The role of forests and trees for the livelihood of African people in a changing climate

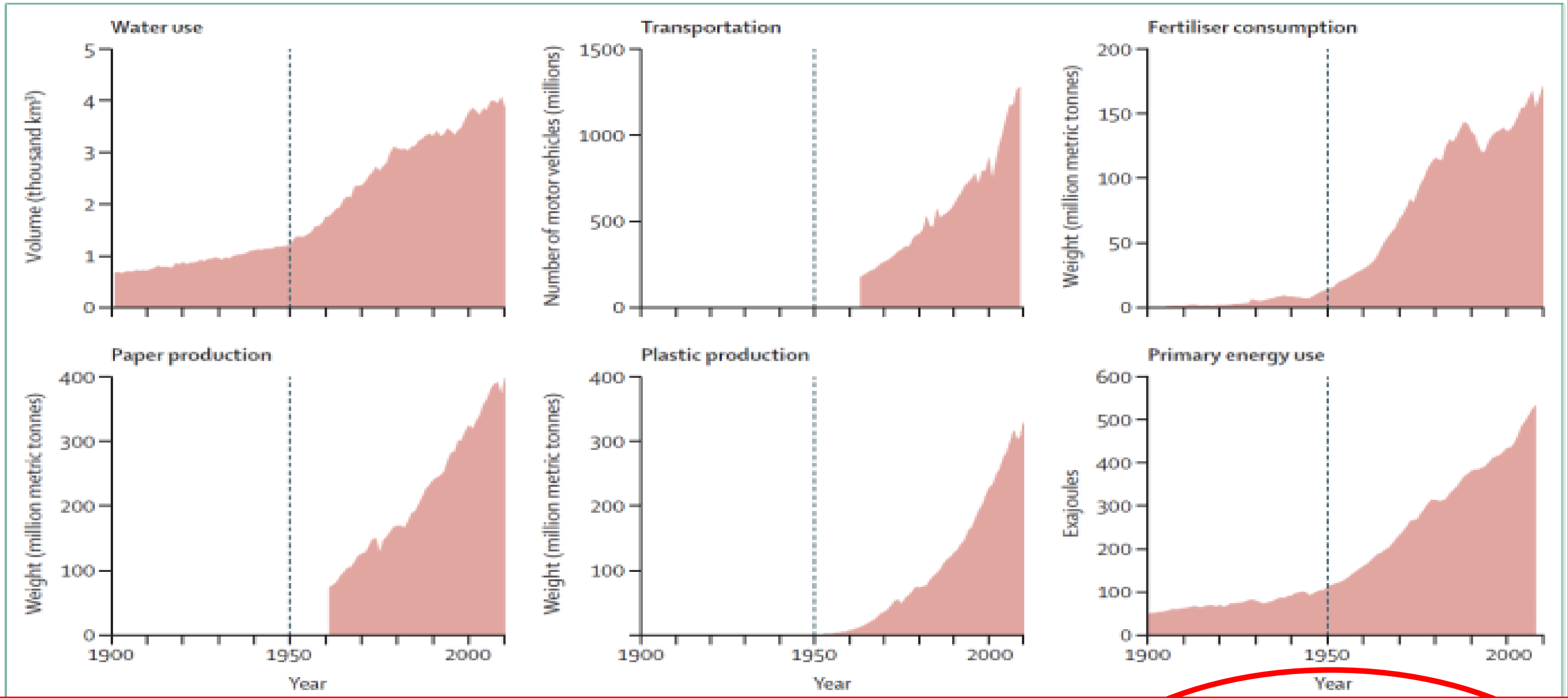
Forest Responses to Climate Change: Why African Forests Matter
Hosted by BMNT, BMBWF and IUFRO

University of Vienna, Universitätsring 1, 1010 Vienna, Kleiner Festsaal
organized by Ministry of Sustainability and Tourism & Ministry of Education, Science and Research & IUFRO

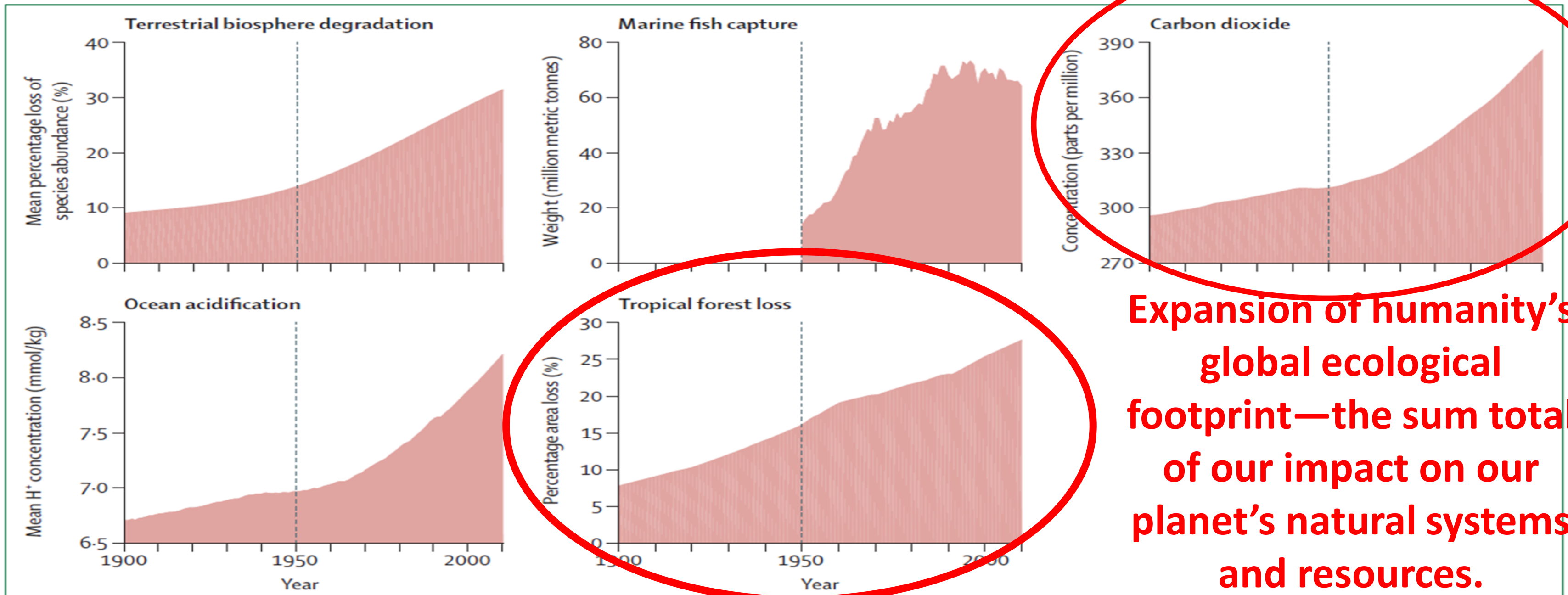
Ramni. H. Jamnadass and Team TREEs

29th May 2019

Measures of Consumption over time



Measures of human impact over natural systems



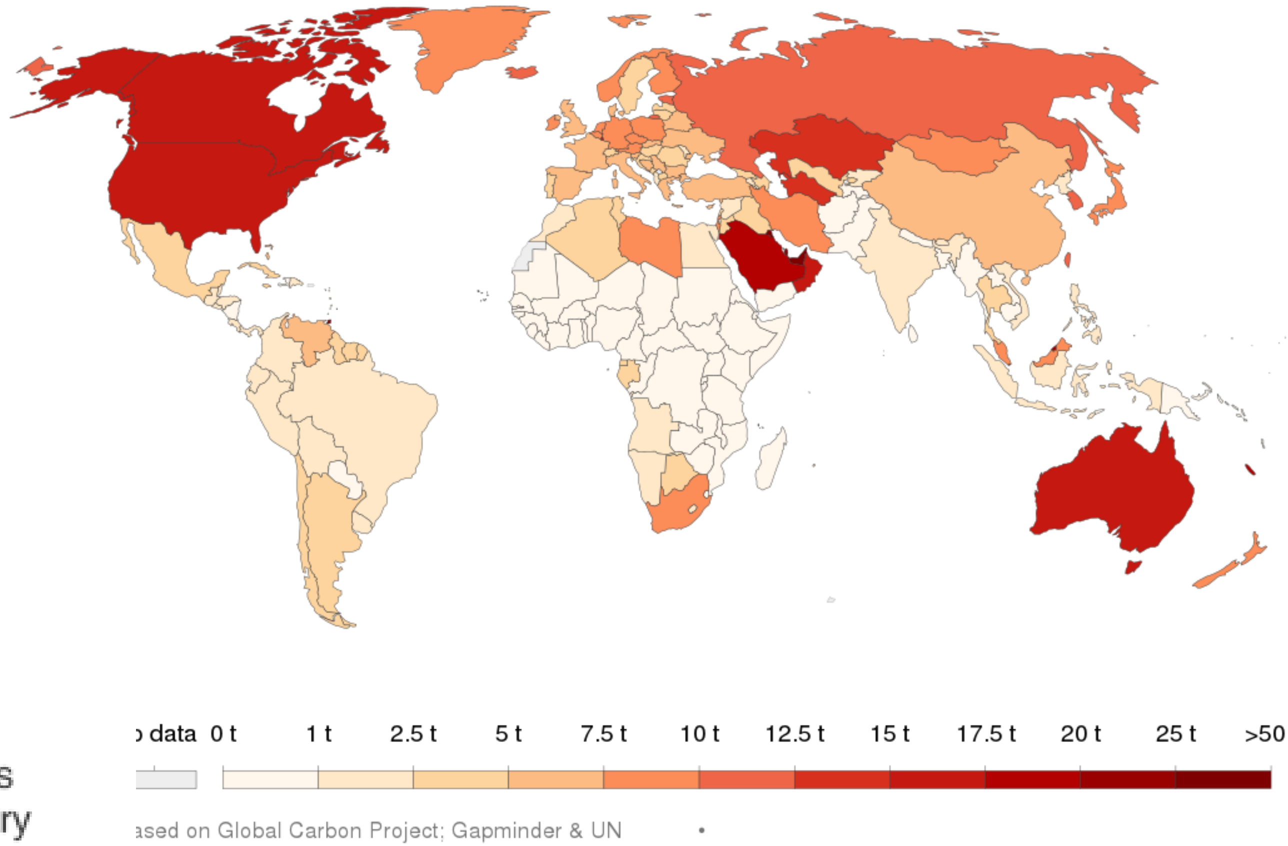
Expansion of humanity's global ecological footprint—the sum total of our impact on our planet's natural systems and resources.

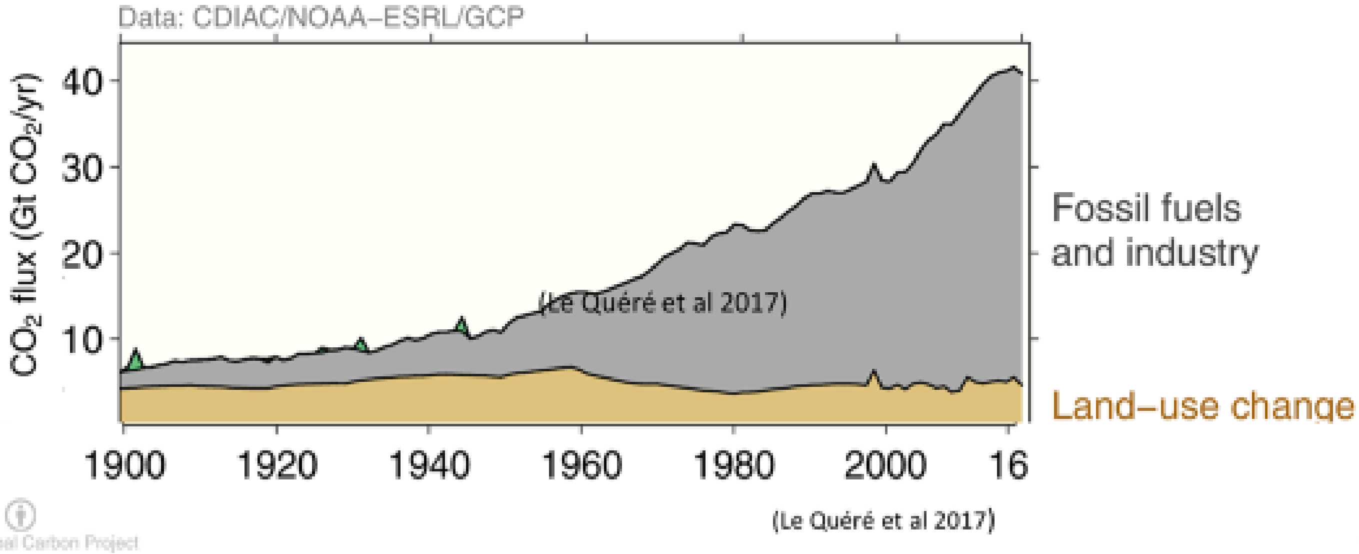
Africa never enjoyed the financial benefits generated by putting greenhouse gases up there in the first place,” he continued, “so it never accumulated the wealth to be able to bear the shocks.”

Sierra Leonean climate scientist Ogunlade Davidson

CO_2 emissions per capita, 2016

Average carbon dioxide (CO_2) emissions per capita measured in tonnes per year.





