Africa Natural Capital Accounting Community of Practice

Natural capital component in the "*Landscape Approach to Riverine Forest Restoration, Biodiversity Conservation and Livelihood Improvement*" FAO GEF project

Virtual training, 29 April 2021

Food and Agriculture Organization of the United Nations

gef

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Outline

- Overview of the "*Landscape approach to riverine forest restoration, biodiversity conservation and livelihood improvement*" FAO GEF project in Sudan

- Natural capital component in the project

  (i) Natural capital *baseline analysis* and the *linkage with FAO data and processes*

  (ii) *Natural capital analysis findings* and proposed next steps

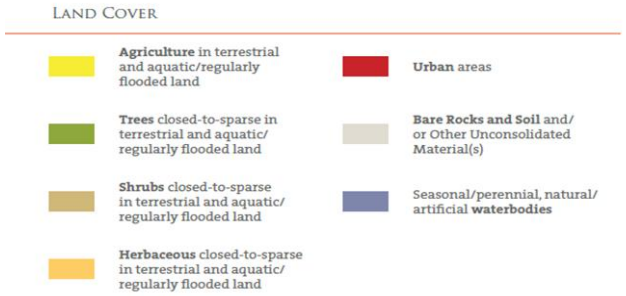
- Questions, answers…and feedbacks form experts attending the workshop

