary Text
Figs. S1 to S20
Tables S1 to S3
References (28–54)

23 April 2013; accepted 30 September 2013
10.1126/science.1239552

High-Resolution Global Maps of 21st-Century Forest Cover Change

M. C. Hansen,[1]* P. V. Potapov,[1] R. Moore,[2] M. Hancher,[2] S. A. Turubanova,[1] A. Tyukavina,[1] D. Thau,[2] S. V. Stehman,[3] S. J. Goetz,[4] T. R. Loveland,[5] A. Kommareddy,[6] A. Egorov,[6] L. Chini,[1] C. O. Justice,[1] J. R. G. Townshend[1]

Quantification of global forest change has been lacking despite the recognized importance of forest ecosystem services. In this study, Earth observation satellite data were used to map global forest loss (2.3 million square kilometers) and gain (0.8 million square kilometers) from 2000 to 2012 at a spatial resolution of 30 meters. The tropics were the only climate domain to exhibit a trend, with forest loss increasing by 2101 square kilometers per year. Brazil's well-documented reduction in deforestation was offset by increasing forest loss in Indonesia, Malaysia, Paraguay, Bolivia, Zambia, Angola, and elsewhere. Intensive forestry practiced within subtropical forests resulted in the highest rates of forest change globally. Boreal forest loss due largely to fire and forestry was second to that in the tropics in absolute and proportional terms. These results depict a globally consistent and locally relevant record of forest change.

Changes in forest cover affect the delivery of important ecosystem services, including biodiversity richness, climate regulation, carbon storage, and water supplies (*1*). However, spatially and temporally detailed information on global-scale forest change does not exist; previous efforts have been either sample-based or employed coarse spatial resolution data (*2*–*4*). We mapped global tree cover extent, loss, and gain for the period from 2000 to 2012 at a spatial resolution of 30 m, with loss allocated annually. Our global analysis, based on Landsat data, improves on existing knowledge of global forest extent and change by (i) being spatially explicit; (ii) quantifying gross forest loss and gain; (iii) providing annual loss information and quantifying trends in forest loss; and (iv) being derived through an internally consistent approach that is exempt from the vagaries of different definitions, methods, and data inputs. Forest loss was defined as a stand-replacement disturbance or the complete removal of tree cover canopy at the Landsat pixel scale. Forest gain was defined as the inverse of loss, or the establishment of tree canopy from a nonforest state. A total of 2.3 million km^2 of forest were lost due to disturbance over the study period and 0.8 million km^2 of new forest established. Of the total area of combined loss and gain (2.3 million km^2 + 0.8 million km^2), 0.2 million km^2 of land experienced both loss and subsequent gain in forest cover during the study period. Global forest loss and gain were related to tree cover density for global climate domains, ecozones, and countries (refer to tables S1 to S3 for all data references and comparisons). Results are depicted in Fig. 1 and are viewable at full resolution at http://earthenginepartners.appspot.com/science-2013-global-forest.

The tropical domain experienced the greatest total forest loss and gain of the four climate domains (tropical, subtropical, temperate, and boreal), as well as the highest ratio of loss to gain (3.6 for >50% of tree cover), indicating the prevalence of deforestation dynamics. The tropics were the only domain to exhibit a statistically significant trend in annual forest loss, with an estimated increase in loss of 2101 km^2/year. Tropical rainforest ecozones totaled 32% of global forest cover loss, nearly half of which occurred in South American rainforests. The tropical dry forests of South America had the highest rate of tropical forest loss, due to deforestation dynamics in the Chaco woodlands of Argentina, Paraguay (Fig. 2A), and Bolivia. Eurasian rainforests (Fig. 2B) and dense tropical dry forests of Africa and Eurasia also had high rates of loss.

Recently reported reductions in Brazilian rainforest clearing over the past decade (*5*) were confirmed, as annual forest loss decreased on average 1318 km^2/year. However, increased annual loss of Eurasian tropical rainforest (1392 km^2/year), African tropical moist deciduous forest (536 km^2/year), South American dry tropical forest (459 km^2/year), and Eurasian tropical moist deciduous (221 km^2/year) and dry (123 km^2/year) forests more than offset the slowing of Brazilian deforestation. Of all countries globally, Brazil exhibited the largest decline in annual forest loss, with a high of over 40,000 km^2/year in 2003 to 2004 and a low of under 20,000 km^2/year in 2010 to 2011. Of all countries globally, Indonesia exhibited the largest increase in forest loss (1021 km^2/year), with a low of under 10,000 km^2/year from 2000 through 2003 and a high of over 20,000 km^2/year in 2011 to 2012. The converging rates of forest disturbance of Indonesia and Brazil are shown in Fig. 3. Although the short-term decline of Brazilian deforestation is well documented, changing legal frameworks governing Brazilian forests could reverse this trend (*6*). The effectiveness of Indonesia's recently instituted moratorium on new licensing of concessions in primary natural forest and peatlands (*7*), initiated in 2011, is to be determined.