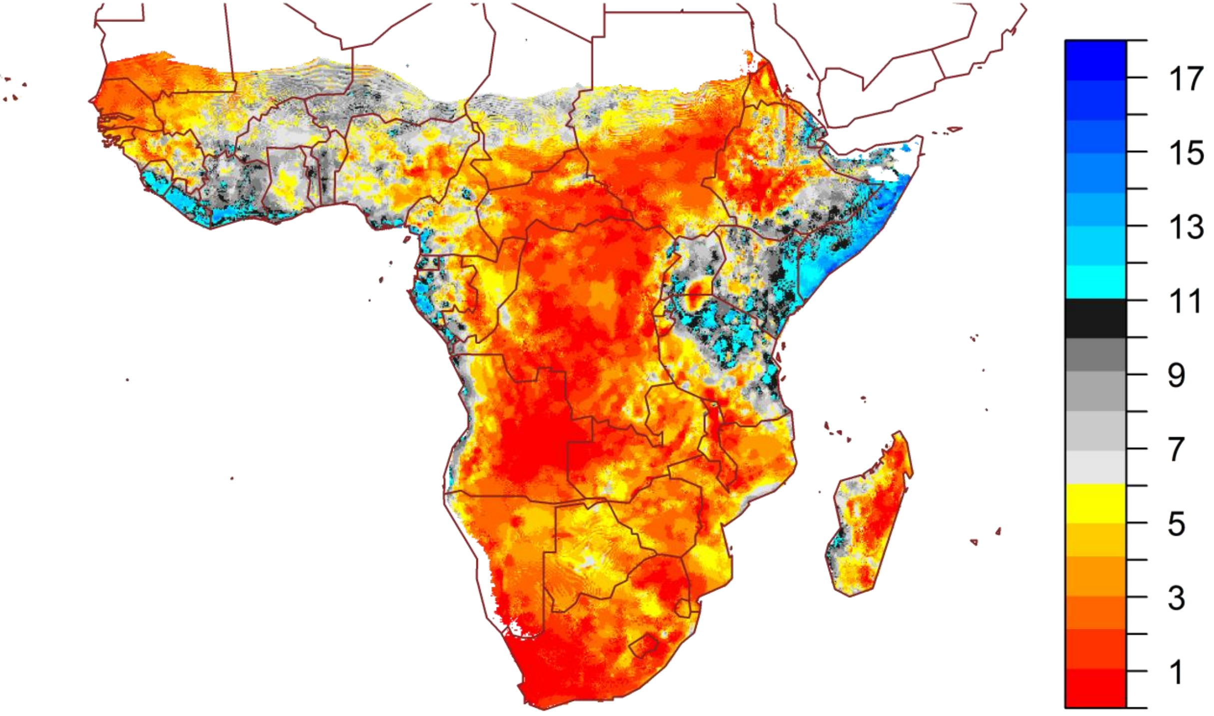
The anthropogenic component of the greenhouse effect is caused by man’s activities that emit greenhouse gases to the atmosphere

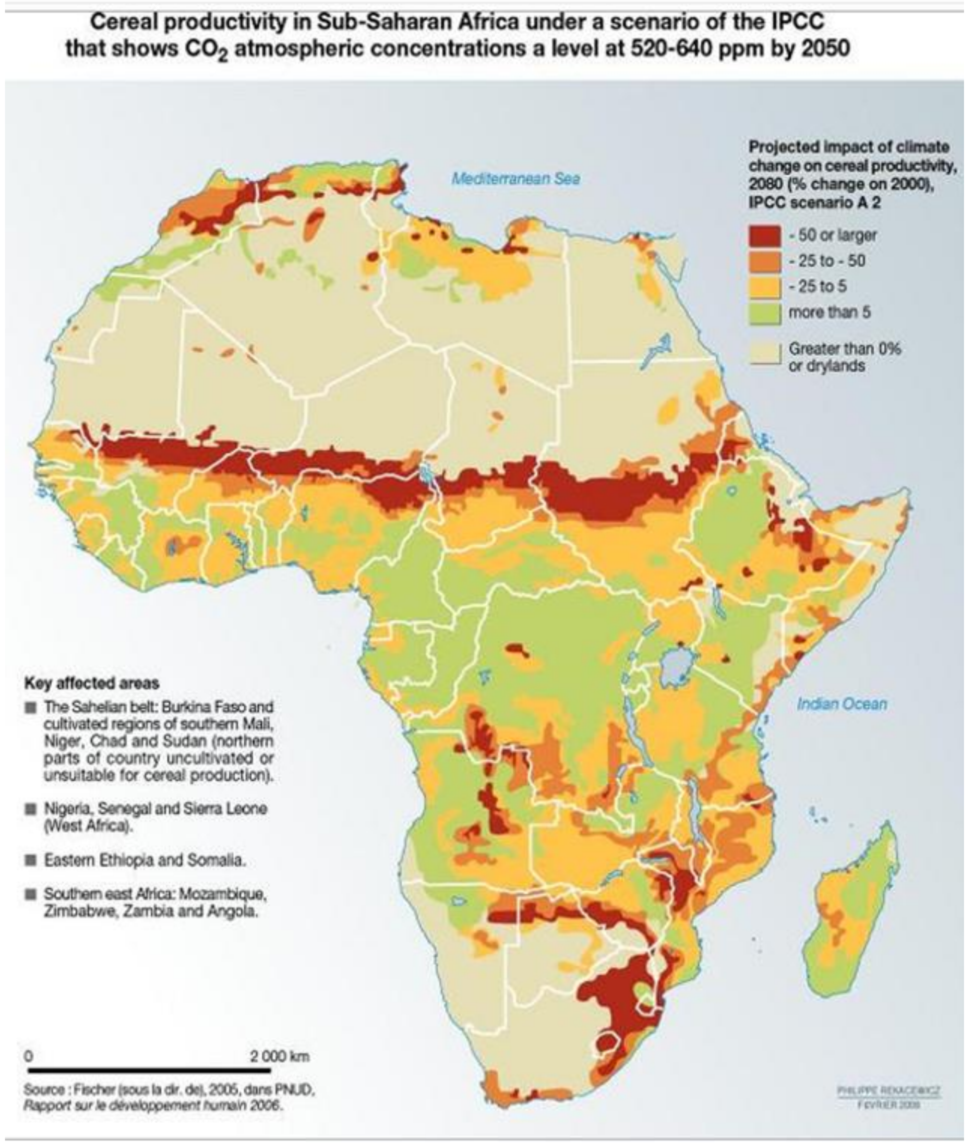
Future climates and projections

World Agroforestry

AFRICLIM Version 3.0 spans ten general circulation models (GCM)

Number out of 18 AFRICLIM models that project increases in the Moisture Index

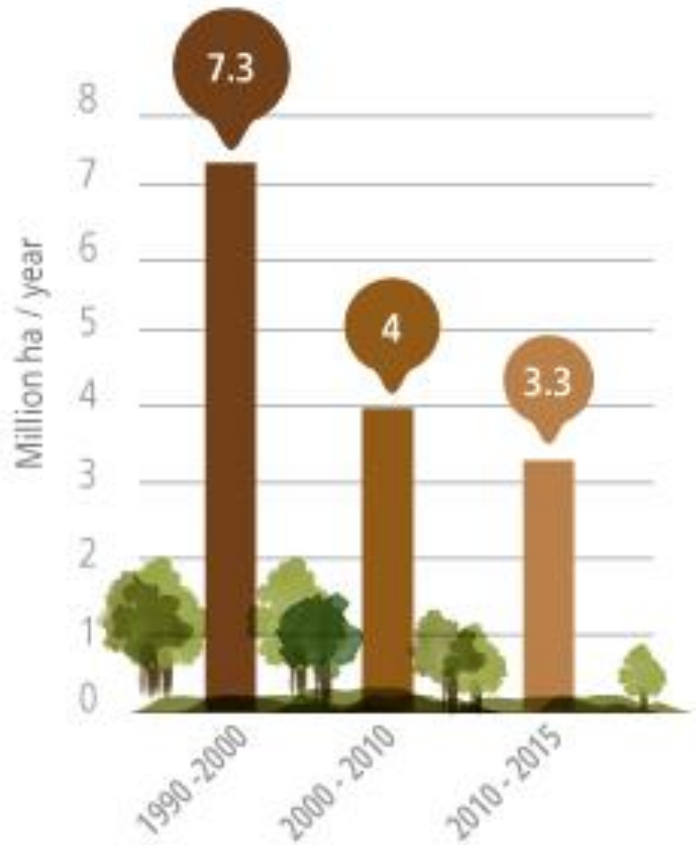


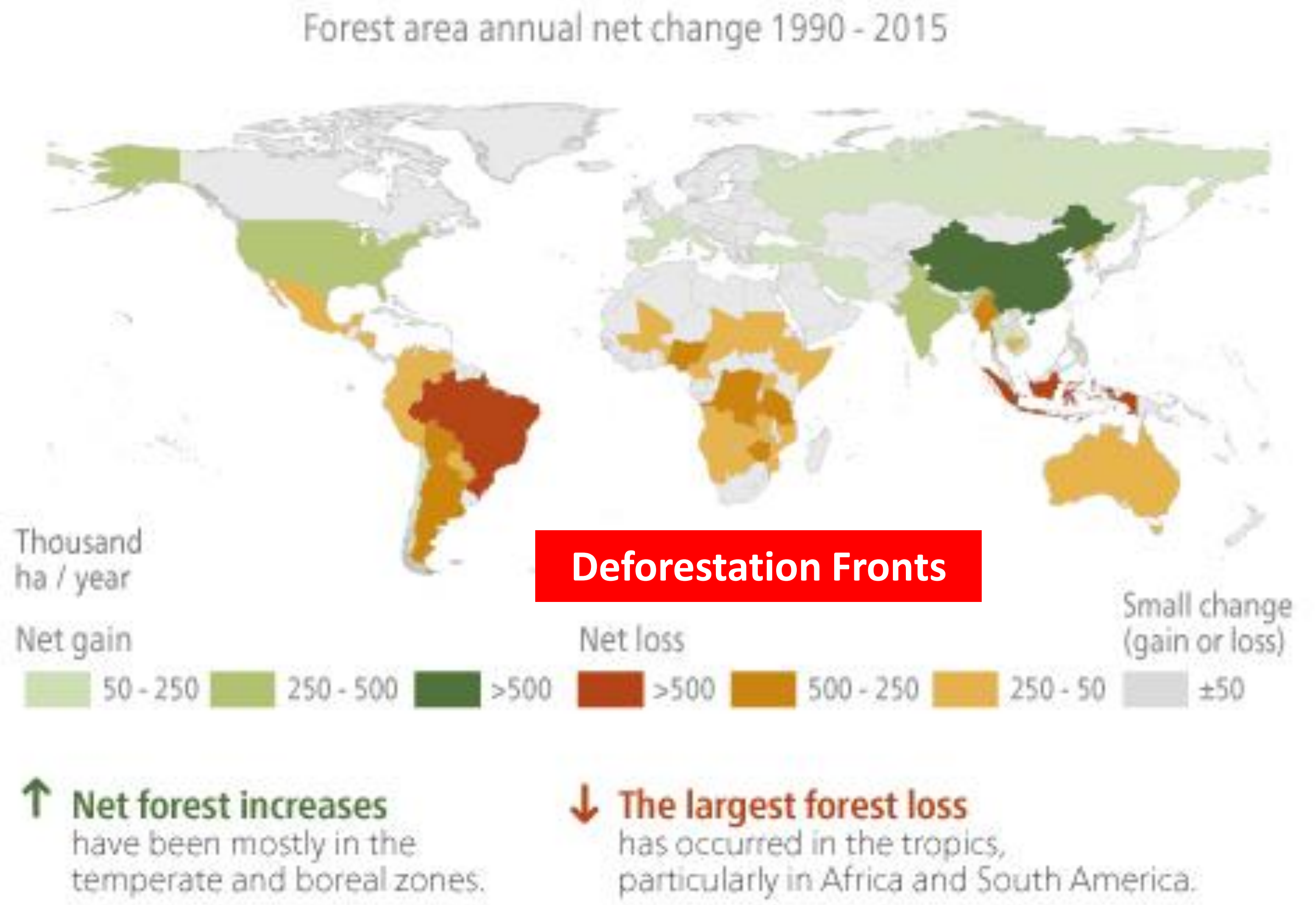


Source: https://www.york.ac.uk/environment/research/kite/resources/

Roeland KINDT : R.Kindt@CGIAR.org

Forest areas have decreased since 1990 but the rate of net forest loss has been cut by 50%





Global Forest Resources Assessment 2015 (FRA)