FAO GEF
PROJECT OVERVIEW

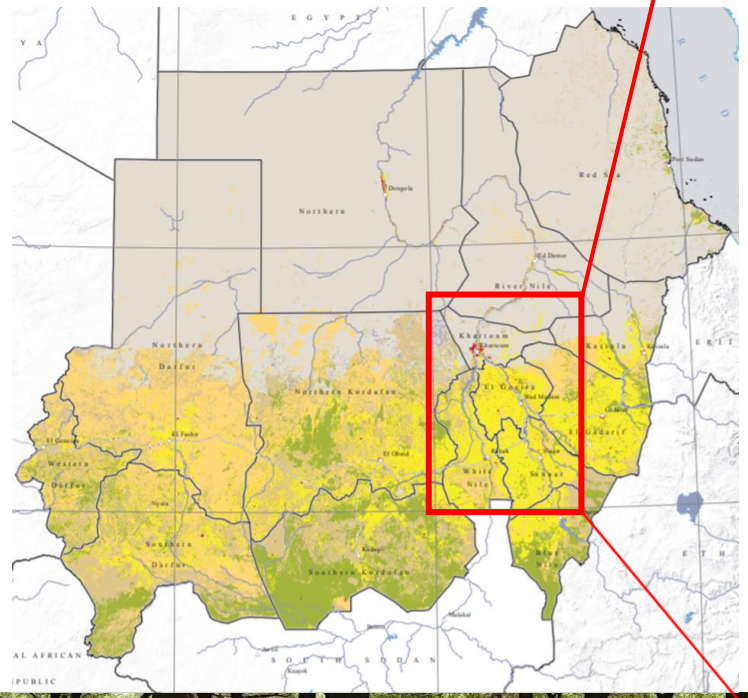
FAO GEF project overview

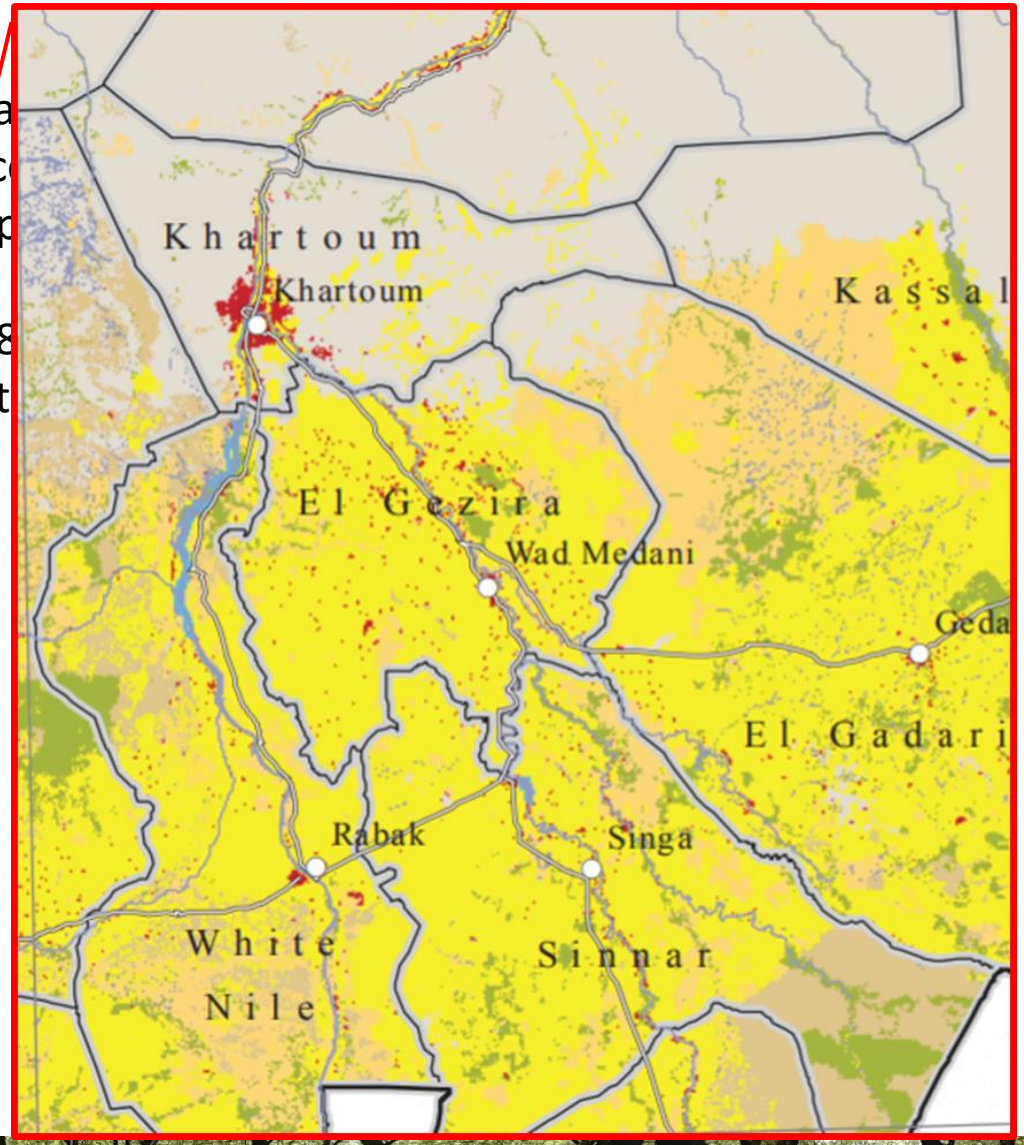
- The FAO GEF project objective is to restore and sustainably mana
along the River Nile in Sudan in order to maintain critical forest ec
provisioning services of wood and non wood forestry products and p

- The project targets 33 riverine forest ecosystems covering 50,878
benefiting biodiversity through habitat restoration and conservat
animal and plant biodiversity



Source: FAO, The Land Cover Atlas of Sudan, 2012, http://www.fao.org/3/be896e/be896e.pdf