Subtropical forests experience extensive forestry land uses where forests are often treated as a crop and the presence of long-lived natural forests is comparatively rare (*8*). As a result, the highest proportional losses of forest cover and the lowest ratio of loss to gain (1.2 for >50% of tree cover) occurred in the subtropical climate domain. Aggregate forest change, or the proportion of total forest loss and gain relative to year-2000 forest area [(loss+gain)/2000 forest], equaled 16%, or more than 1% per year across all forests within the domain. Of the 10 subtropical humid and dry forest ecozones, 5 have aggregate forest change >20%, three >10%, and two >5%. North American subtropical forests of the southeastern United States are unique in terms of change dynamics because of short-cycle tree planting and harvesting (Fig. 2C). The disturbance rate of this ecozone was four times that of South American

[1]Department of Geographical Sciences, University of Maryland, College Park, MD 20742, USA. [2]Google, Mountain View, CA, USA. [3]Department of Forest and Natural Resources Management, State University of New York, Syracuse, NY, USA. [4]Woods Hole Research Center, 149 Woods Hole Road, Falmouth, MA 02540, USA. [5]Earth Resources Observation and Science, United States Geological Survey, 47914 252nd Street, Sioux Falls, SD 57198, USA. [6]Geographic Information Science Center of Excellence, South Dakota State University, Brookings, SD, USA.
*Corresponding author. E-mail: mhansen@umd.edu

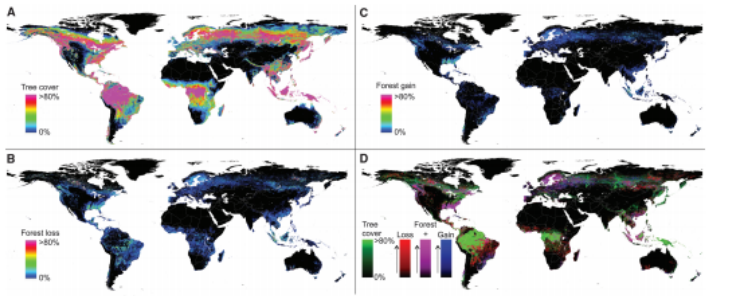


Fig. 1. (A) Tree cover, (B) forest loss, and (C) forest gain. A color composite of tree cover in green, forest loss in red, forest gain in blue, and forest loss and gain in magenta is shown in (**D**), with loss and gain enhanced for improved visualization. All map layers have been resampled for display purposes from the 30-m observation scale to a 0.05° geographic grid.