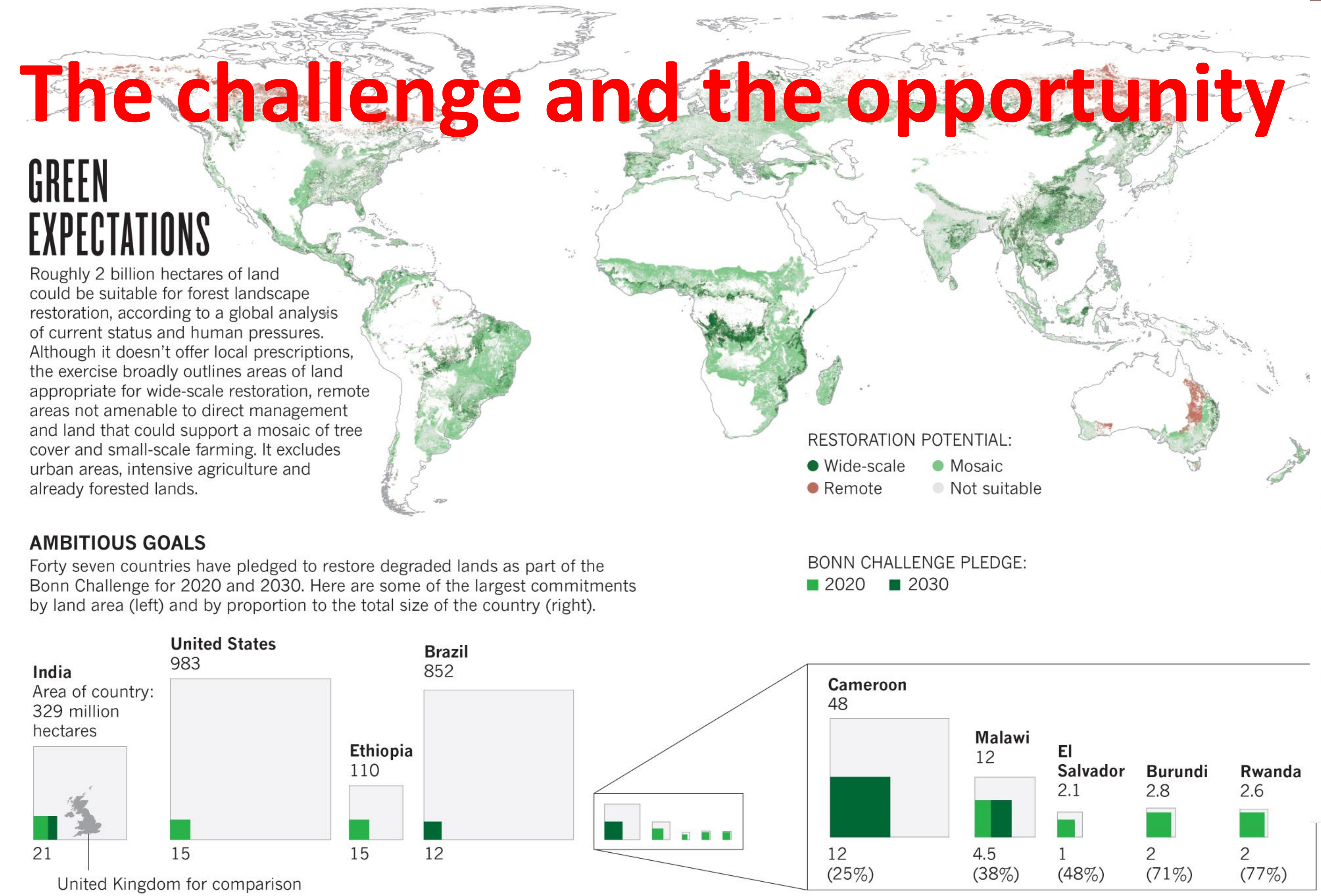
How are the world's forests changing?*

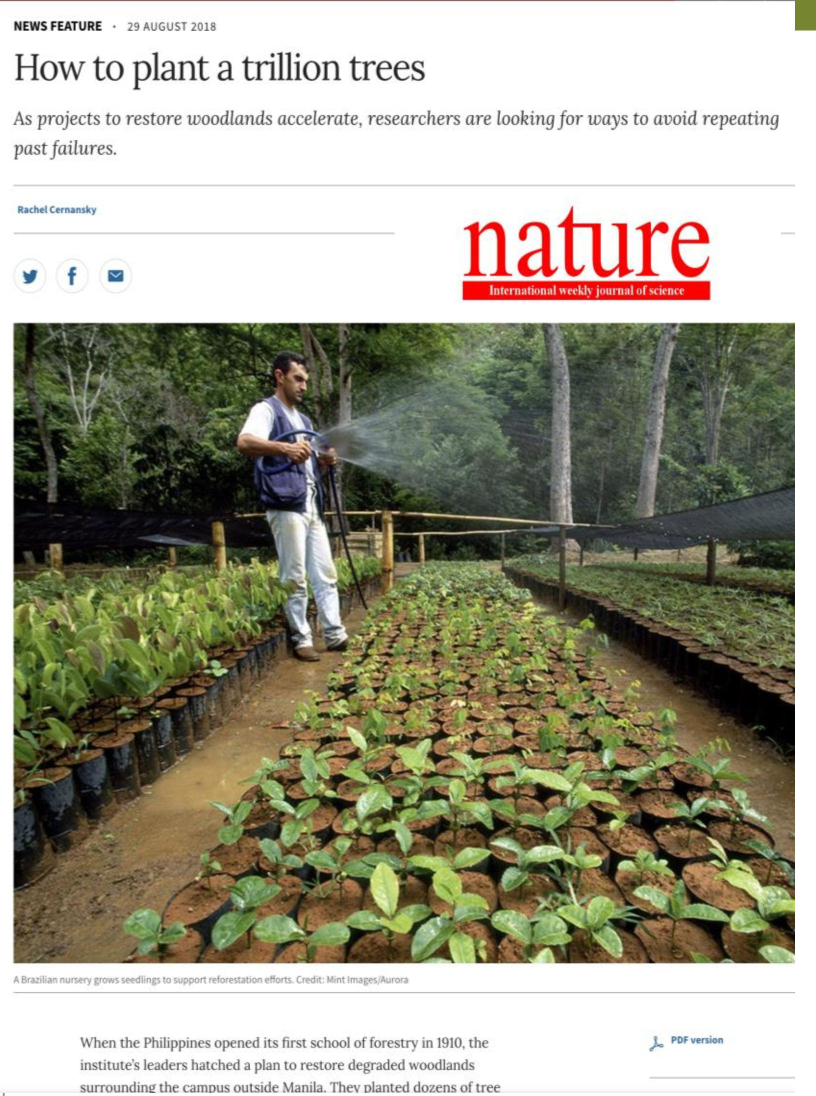
A lot is being asked of agricultural areas – produce food, energy for towns, produce water for towns and energy for industry.

Zambia turns to charcoal as hydroelectricity sources drain

Zambia has long relied on rainfall to generate electricity. But with climate change rapidly depleting water sources, people are turning to charcoal for their power needs, prompting calls to ban the black fuel.

The challenge and the opportunity




NEWS FEATURE · 29 AUGUST 2018

How to plant a trillion trees

As projects to restore woodlands accelerate, researchers are looking for ways to avoid repeating past failures.

Rachel Cernansky

nature
International weekly journal of science

A Brazilian nursery grows seedlings to support reforestation efforts. Credit: Mint Images/Aurora

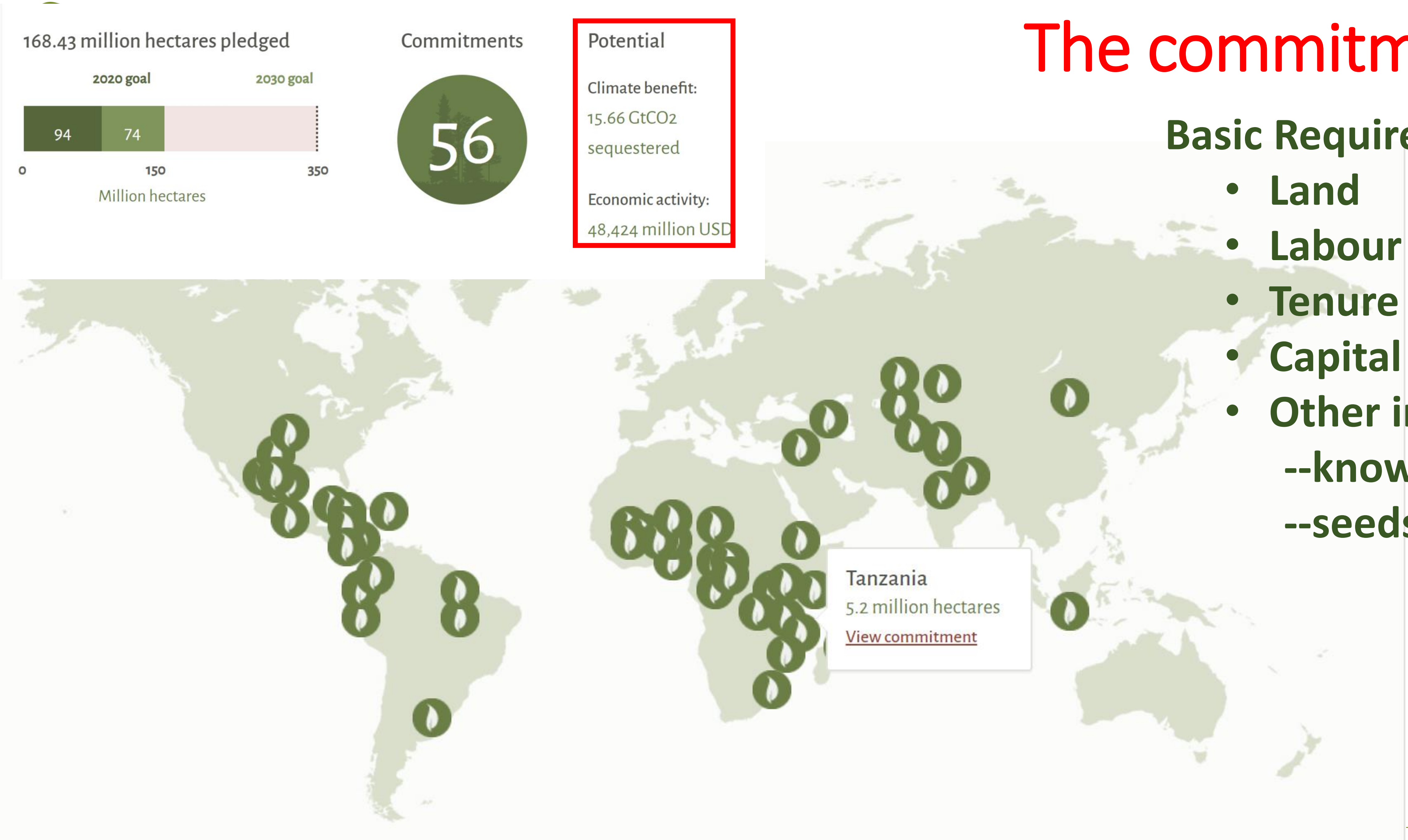
When the Philippines opened its first school of forestry in 1910, the institute's leaders hatched a plan to restore degraded woodlands surrounding the campus outside Manila. They planted dozens of tree

PDF version

HOW TO REBUILD A FOREST

BONN Challenge :350 million ha by 2030

The commitments

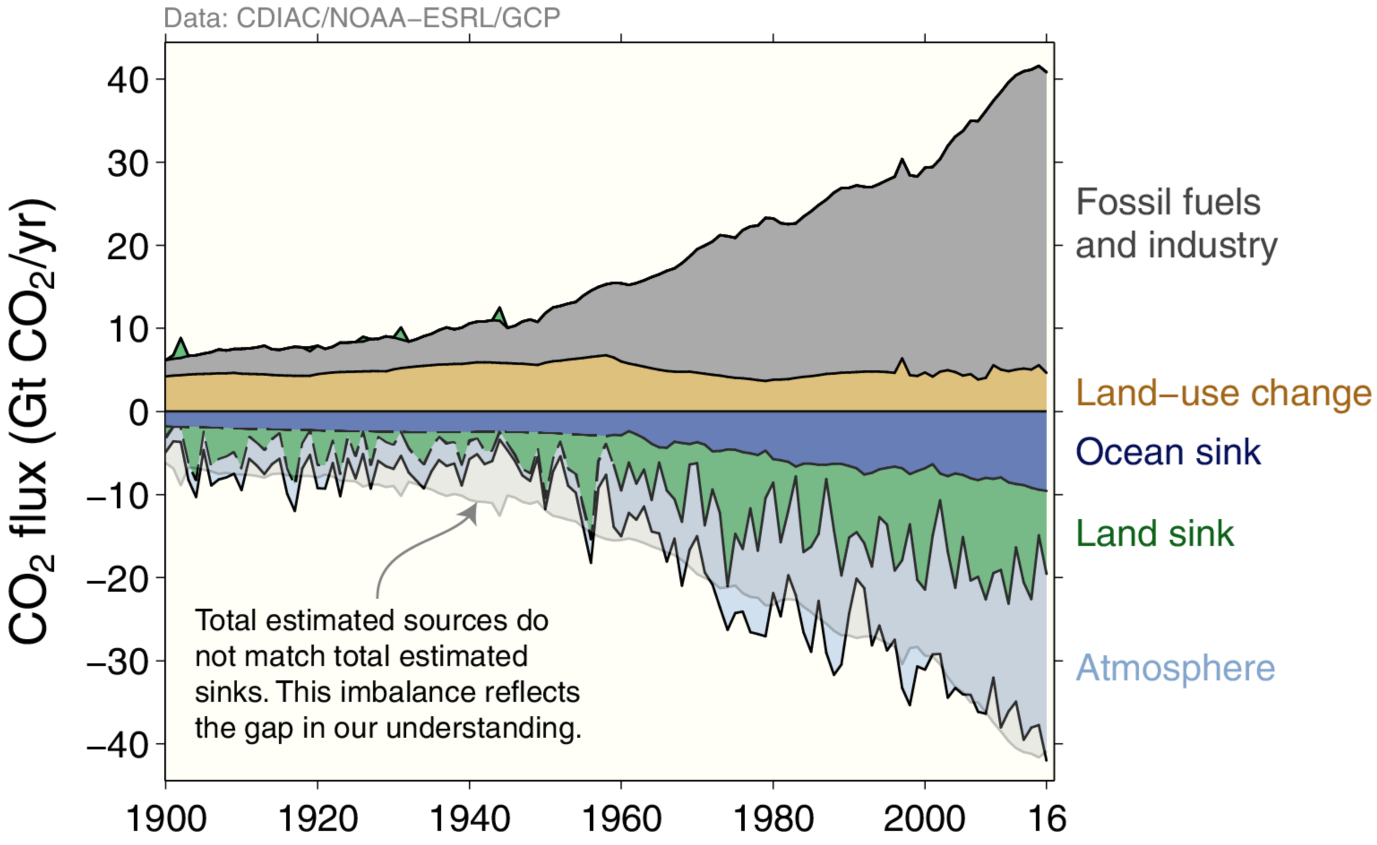


Basic Requirements:

- **Land**
- **Labour**
- **Tenure**
- **Capital**
- **Other inputs**
  - **--know-how**
  - **--seeds**