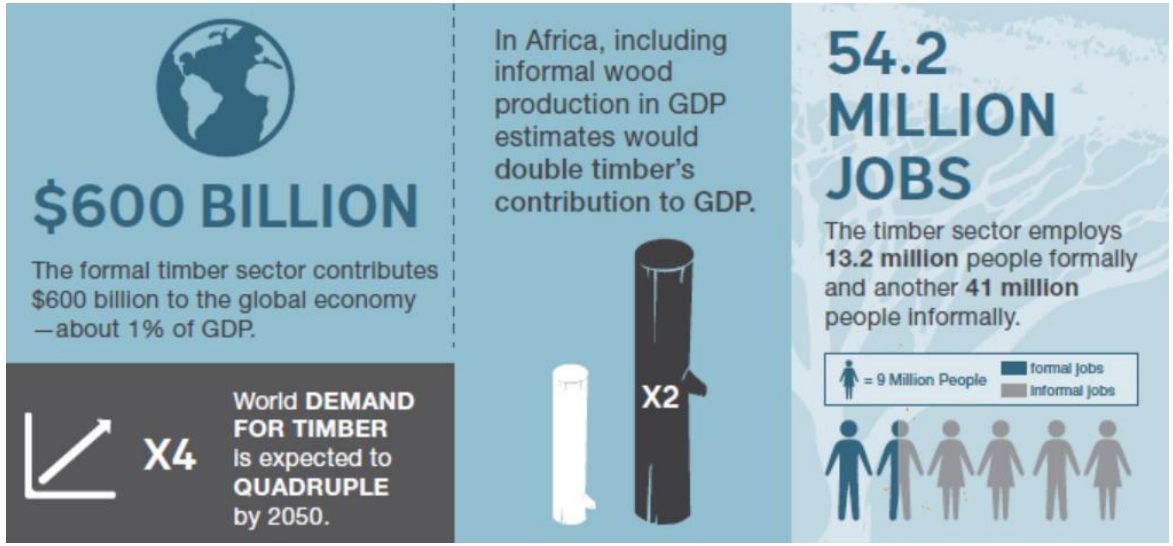




Natural capital baseline analysis

Natural capital baseline analysis and the linkage with FAO data and processes

- Natural capital can be defined as the world's stocks of natural assets which include geology, soil, air, water, forests and all living things.
- It is from this natural capital that humans derive a wide range of services, often called ecosystem services, which make human life possible.
- Scope of natural capital assessment and accounting (NCAA) is to measure in physical and monetary terms this stock of natural resources that is *not* recorded by official statistics and main economic aggregates as the GDP to support an informed policy decision making process. E.g.:



Source: FAO and World Bank, 2016

Natural capital baseline analysis and the linkage with FAO data and processes

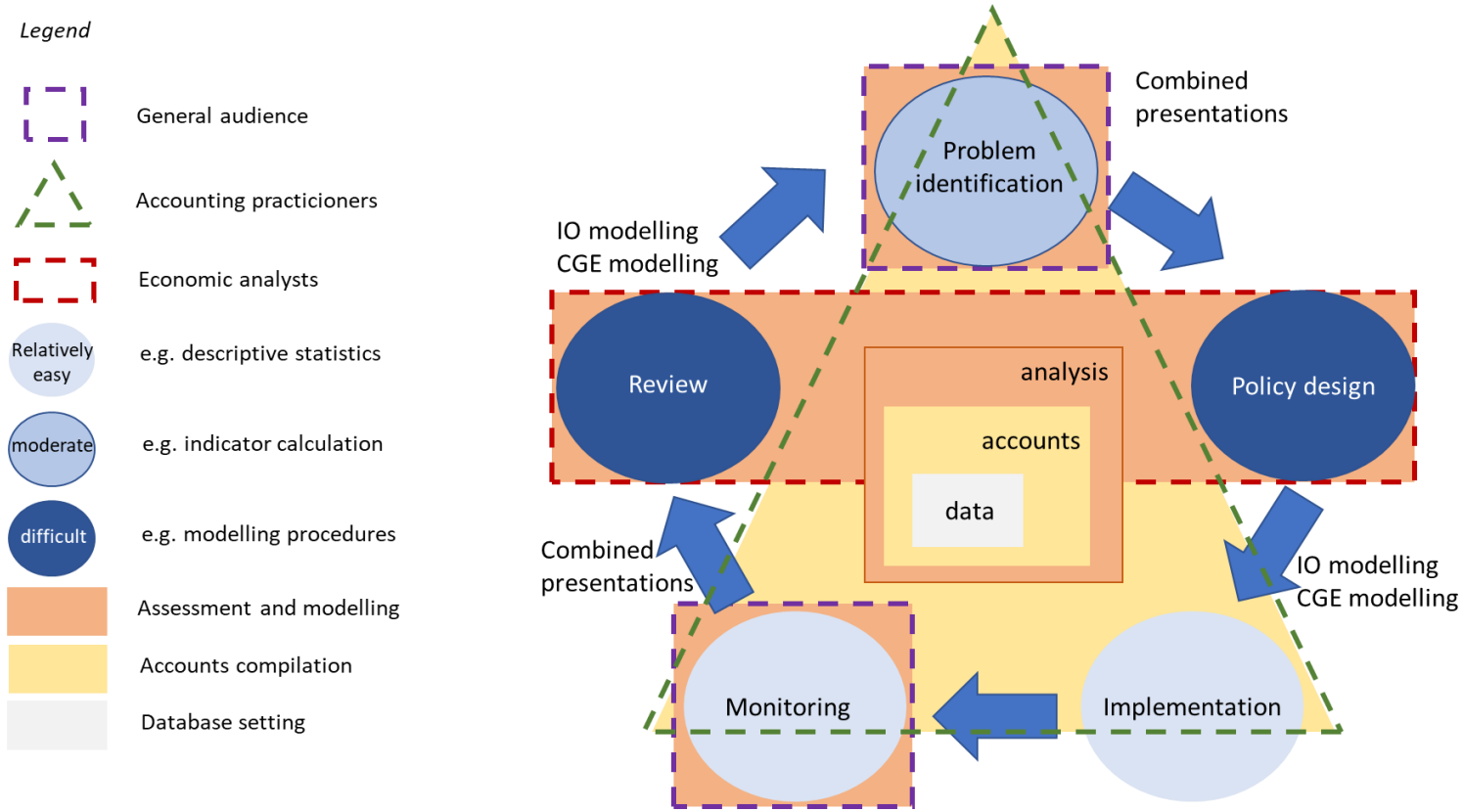
- NCAA is composed by two phases:

➢ *Natural Capital Assessment* (i.e. valuation: *quantification in physical and/or monetary terms of the natural resource stock* – riverine forest ecosystem). Natural capital assessment are therefore spatial assessments of stocks of natural capital and/or delivery of ecosystem services, which are often accompanied by assessments of change under different scenarios with decision-makers and stakeholders.

➢ *Natural Capital Accounting* (i.e. *associated changes in policies, planning and budgeting* – riverine forest management and planning). Data from natural capital assessments can serve as an input to the construction of national accounts that reflect these values.

Natural capital baseline analysis and the linkage with FAO data and processes

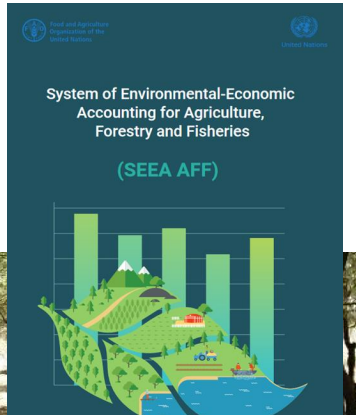
- Both natural capital assessments and accounts are required to advance policy dialogue and to aid in decision-making, including the allocation of financing for management of natural capital and biodiversity. They are *interlinked:*



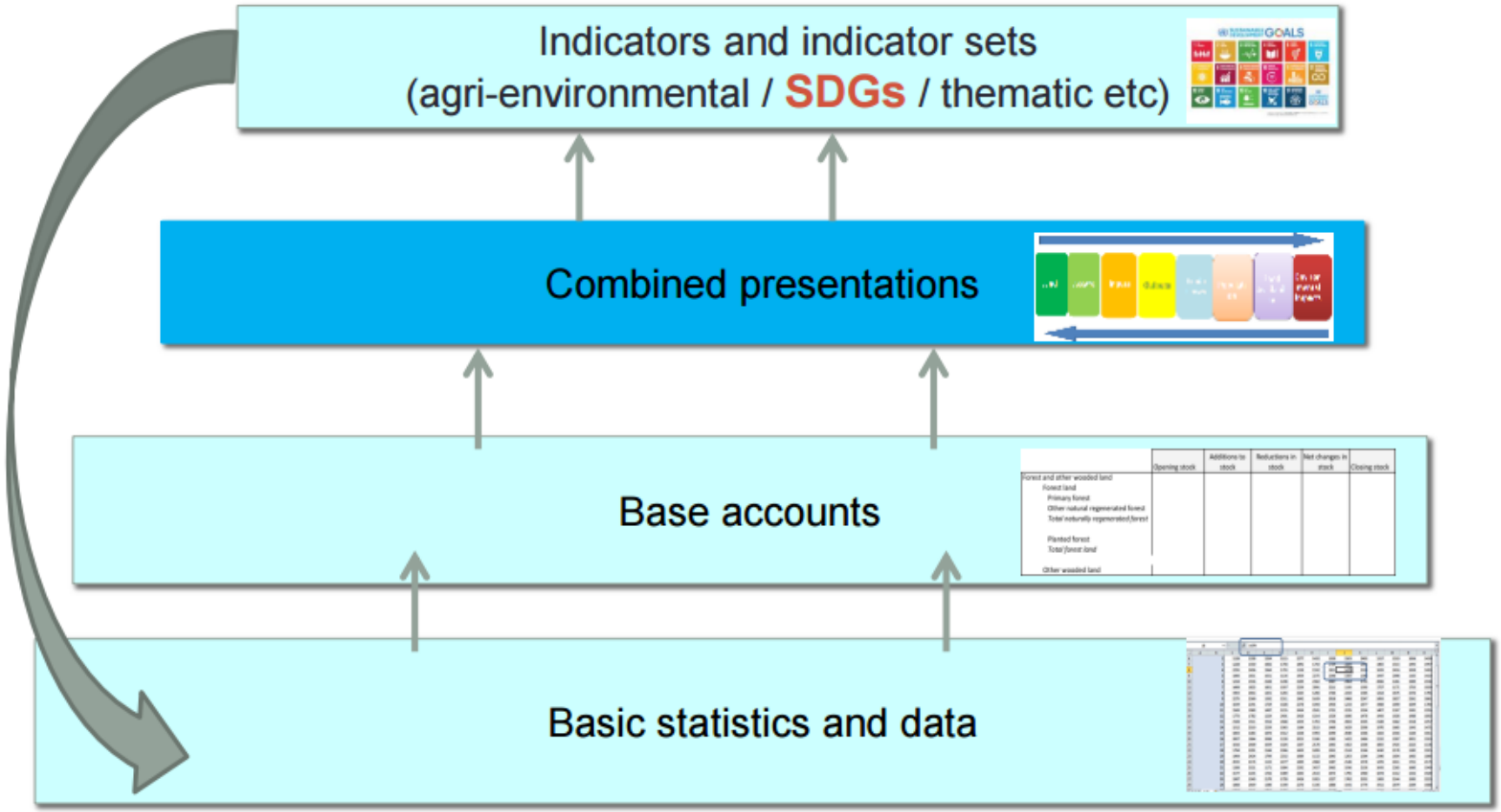
Source: Alessandra La Notte et

System for Environmental-Economic Accounting for Agriculture Forestry and Fisheries

- In the Sudan FAO GEF project we used the SEEA AFF statistical framework. It applies the environmental economic structures and principles described in the System of National Accounts (SNA) and in the System of Environmental Economic Accounting - Central Framework (SEEA-CF) to the activities of *Agriculture*, *Forestry* and *Fisheries*.