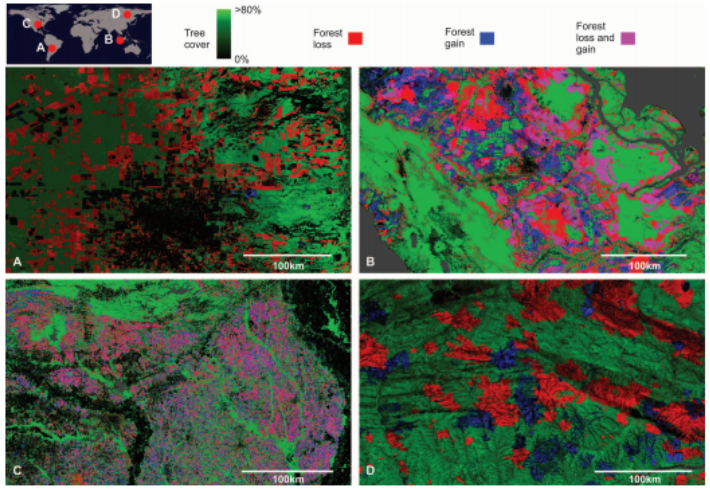
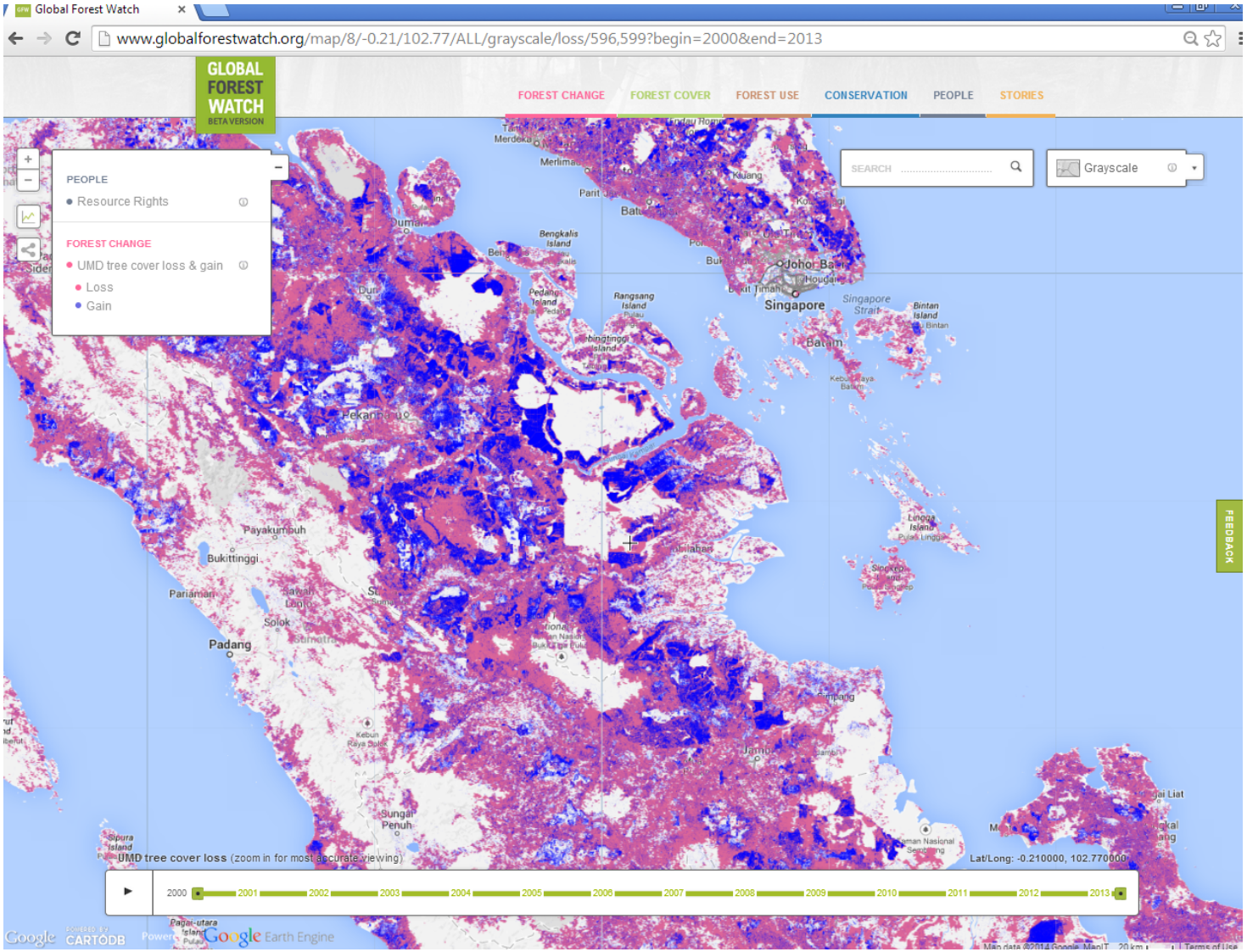