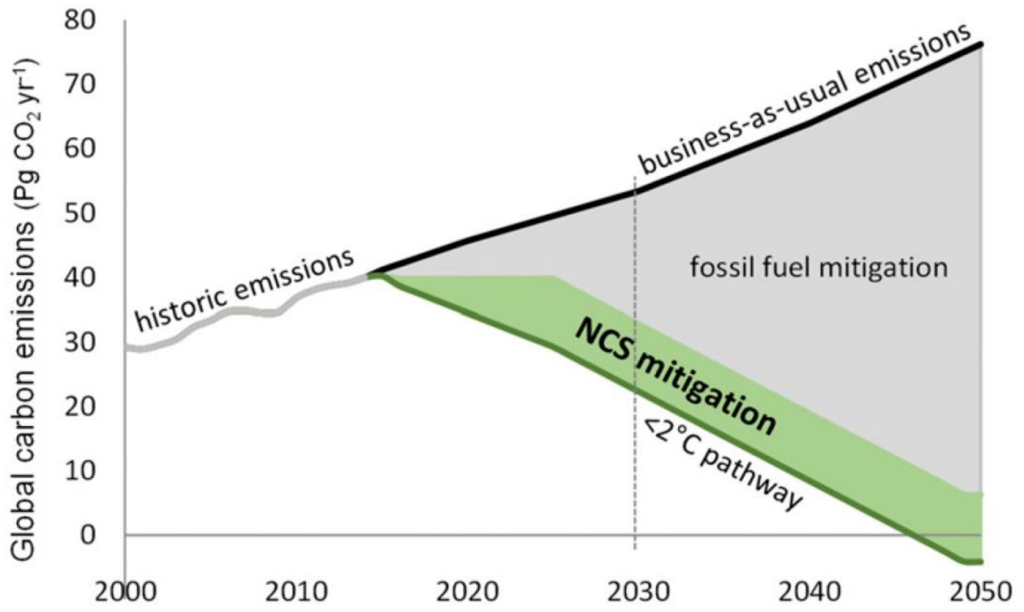
The benefits: climate mitigation

Land-use change and the land sink significant in the global carbon balance (Le Quéré et al 2017)



Natural Climate Solutions "can provide over one-third of the cost effective climate mitigation needed between now and 2030 to stabilize warming to below 2° C"

(Griscom et al 2017)

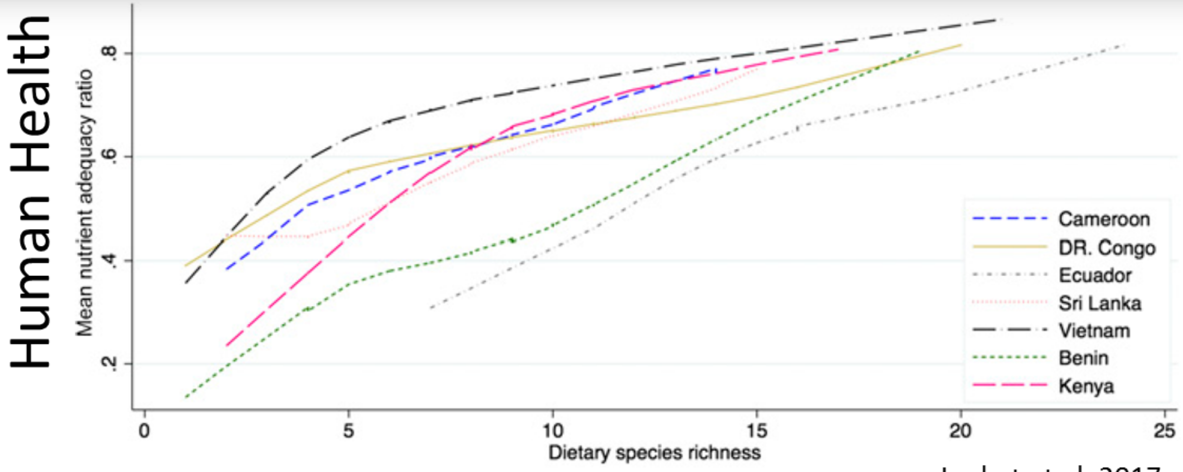


World Agroforestry

Other benefits:

- Economic value: positive, one to two digits rate of return.
- Positive correlations with biodiversity and resilience; and with agricultural produce and dietary diversity

Chazdon et al 2017		Direct cost and intensity of intervention	Similarity between biodiversity at target state and native forest	Agricultural or forestry production value
Natural regeneration interventions	Spontaneous natural regeneration	$	🍃🍃🍃	🌾
	Assisted natural regeneration	$$	🍃🍃	🌾🌾
	Farmer managed natural regeneration	$$	🍃	🌾🌾🌾
Other types of restoration interventions	Mixed species planting with native tree species	$$$	🍃🍃🍃	🌾🌾🌾
	Agroforestry systems	$$$	🍃🍃	🌾🌾🌾🌾🌾 🌾🌾🌾
	Monoculture or plantations using few species	$$$	🍃	



Lachat et al. 2017

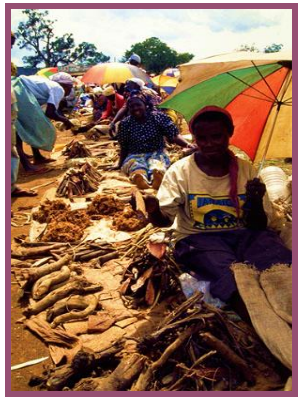
Biodiversity

TREES for ADAPTATION and MITIGATION

Products for food, health and income


food & nutrition


firewood


medicine


income


sawn wood


fodder

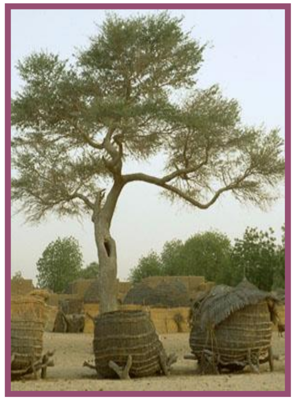
Services for sustainability and resilience


soil fertility


carbon


erosion


watershed


shade


biodiversity

RESEARCH ARTICLE

ECOLOGY

Estimating the global conservation status of more than 15,000 Amazonian tree species

10.1126/sciadv.1500936

Hans ter Steege,[1,2]* Nigel C. A. Pitman,[3,4] Timothy J. Killeen,[5] William F. Laurance,[6] Carlos A. Peres,[7] Juan Ernesto Guevara,[8,9] Rafael P. Salomão,[10] Carolina V. Castilho,[11] Iêda Leão Amaral,[12] Francisca Dionízia de Almeida Matos,[12] Luiz de Souza Coelho,[12] William E. Magnusson,[13] Oliver L. Phillips,[14] Diogenes de Andrade Lima Filho,[12] Marcelo de Jesus Veiga Carim,[15] Mariana Victória Irume,[12] Maria Pires Martins,[12] Jean-François Molino,[16] Daniel Sabatier,[16] Florian Wittmann,[17] Dairon Cárdenas López,[18] José Renan da Silva Guimarães,[15] Abel Monteagudo Mendoza,[19] Percy Núñez Vargas,[20] Angelo Gilbe
Juan Carlos Montero,[12,23] Ted R. Fel
Charles Eugene Zartman,[12] Bonifaci
Marcelo Fragomeni Simon,[29] Ana Ar
Henrique Eduardo Mendonça Nascin
Natalia Targhetta,[28] Ima Célia Guim
Hugo F. Mogollón,[34] Maria Teresa F
Nállarett Dávila,[37] Roosevelt García-
Carolina Levis,[13,42] Juliana Schietti,[13]
David Neill,[44] Alejandro Araujo-Mura
Dário Dantas do Amaral,[10] Rogerio G
Paul Fine,[8] Marisol Toledo,[23] Chris B
Paul Maas,[55] Maria Cristina Peñuela
Juliana Stropp,[58,59] Raquel Thomas-C
Alfredo Fuentes,[63] Peter Møller Jørge
Bruno Barçante Ladvocat Cintra,[28] Fe
Tinde R. van Andel,[1] Patricio von Hil
Deborah de Castro,[28] Emanuelle de
Yadvinder Malhi,[74] Ires Paula de Andr
César I.A. Vela,[78] Vincent A. Vos,[79,80]
Alexandre A. Oliveira,[83] Hirma Ramir
Maria Natalia Umaña Medina,[86] Geer
Kenneth R. Young,[89] Claudia Baider,
Casimiro Mendoza,[92,93] Italo Mesone
Roderick Zagt,[94] Miguel N. Alexiades
William Milliken,[97] Walter Palacios C
Adeilza Felipe Sampaio,[99] Elvis H. Valderrama Sandoval,[101,102] Luis Valenzuela Gamarra[19]

We show that the trends observed in Amazonia apply to trees throughout the tropics, and we predict that most of the world's >40,000 tropical tree species now qualify as globally threatened

Ter Stege et al 2016, Sci. Adv.

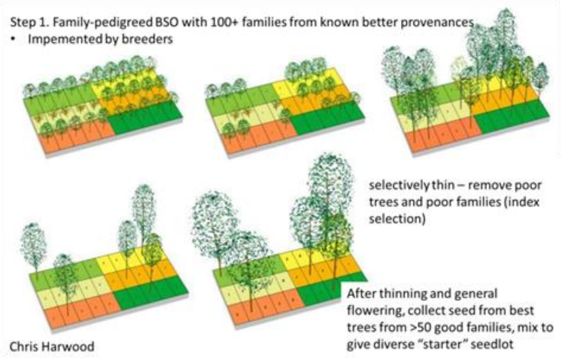
Estimates of extinction risk for Amazonian plant and animal species are rare and not often incorporated into land-use policy and conservation planning. We overlay spatial distribution models with historical and projected deforestation to show that at least 36% and up to 57% of all Amazonian tree species are likely to qualify as globally threatened under International Union for Conservation of Nature (IUCN) Red List criteria. If confirmed, these results would increase the number of threatened plant species on Earth by 22%. We show that the trends observed in Amazonia apply to trees throughout the tropics, and we predict that most of the world's >40,000 tropical tree species now qualify as globally threatened. A gap analysis suggests that existing Amazonian protected areas and indigenous territories will protect viable populations of most threatened species if these areas suffer no further degradation, highlighting the key roles that protected areas, indigenous peoples, and improved governance can play in preventing large-scale extinctions in the tropics in this century.

INTRODUCTION

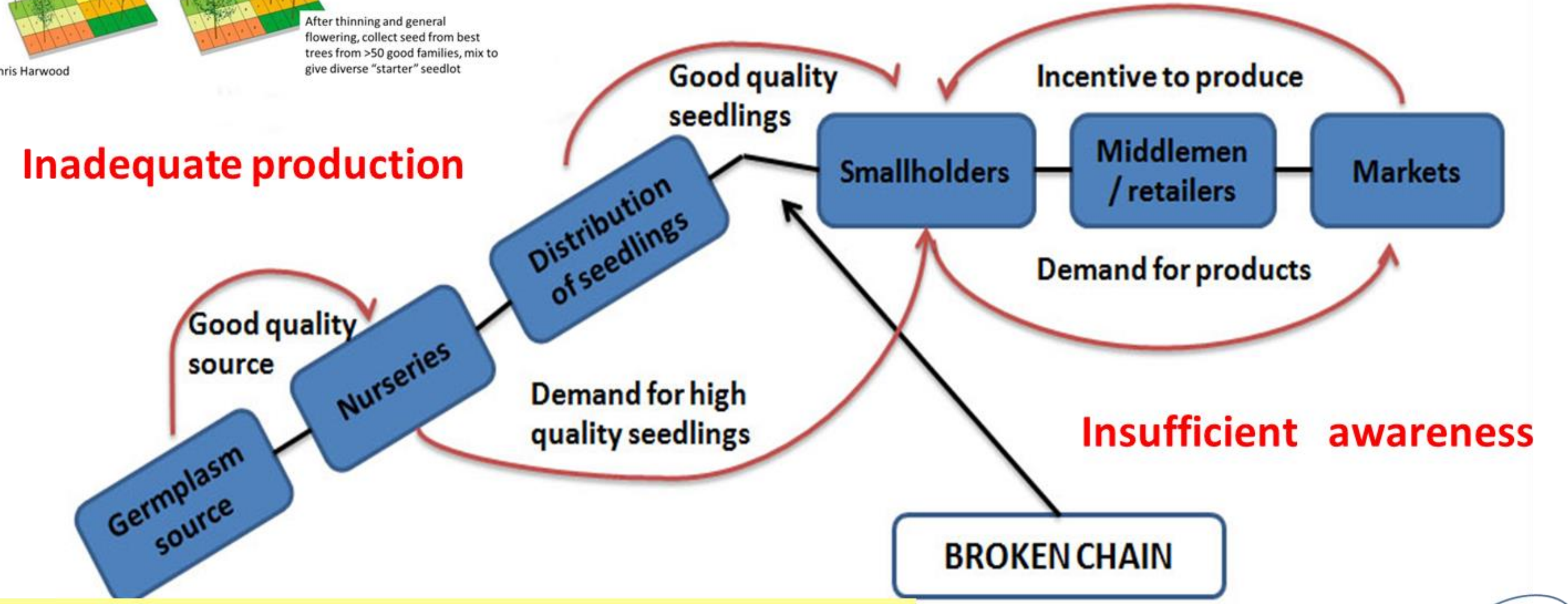
Amazonian forests have lost ~12% of their original extent and are projected to lose another 9 to 28% by 2050 (*1*, *2*). The consequences of ongoing forest loss in Amazonia (here all rainforests of the Amazon basin and Guiana Shield) are relatively well understood at the ecosystem level, where they include soil erosion (*3*, *4*), diminished ecosystem services (*5*–*8*), altered climatic patterns (*5*, *7*, *9*–*11*), and habitat degradation. By contrast, little is known about how historical forest loss has affected the population sizes of plant and animal species in the basin and how ongoing deforestation will affect these populations in the future.