- Through a a comprehensive set of tables and accounts, the SEEA AFF aims to point out linkages between Agriculture, Forestry and Fisheries and among these economic sectors, the environment and its ecosystems.
- The SEEA AFF is the output of two global consultations, in 2013 and 2015, and has been endorsed in March 2016 by the UNCEEA as an "*Internationally Agreed Methodological Document in support of the SEEA CF*".
- After additional feedbacks by pilot countries, international fora, and FAO internal revision, the final version has been published on-line 2020: http://www.fao.org/publications/card/en/c/CA7735EN



Natural capital baseline analysis and the linkage with FAO data and processes



Natural capital baseline analysis and the linkage with FAO data and processes

- Being **forests** and their ecosystem the scope of our natural capital analysis in Sudan, we selected forest ecosystem services and SEEA AFF related accounting tables as shown below:

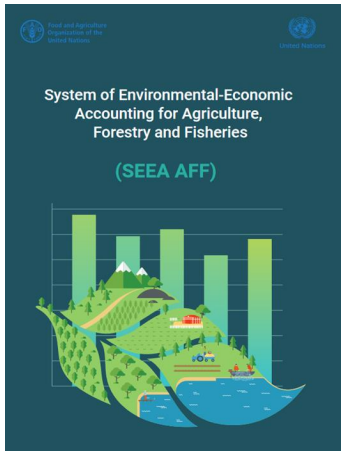
Ecosystem services		
Provisioning	**Regulating**	**Cultural/ recreation**
Timber	Soil protection	Turisms
NWFP	Flood prevention	Birdwatching
Wilde animals /Hunting	Carbon sequestration	Natural parks