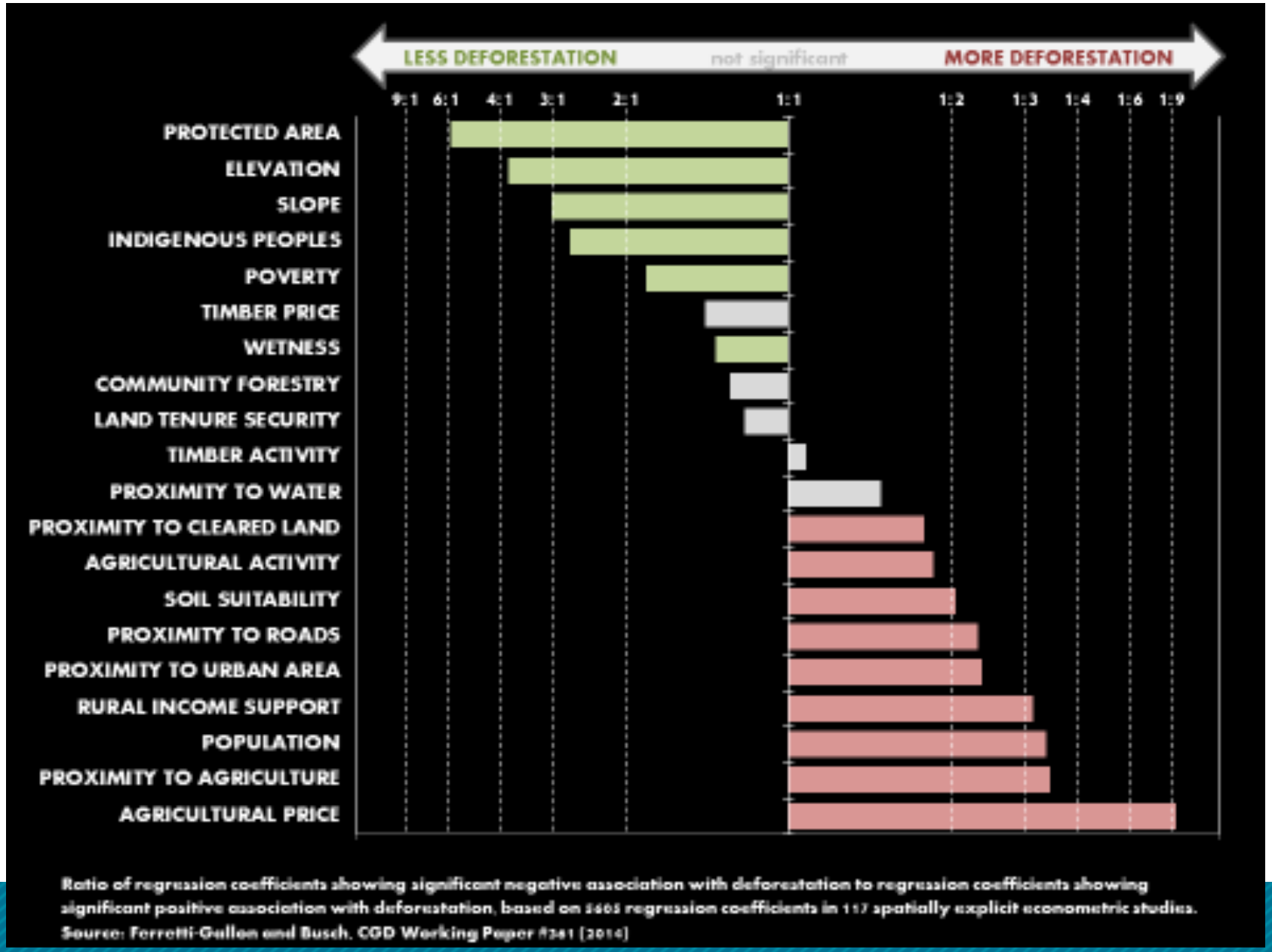