Specific challenges with respect to planting material

- The resource of diversity is under threat
- The demand is huge
- Innovations in field testing to address multiplicity of species and functions
- Link between domestication/breeding and delivery – unimproved material – challenge to establish markets and scaling up
- Efficiency of delivery systems (knowledge, standards, trust and traceability)

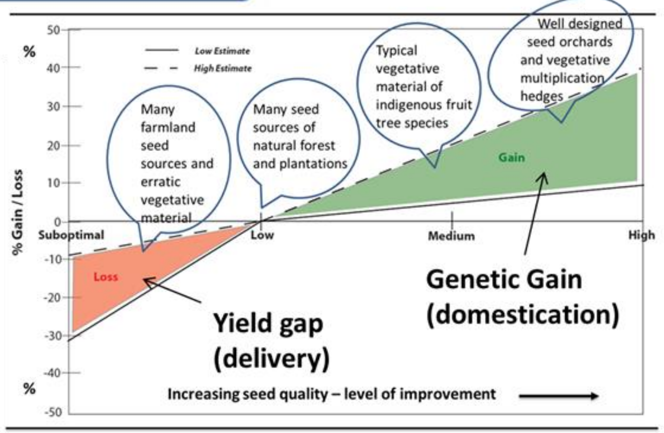


Major bottlenecks in input supply and demand with a broken chain of availability information and value



- Smallholders must know that "high quality" seedlings perform better than alternatives – need results from comparative trials.
- Supply chain for "high quality" seedlings must be financed

Lillesø et al. Dev. Pol. Review 2018 http://dx.doi.org/10.1111/dpr.12233



Many project design documents pay insufficient attention to the choice, sourcing and delivery of planting material, which is likely to impact on the quality of the trees planted Rosehtko et al 2018

Our results indicate that lack of sufficiently diverse tree seed is a widespread problem in FLR projects and programmes worldwide, commonly causing delays and increasing project costs – and above all, constraining the achievement of restoration objectives.
Jalonen et al 2018

The benefits: Livelihoods

World Agroforestry

Trees account for an average of 17% of total annual gross income for tree-growing households

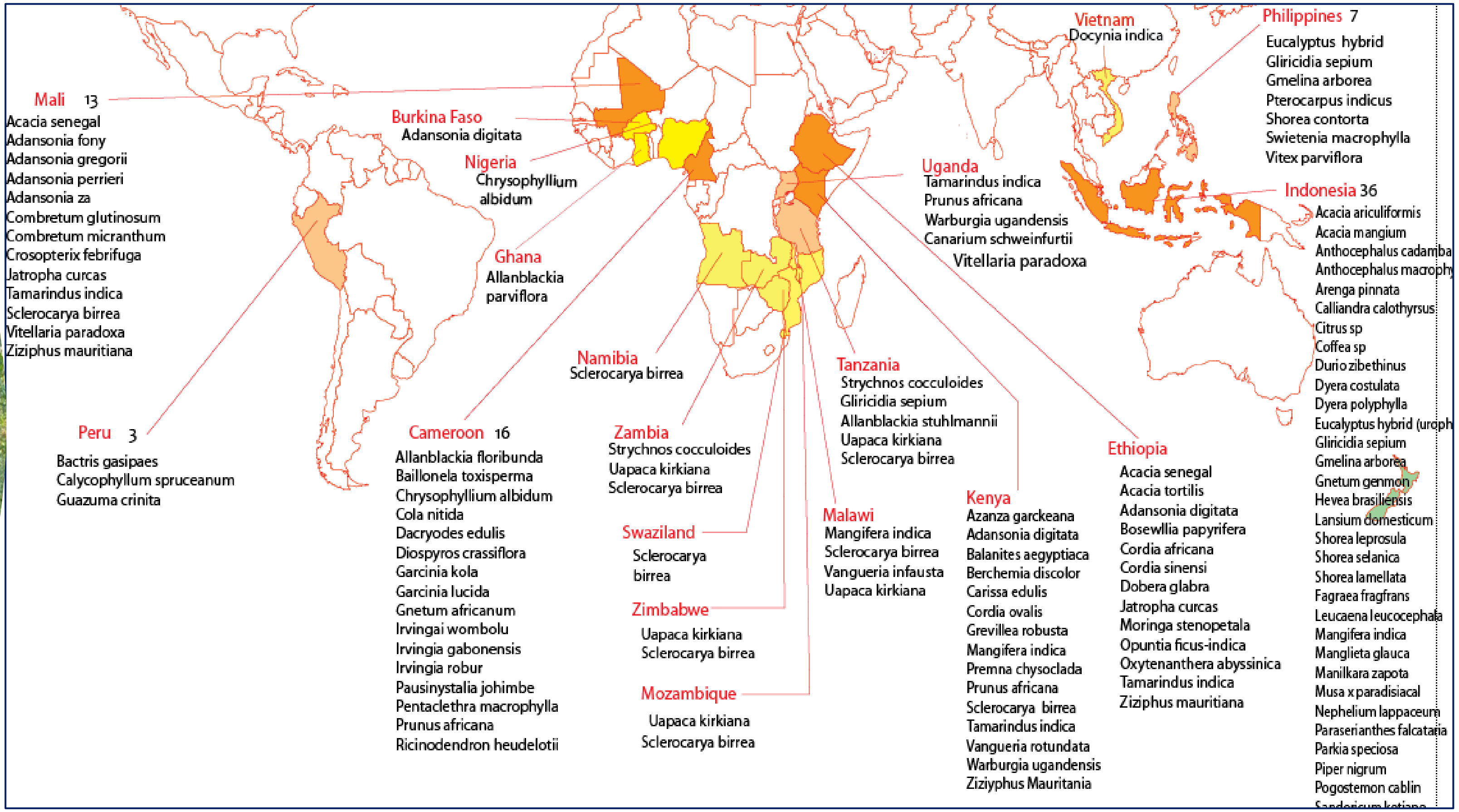
Miller, D.C., et al., Forest Policy and Economics (2019),

Beyond timber: perennial crops in Africa, last 5 years for which data are available in FAOSTAT

	Gross Production Value (constant 2004-2006 million US$)					
Crop	Value 2012	Value 2013	Value 2014	Value 2015	Value 2016	Mean value 2012-2016
Bananas [486]	3,657	4,294	4,100	3,932	3,880	3,973
Plantains and others [489]	3,452	3,518	3,604	3,703	3,766	3,609
Grapes [560]	2,935	3,122	3,072	3,230	3,217	3,115
Cocoa, beans [661]	2,440	2,345	2,265	2,273	2,323	2,329
Dates [577]	2,019	2,102	2,279	2,465	2,572	2,287
Oil palm fruit [254]	2,045	2,032	2,050	2,061	2,056	2,049
Olives [260]	1,493	1,568	1,362	1,945	1,593	1,592
Apples [515]	1,349	1,562	1,491	1,645	1,541	1,518
Mangoes, mangosteens, guavas [571]	978	935	1,079	1,241	1,297	1,106
Cashew nuts, with shell [217]	791	911	888	906	967	893
Coffee, green [656]	710	838	878	927	938	858
Tea [667]	726	843	868	793	922	830
Tangerines, mandarins, clementines, satsumas [495]	718	676	851	831	849	785
Papayas [600]	431	446	476	481	467	460
Coconuts [249]	450	443	445	455	463	451
Rubber, natural [836]	403	[illegible]	[illegible]	[illegible]	[illegible]	430
Pears [521]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Karite nuts (sheanuts) [263]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Peaches and nectarines [534]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Apricots [526]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Lemons and limes [497]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Kola nuts [224]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Avocados [572]	210	[illegible]	[illegible]	[illegible]	[illegible]	186
Palm kernels [256]	159	161	199	199	199	183
Grapefruit (inc. pomelos) [507]	108	131	128	124	121	122
Cashewapple [591]	47	26	42	39	41	39
Cherries [531]	31	37	38	43	31	36
Cloves [698]	20	22	27	28	27	25
Pistachios [223]	17	21	22	23	26	22
Total value (millions of USD)	**26,988**	**28,467**	**28,636**	**29,896**	**29,733**	**28,744**

US$ 28,744,000

Tree species domestication by country / region (130 tree species) focus was mostly participatory domestication



800 Food tree species in Africa that we know of!!

Scaling-up: The Seed Challenge: Provision of Adequate Tree Seed Portfolios (PATSPO) in Ethiopia 2017-2020

to enhance productivity and reselience of forest landscape restoration in Ethiopia – strengthening the development of the green economy in Ethiopia

World Agroforestry

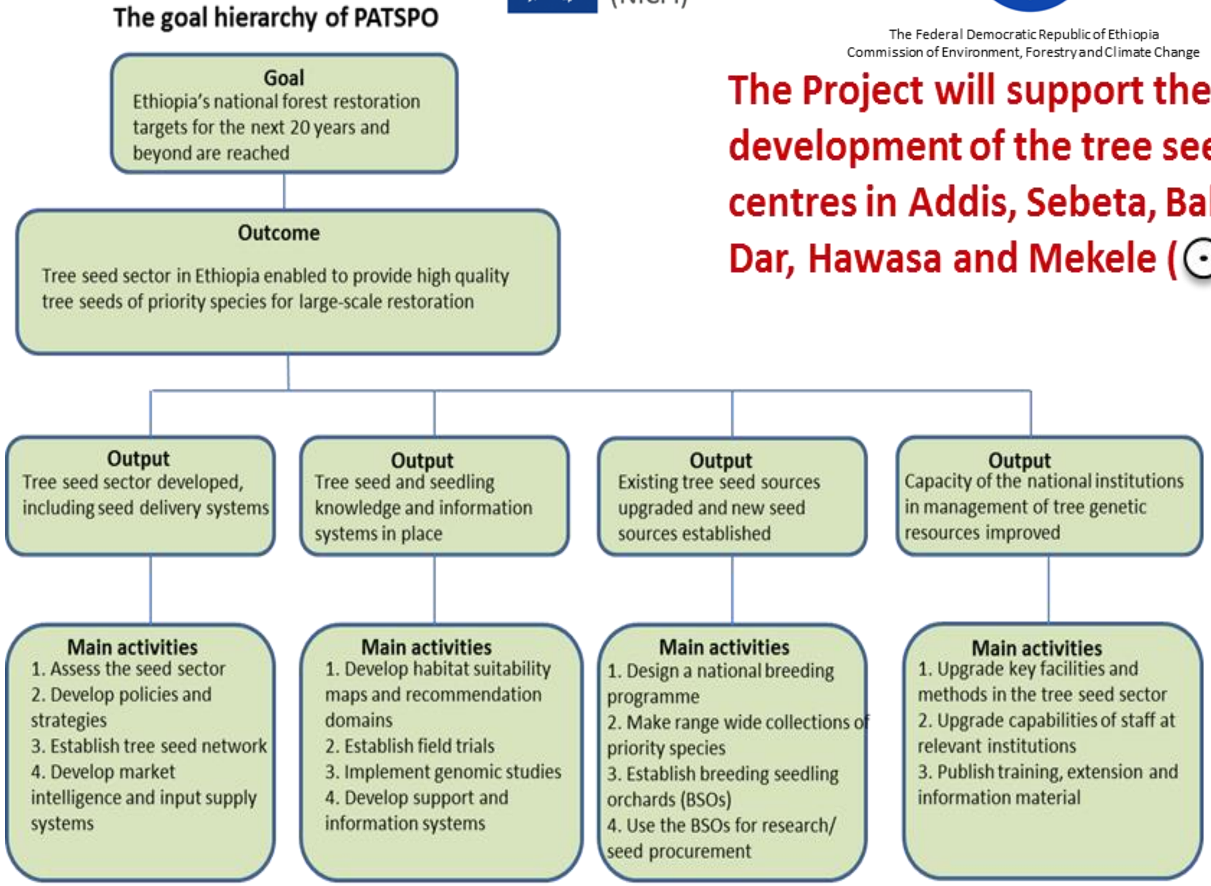
Norway's International Climate and Forest Initiative (NICFI)

The Federal Democratic Republic of Ethiopia
Commission of Environment, Forestry and Climate Change

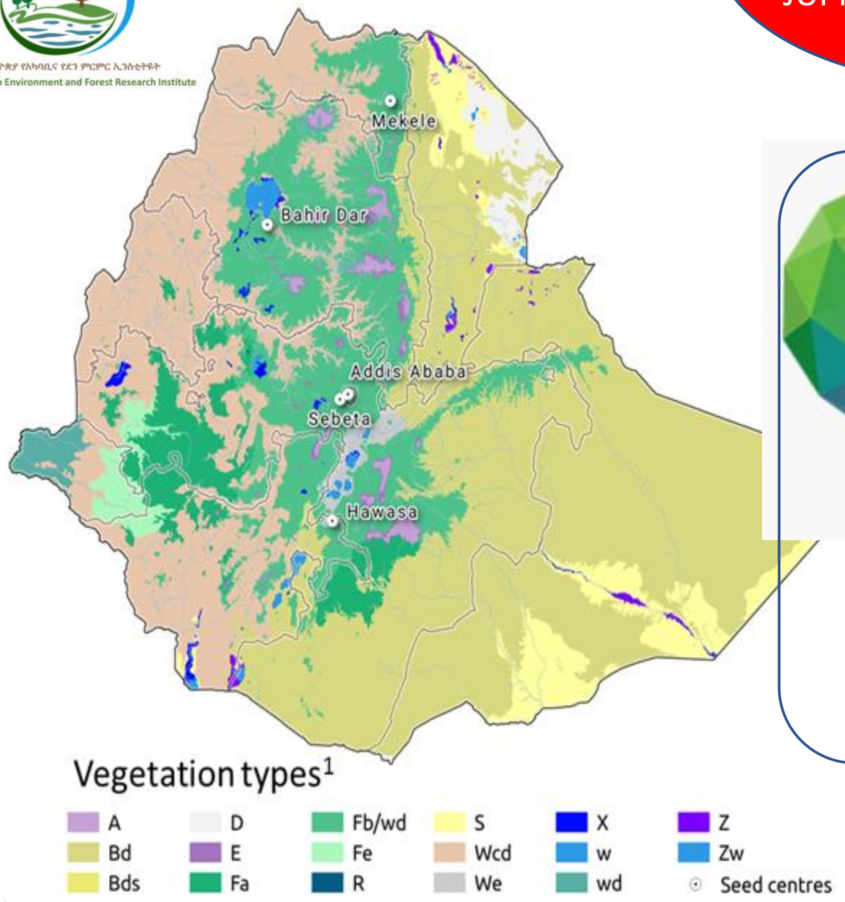
Ethiopian Environment and Forest Research Institute

BFW Austrian Research Centre for Forests

Austrian partners
JUPRET *Juniperus procera*



The Project will support the development of the tree seed centres in Addis, Sebeta, Bahir Dar, Hawasa and Mekele (⊙)



GREEN CLIMATE FUND

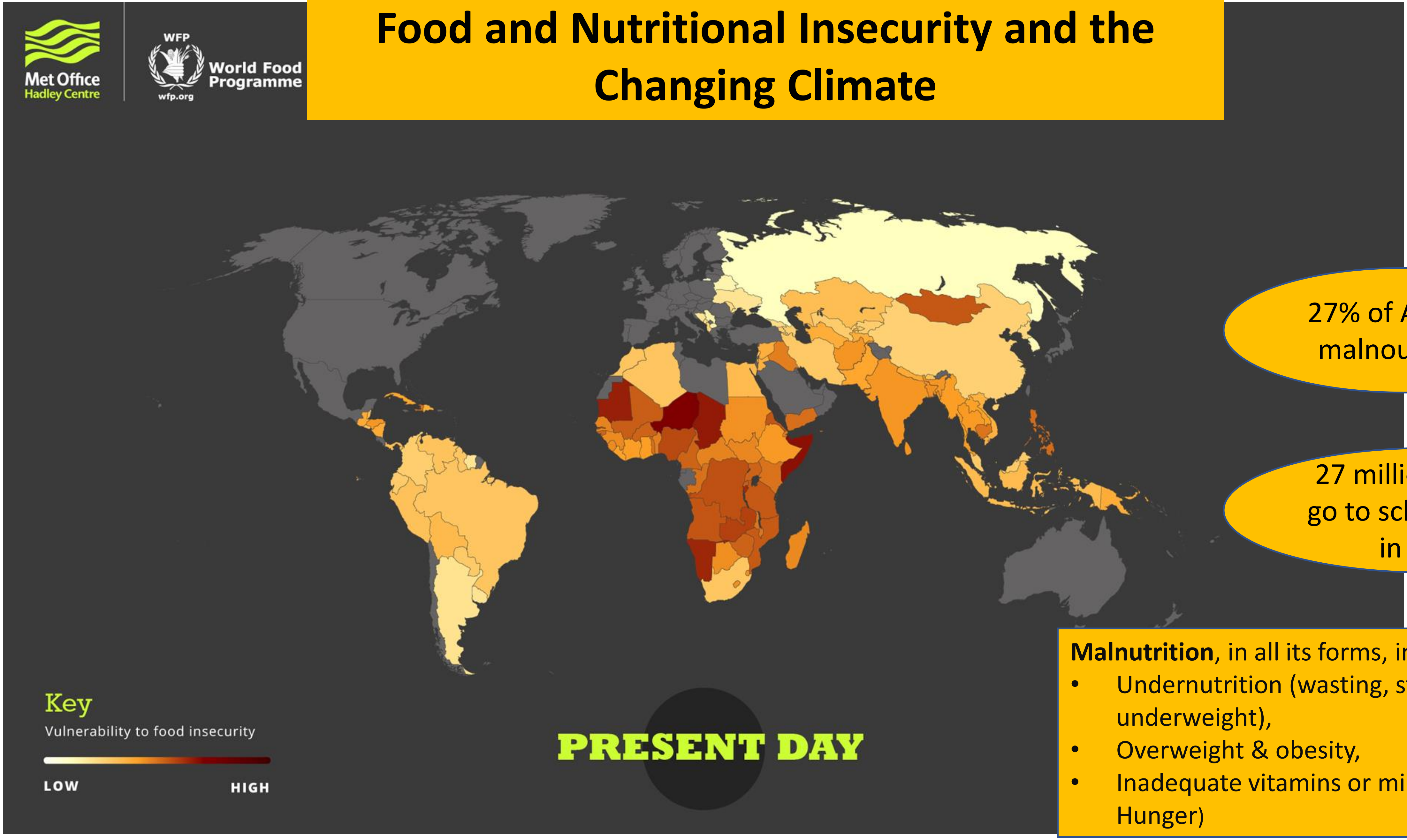
Gambia
Rwanda
Tanzania
Uganda

1) A Afroalpine vegetation; Bd Somalia-Masai Acacia-Commiphora deciduous bushland and thicket; Bds Acacia-Commiphora stunted bushland; D Desert; E Montane Ericaceous belt; Fa Afromontane rain forest; Fb/wd Afromontane undifferentiated forest/

Research in Development

CONSERVATION; FOOD SECURITY; WATER SHED MANAGEMENT; SOIL EROSION; BREEDING; DELIVERY SYSTEMS; RESTORATION

Food and Nutritional Insecurity and the Changing Climate

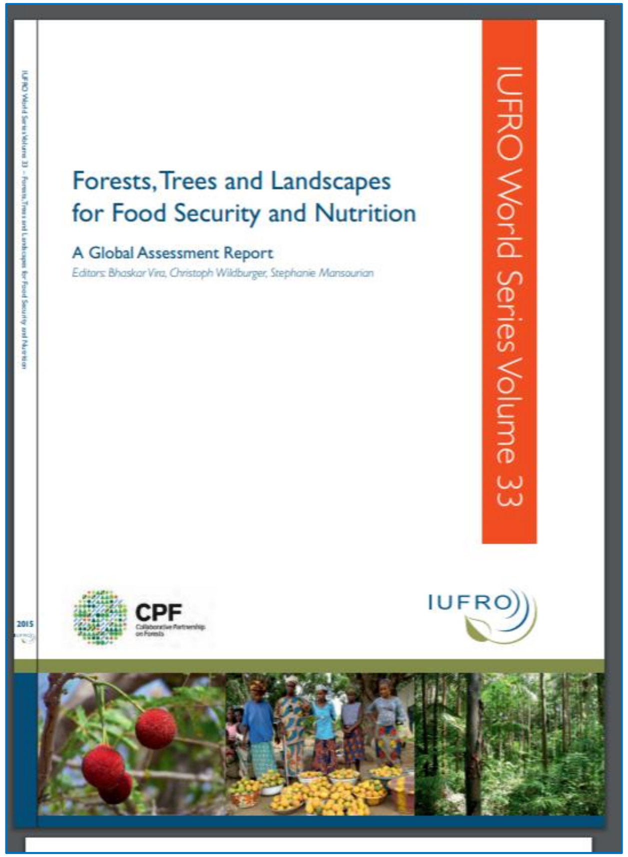


27% of Africans malnourished

27 million children go to school hungry in Africa

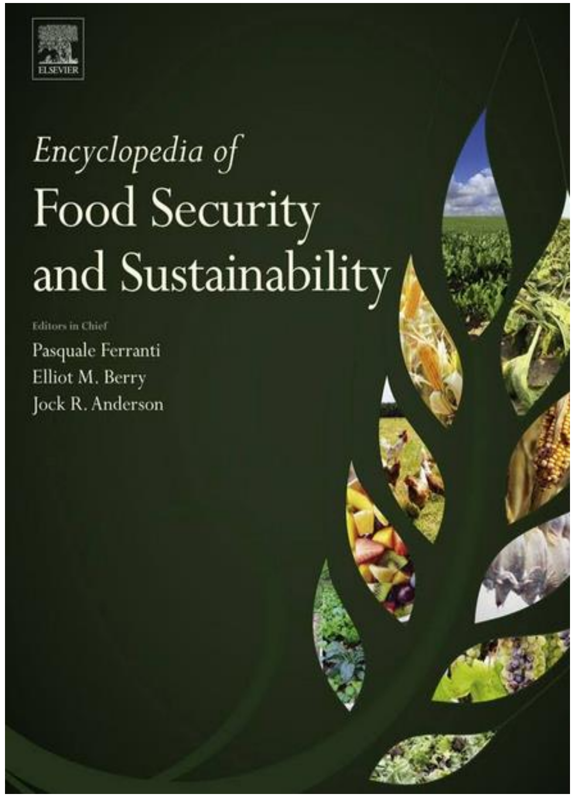
Malnutrition, in all its forms, include:

- Undernutrition (wasting, stunting, underweight),
- Overweight & obesity,
- Inadequate vitamins or minerals, (Hidden Hunger)

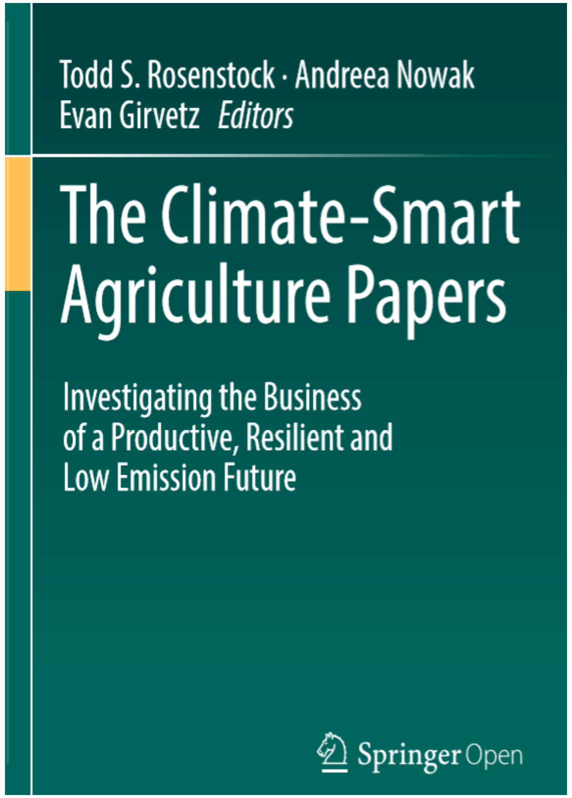


- Forests, Trees and Landscapes for Food Security and Nutrition
- Understanding the Roles of Forests and Tree-based Systems in Food Provision

IUFRO A Global Assessment Report



McMullin et al. 2019.
Fresh Fruit and Vegetables: Contributions to Food and Nutrition Security.
Encyclopedia of Food Security and Sustainability



Dawson, I.K., et al. 2018.
Integrating perennial new and orphan crops into climate-smart African agricultural systems to support nutrition. ***The Climate-Smart Agriculture Papers.***

Nutritional value of indigenous & underutilised food tree and crop species

Nutritional value of underutilised food species




Food	**Vitamin C** (mg/100 g EP)	**Vitamin A*** (RE) (mcg/100 g EP)	**Iron** (mg/100 g EP)	**Folate** (mcg/100g EP)
Oranges, raw *(Citrus sinensis)*	**53**	22	0.1	30
Baobab, fruit pulp, raw *(Adansonia digitata)*	**273**		2.7	
Marula, fruit, raw *(Sclerocarya birrea)*	**167**		3.4	
Amaranth leaves, raw (*Amaranthus gangeticus*)	**77**	**652**	**6.8**	**64**

Vitamin A retinol equivalent (RE)*: mcg retinol + 1/6 beta-carotene + 1/12 alpha-carotene + 1/12 beta cryptoxanthin

FAO (2012) West African Food Composition Table. FAO Rome. FAO/Government of Kenya. 2018. Kenya Food Composition Tables. Nairobi, 254 pp. Nutrient composition of selected indigenous fruits from sub-Saharan Africa. Journal of the Science of food and Agriculture. Pictures © i Stock; © CIFOR

Source: Barbara Stadlmayr


Food tree and crop portfolios to target harvest and nutrient gaps
(addressing seasonality and nutritional gaps)