Fig. 2. Regional subsets of 2000 tree cover and 2000 to 2012 forest loss and gain. (A) Paraguay, centered at 21.9°S, 59.8°W; **(B)** Indonesia, centered at 0.4°S, 101.5°E; **(C)** the United States, centered at 33.8°N, 93.3°W; and **(D)** Russia, centered at 62.1°N, 123.4°E.

…or more accessible

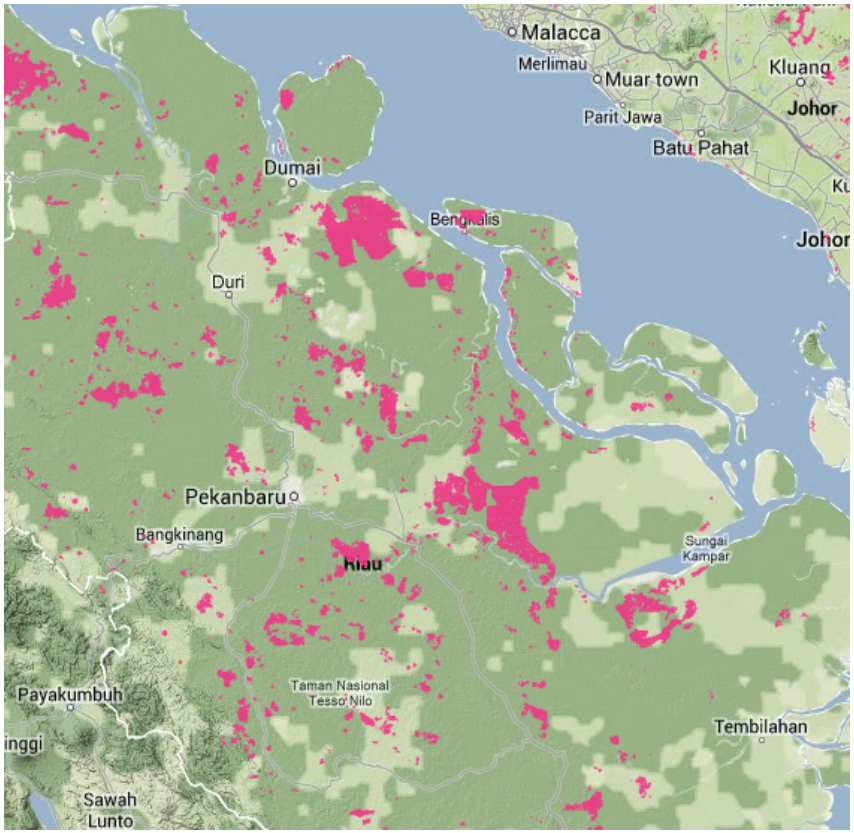


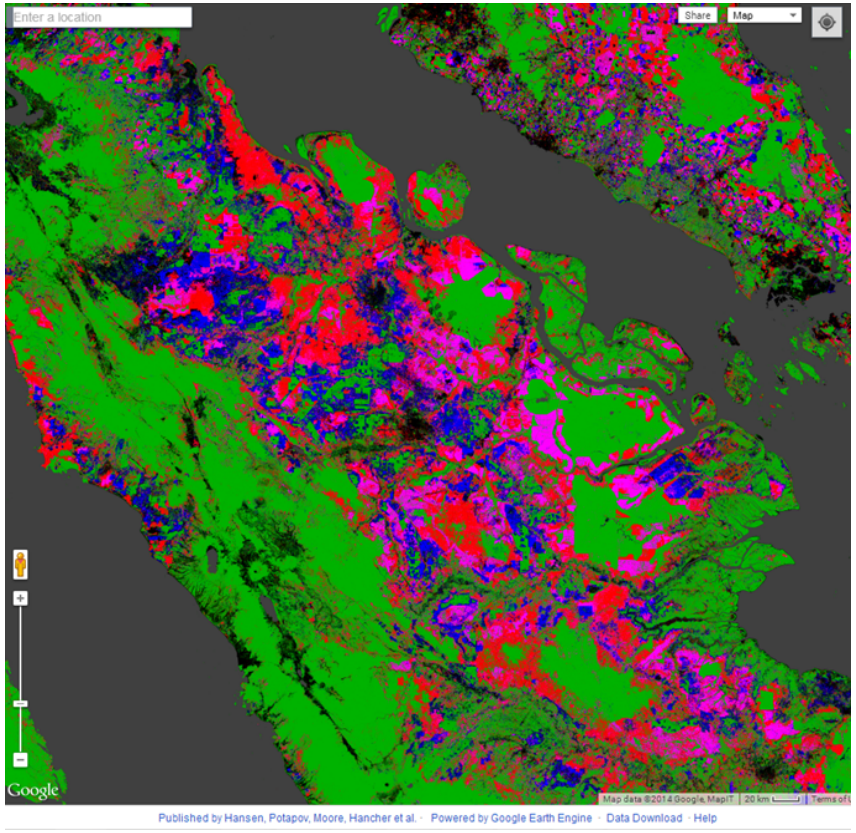
We know what drives deforestation…



Ratio of regression coefficients showing significant negative association with deforestation to regression coefficients showing significant positive association with deforestation, based on 2603 regression coefficients in 117 spatially explicit econometric studies.
Source: Ferretti-Gallon and Busch, CGD Working Paper #361 (2014)

…and can track and respond to change





High temporal resolution
for near real-time monitoring and response

High spatial resolution
for accurate measurement of annual deforestation

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