PRODUCTIVE RESTORATION

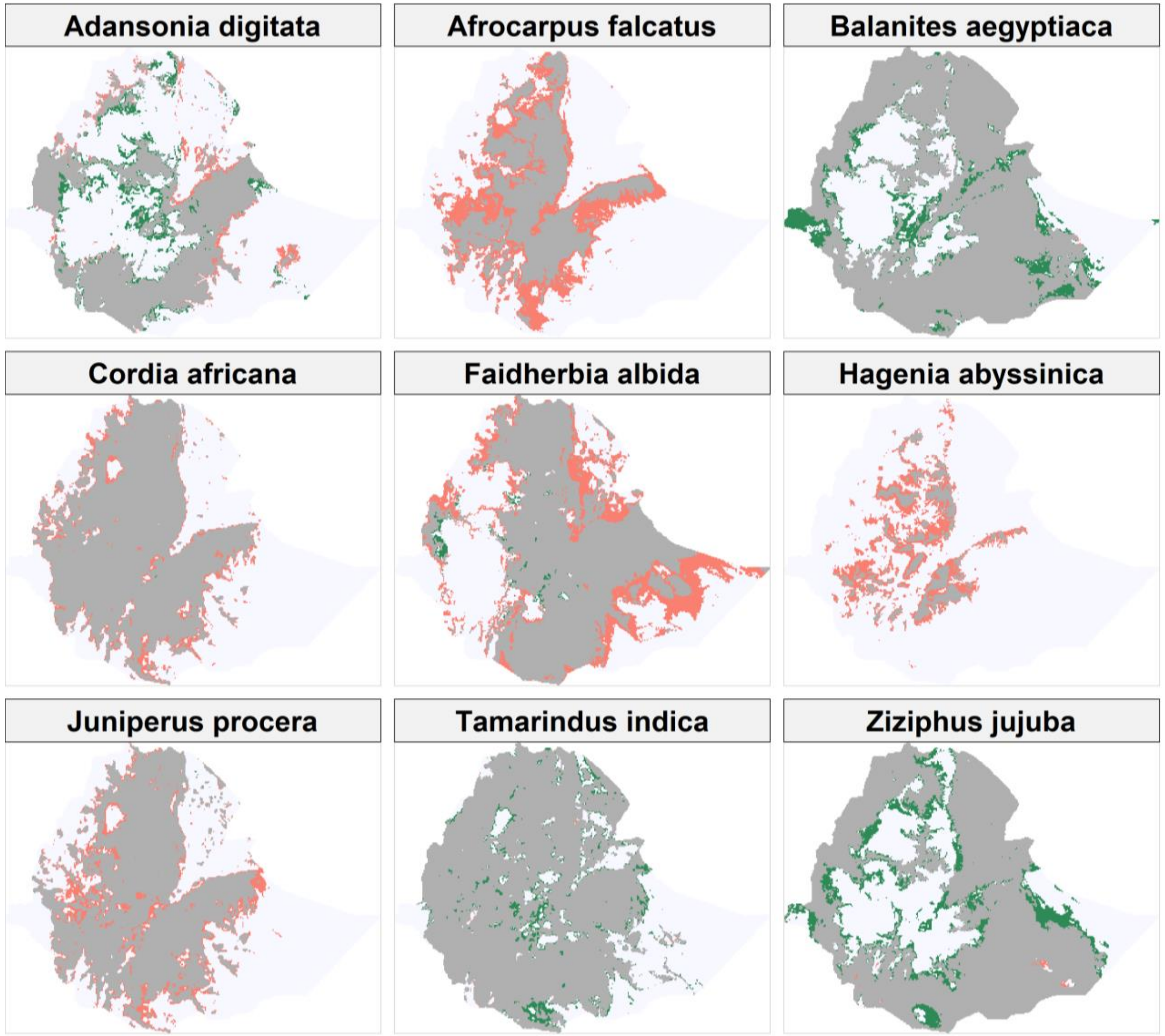
Targeting food production and consumption diversity for healthier diets scaled across 16 sites in East Africa (Kenya, Uganda, Ethiopia) McMullin et al. 2018

Food Type	Food Name	Food description	Scientific Name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Iron	Vitamin A*	Folate	Vitamin C
Fruits	Pawpaw/Papaya	pulp, raw	*Carica papaya* *[2]													~	++	~	+++
	Banana	pulp, raw	*Musa spp.*															~	~
	Passion fruit	purple, raw	*Passiflora edulis*													~	++		++
	Mango	pulp, ripe, raw	*Mangifera indica* **[1]													~	+++	~	++
	Bird cherry	raw	*Berchemia discolor* **[2]													++			+++
	Tamarind	pulp, ripe, raw	*Tamarindus indica* **[3], *[1]													++			
	Grewia/Mallow raisin	raw	*Grewia villosa*													~		~	~
	Ntuuka	raw	*Tennantia sennii*																
	Guava	pulp, raw	*Psidium guajava*													~	~		+++
	Desert date	fresh, raw	*Balanites aegyptiaca*													~			+++
	Desert date	dried, raw	*Balanites aegyptiaca*													+++		~	
	Common wild medlar	raw	*Vangueria madagascariensis*																
	Mobola plum	raw	*Parinari curatellifolia*													++			+++
	Moringa	seeds, raw	*Moringa oleifera*																
	Moringa	leaves, boiled	*Moringa oleifera*													++	+++	~	+++
Vegetables	Pumpkin	leaves, boiled	*Cucurbita maxima*													++	++	~	
	Cowpea	leaves, boiled	*Vigna unguiculata*																
	Amaranth	leaves, boiled	*Amaranthus spp.*																
Pulses & Nuts	Bean	mature, whole, water-soaked, boiled	*Phaseolus vulgaris* **[2]																
	Green gram/ Mung bean	mature, whole, water-soaked, boiled	*Vigna radiata* **[3], *[1]																
	Cowpea	mature, whole, water-soaked, boiled	*Vigna unguiculata* *[2]																
	Groundnut/peanut	raw	*Arachis hypogaea*																
Staples	Maize	sweet, yellow, boiled	*Zea mays* **[1]																
	Millet/Pearl millet	whole grain, boiled	*Pennisetum glaucum* *[3]																
	Sorghum	whole grain, boiled	*Sorghum bicolor*																

Notes:* Vitamin A (calculations based on Vitamin A retinol equivalent = retinol + 1/6 beta-carotene + 1/12 alpha-carotene + 1/12 beta-cryptoxanthin), Data are expressed per 100 g fresh weight of edible portion, ** = most consumed * = most sold

CONFIRMING ECOLOGICAL SUITABILITY IS OF IMPORTANCE THE RIGHT SPECIES FOR THE RIGHT PLACE (soils and water)

Future changes in habitat (2050s for RCP4.5)



A species was mapped to be suitable in the future if it was predicted to be present for 66% of models (IPCC Likelihood scale; Mastrandea et al. 2011)

Habitat changes

- no change (not suitable)
- new habitat
- lost habitat
- no change (suitable)

Habitat changes in km^2

Species	no change	new habitat	lost habitat
Adansonia digitata	346,853	64,628	34,909
Afrocarpus falcatus	280,963	0	184,849
Balanites aegyptiaca	735,881	100,435	590
Cordia africana	570,645	42	59,834
Faidherbia albida	562,248	10,070	178,200
Hagenia abyssinica	73,219	0	107,197
Juniperus procera	527,188	167	89,233
Tamarindus indica	800,725	49,955	1,184
Ziziphus jujuba	692,944	122,546	2,018

African Orphan Crops Consortium
Translational Agri-genomics

African Plant Breeding Academy

Five orphan crop genomes were published in *GigaScience* as a first step to develop genomics resources


GigaScience, 8, 2018, 1–16

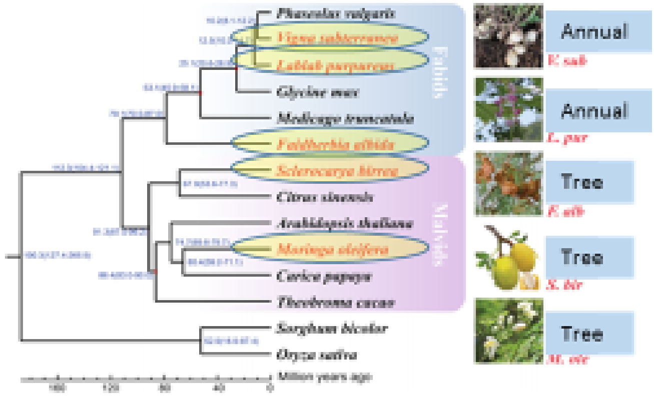
Advance Access Publication Date: 7 December 2018

Data Note

DATA NOTE

The draft genomes of five agriculturally important African orphan crops

Yue Chang[1,2,†], Huan Liu[1,2,3,†], Min Liu[1,2,3,†], Xuezhu Liao[1,2,3], Sunil Kumar Sahu[1,2,3], Yuan Fu[1,2], Bo Song[1,2], Shifeng Cheng[1,2], Robert Kariba[4], Samuel Muthemba[4], Prasad S. Hendre[4], Sean Mayes[5,6,7], Wai Kuan Ho[6,7], Anna E.J. Yssel[11], Presidor Kendabie[5], Sibo Wang[1,2], Linzhou Li[1,2], Alice Muchugi[4], Ramni Jamnadass[4], Haorong Lu[1,2], Shufeng Peng[1,2], Allen Van Deynze[4,8], Anthony Simons[4], Howard Yana-Shapiro[4,8], Yves Van de Peer[9,10,11], Xun Xu[1,2], Huanming Yang[1,2], Jian Wang[1,2] and Xin Liu[1,2,3,12,*]

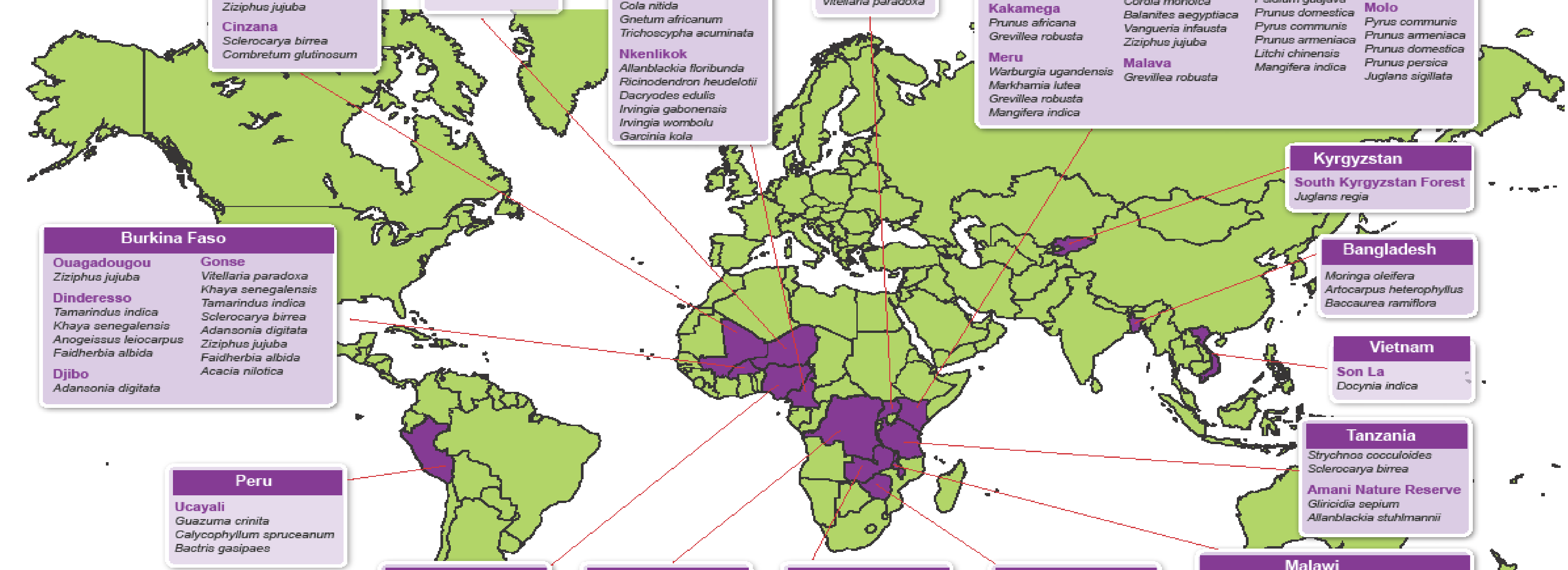


Species	Estimated genome size (Gb) and coverage	Gene completeness (BUSCO)
Faidherbia albida	0.65, 98.9%	85.5%
Moringa oleifera	0.22, 77.9%	88.8%
Sclerocarya birrea	0.33, 92.9%	93.9%
Vigna subterranea	0.54, 97.3%	86.4%
Lablab purpureus	0.4, 93.5%	87.4%

- Five high quality genomes were published and made publicly available- 3 trees and 2 annual crops
- A thorough genome composition and gene content analysis indicated conserved pathways, which can be used for identification of candidate genes and development of targeted gene markers
- A very significant first step towards development of genomics tools and resources

Agroforestry Tree Field Genebanks

World Agroforestry Centre



Mali
Samanko
Adansonia digitata
Adansonia gregorii
Adansonia za
Tamarindus indica
Vitellaria paradoxa
Jatropha curcas
Ziziphus jujuba
Cinzana
Sclerocarya birrea
Combretum glutinosum

Niger
Sadore
Prosopis africana
Ziziphus jujuba
Moringa oleifera
Adansonia digitata
Saba senegalensis
Mangifera indica

Cameroon
Mbalmayo
Dacryodes edulis
Dacryodes macrophylla
Irvingia wombolu
Ricinodendron heudelotii
Allanblackia floribunda
Garcinia kola
Cola nitida
Gnetum africanum
Trichoscypha acuminata
Nkenlikok
Allanblackia floribunda
Ricinodendron heudelotii
Dacryodes edulis
Irvingia gabonensis
Irvingia wombolu
Garcinia kola

Uganda
Mukongoro
Vitellaria paradoxa
Nalwana
Prunus africana
Ngetta-Lira
Vitellaria paradoxa

Kenya
Muguga
Warbugia ugandensis
Leucaena trichandra
Leucaena diversifolia
Leucaena pallida
Grevillea robusta
Prunus africana
Kakamega
Prunus africana
Grevillea robusta
Meru
Warburgia ugandensis
Markhamia lutea
Grevillea robusta
Mangifera indica
Kitui
Adansonia digitata
Azanza garckeana
Berchemia discolor
Carissa spinarum
Sclerocarya birrea
Tamarindus indica
Cordia monoica
Balanites aegyptiaca
Vangueria infausta
Ziziphus jujuba
Malava
Grevillea robusta
Thika
Citrus sinensis
Citrus paradisi
Citrus reticulata
Citrus hystrix
Citrus limon
Punica granatum
Psidium guajava
Prunus domestica
Pyrus communis
Prunus armeniaca
Litchi chinensis
Mangifera indica
Matuga
Citrus sinensis
Citrus reticulata
Citrus paradisi
Citrus latifolia
Citrus hystrix
Citrus limon
Molo
Pyrus communis
Prunus ameniaca
Prunus domestica
Prunus persica
Juglans sigillata

Kyrgyzstan
South Kyrgyzstan Forest
Juglans regia

Burkina Faso
Ouagadougou
Ziziphus jujuba
Dinderesso
Tamarindus indica
Khaya senegalensis
Anogeissus leiocarpus
Faidherbia albida
Djibo
Adansonia digitata
Gonse
Vitellaria paradoxa
Khaya senegalensis
Tamarindus indica
Sclerocarya birrea
Adansonia digitata
Ziziphus jujuba
Faidherbia albida
Acacia nilotica

Bangladesh
Moringa oleifera
Artocarpus heterophyllus
Baccaurea ramiflora

Vietnam
Son La
Docynia indica

Peru
Ucayali
Guazuma crinita
Calycophyllum spruceanum
Bactris gasipaes

Tanzania
Strychnos cocculoides
Sclerocarya birrea
Amani Nature Reserve
Gliricidia sepium
Allanblackia stuhlmannii

Nigeria
Onne
Irvingia gabonensis
Ibadan
Irvingia wombolu

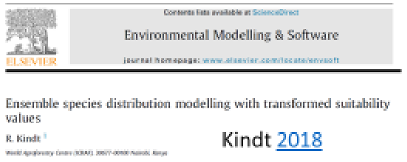
DRC
Kinshasa/INERA
Dacryodes edulis

Zambia
Masupe
Uapaca kirkiana
Sclerocarya birrea
Msekera
Strychnos cocculoides

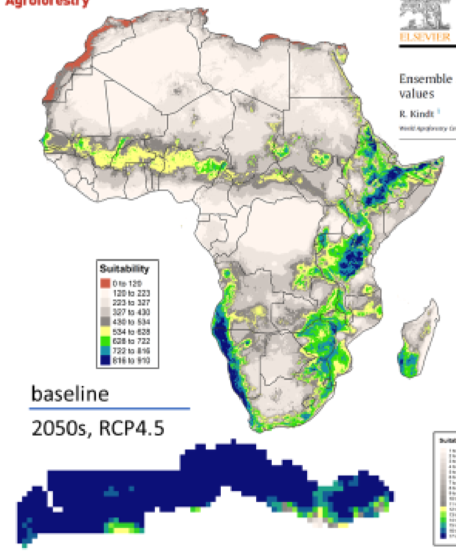
Zimbabwe
Domboshawa
Uapaca kirkiana
Acacia angustissima
Leucaena spp

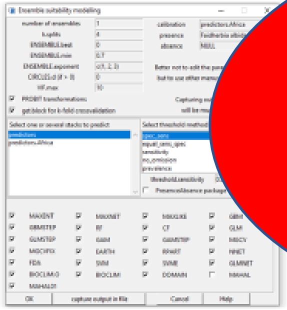
Malawi
Makoka
Uapaca kirkiana
Gliricidia sepium
Nauko-Machinga
Uapaca kirkiana
Mangochi
Sclerocarya birrea
Chitedze
Gliricidia sepium

Ensemble suitability modelling with *BiodiversityR*


Environmental Modelling & Software
Ensemble species distribution modelling with transformed suitability values
R. Kindt

Kindt [2018]



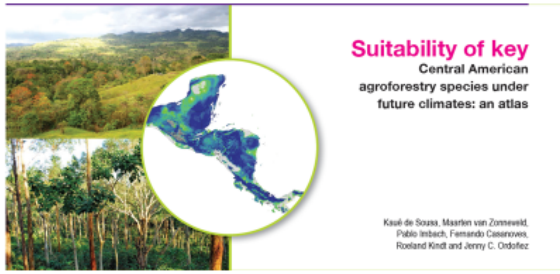


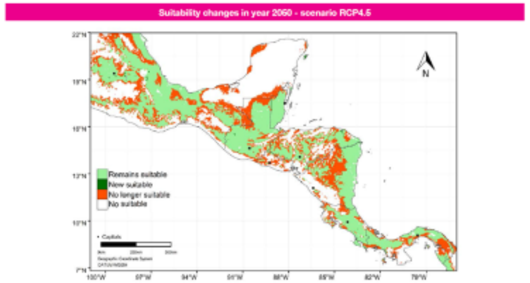
- Ensemble modelling based on 25 algorithms (maximum entropy, boosted regression trees, random forests, artificial neural networks, support vector machines, (stepwise) GLM, (stepwise) GAM, BIOCLIM, DOMAIN, …)
- Uniqu… …ensemble

AFRICA Climate Change Atlas

- *BiodiversityR* has already been installed > 100,000 times in RStudio
- [Graphical User Interface] and [manuals]

Central America Climate Change Atlas was published in 2017





Zone	Current distribution per zone (km²)	Remains suitable	Potential new habitat	No longer suitable	Net change
Dry forest	67,032	61%	0%	39%	-39%
Rain forest	102,444	66%	0%	34%	-34%
Whole region	169,476	64%	0%	36%	-36%

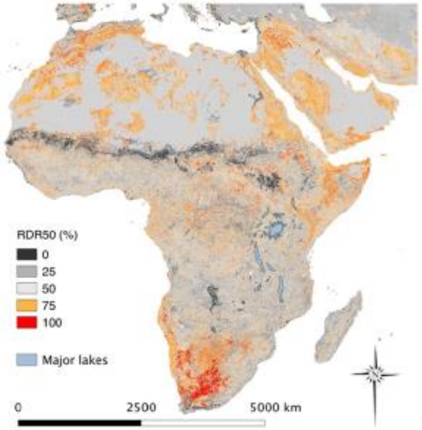
[http://www.worldagroforestry.org/atlas-central-america]

[Recorded livestream from launch @ Global Landscape Forum, Bonn, December 2017]

The need for Land Restoration in Drylands

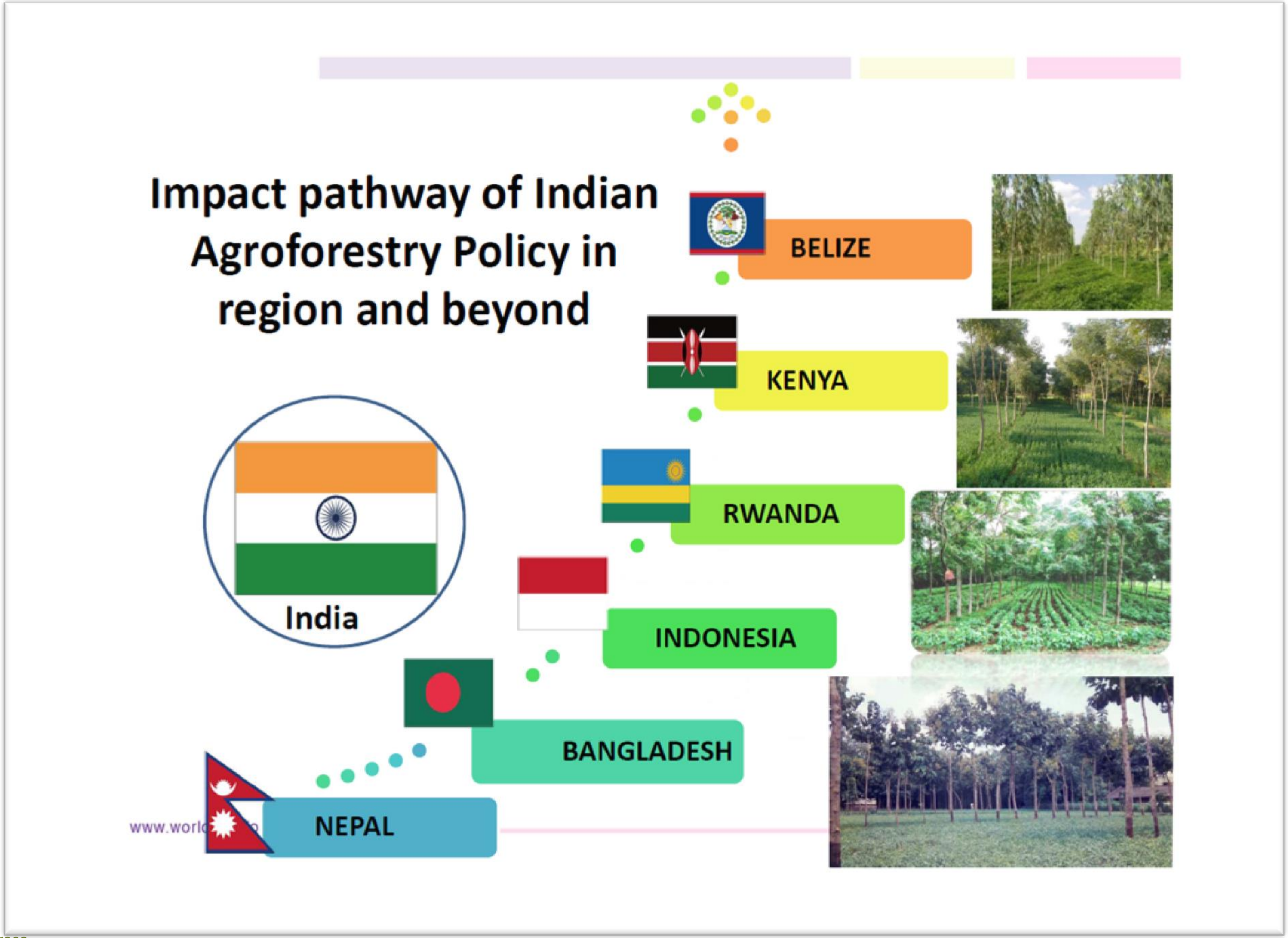
"Despite their importance, drylands are being degraded through a complex combination of climatic and human stresses" IFAD, 2016

Map on the left, developed by ICRAF GeoScience Lab, using field data collected with the [Land Degradation Surveillance Framework (LDSF)] and remote sensing data, shows spatially explicit patterns of root depth restrictions as an indicator of land degradation.



Vågen, Tor-G., Winowiecki, L., Tondoh, J.E., Desta, L.T. and Gumbricht, T. 2016. **Mapping of soil properties and land degradation risk in Africa using MODIS reflectance.** Geoderma. http://www.sciencedirect.com/science/article/pii/S0016706115300082

World Agroforestry



Summary and conclusions

Africa is large with area equal to USA, China, India, Japan and most of Europe combined

http://kai.sub.blue/en/africa.html

- First phase of model calibrations and projections for African Climate Atlas are well underway for 150 species. We need to go beyond trees to include complementary crops.
- Healthy food-tree/crops/fuel/fodder/etc species portfolios…really context specific with complementary plant, soils, water management packages
- Sustainable timber: On farm timber? ; short rotation timber?;
- Improving productivity (upstream and downstream breeding approaches)
- Overcome the bottle neck for planting material… PATSPO model addresses conservation, breeding, seed supply and delivery systems…. Great possibilities in GCF!!
- It is urgent !! The resource of diversity that we depend on to adapt is under threat. Most of the world's >40,000 tropical tree species now seem to qualify as globally threatened.
- Strategic investments to protect and mobilize this resource is critical for our future

ICRAF-CIFOR as the support service and the technical arm of development programs in Africa!

Thank you!

Ramni Jamnadass
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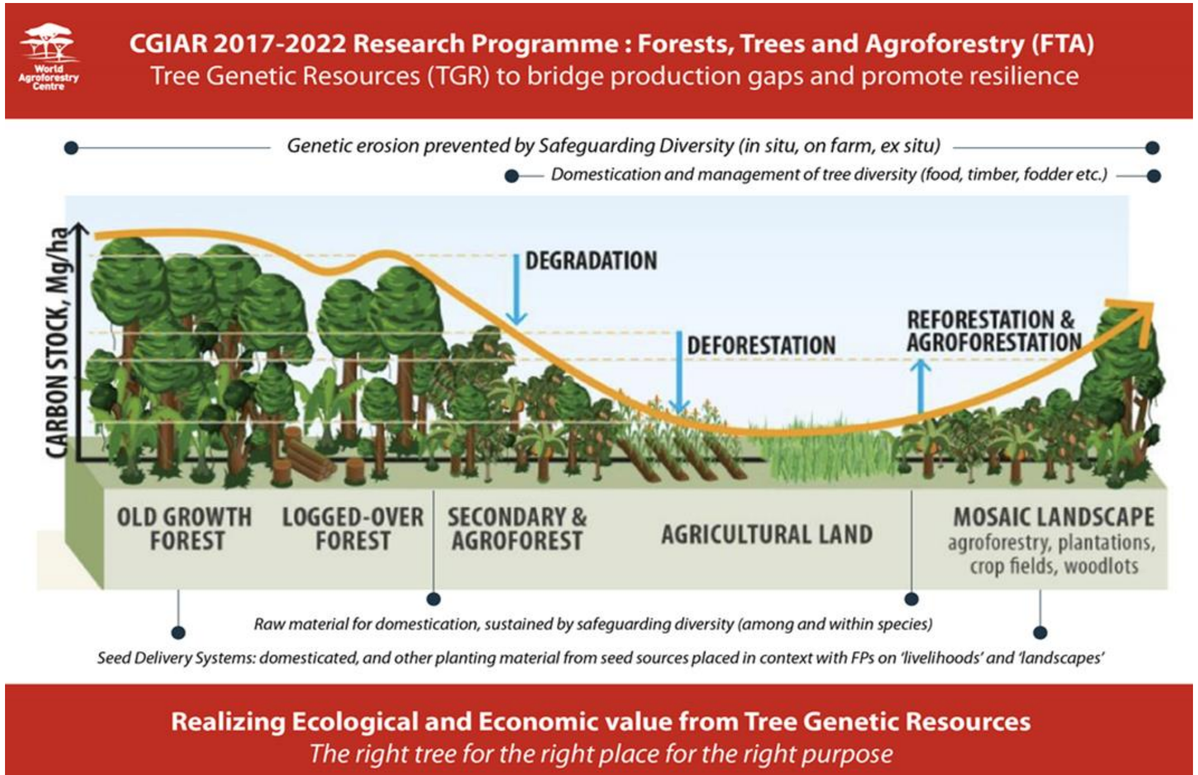

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World Agroforestry

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