Air Emissions Accounts

PES on beekeeping

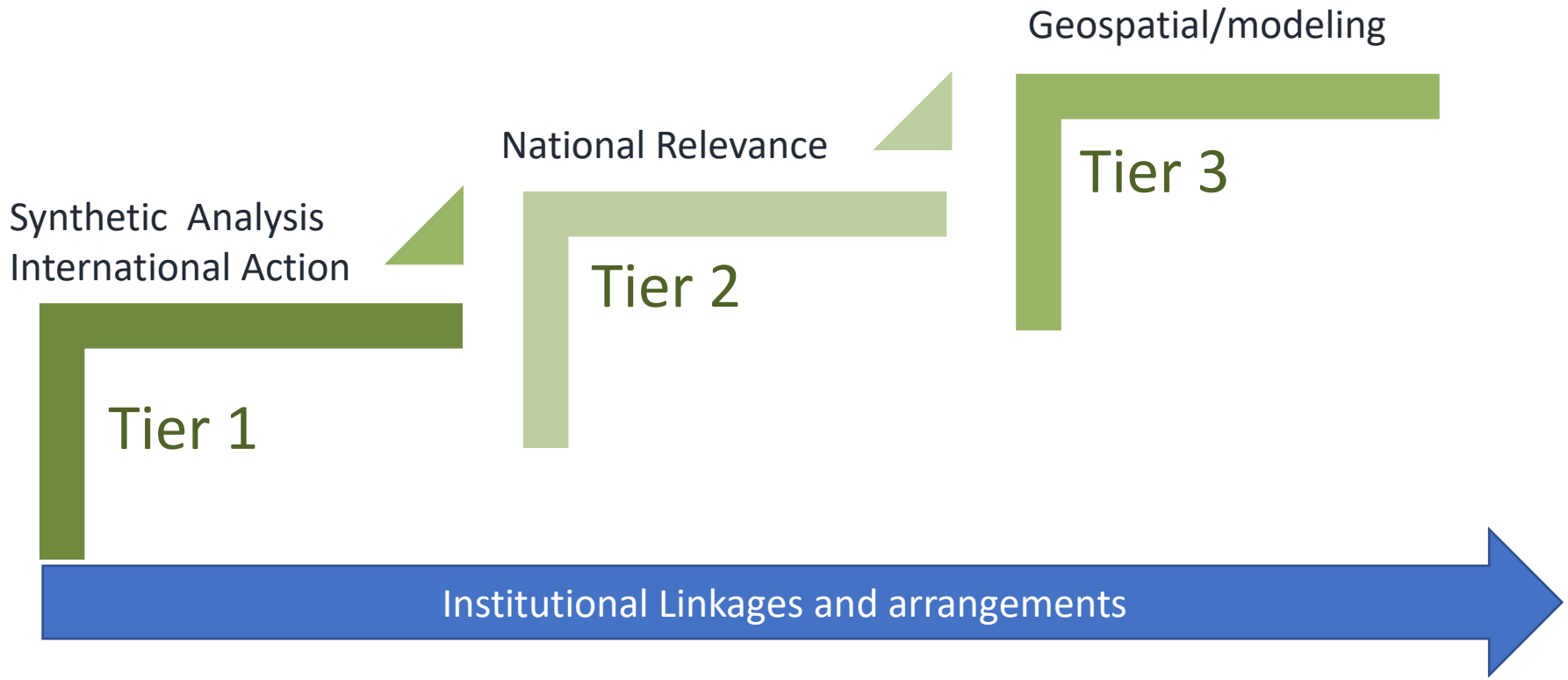
SEE AFF accounts for forest
Asset accounts for forest area(ha)/land accounts
Physical Asset Account for Timber Resources (000 m3)
Physical flow account for wood forestry products (m3), NWFPs, honey ……..

Provisioning services



Natural capital baseline analysis and the linkage with FAO data and processes

A Phased Tiered Approach for national processes



Natural capital baseline analysis and the linkage with FAO data and processes

NATIONAL Statistics: FAOSTAT data collection process

Annual Data Collection, Analysis and Dissemination

Food and Agriculture Organization of the United Nations

QUESTIONNAIRE ON FERTILIZERS

Country: _country_ - Reference: calendar years from _from_ to _to_
Units of measurement: tonnes (t) and percentages (%)

Food and Agriculture Organization of the United Nations

QUESTIONNAIRE ON PESTICIDES USE

Country: _country_ - Reference: calendar years from _from_ to _to_
Unit of measurement: tonnes (t)

Food and Agriculture Organization of the United Nations

QUESTIONNAIRE ON LAND USE, IRRIGATION AND AGRICULTURAL PRACTICES

Country: _country_ – Reference: calendar years from _from_ to _to_
Unit of measurement: thousand hectares (000 ha)

Purpose of the questionnaire

This questionnaire is designed to collect national data on land use (primarily focusing on agriculture, forestry, aquaculture and fisheries), and on irrigation and agricultural practices. These data are useful to monitor the evolution of land use and a range of agricultural practices, at national, regional and global level. The names and definitions of categories used in this questionnaire are aligned with the System of Environmental-Economic Accounting (SEEA) and also use some definitions of the World Census of Agriculture 2020 (WCA). A possible correspondence with the 2006 Guidelines of the Intergovernmental Panel on Climate Change (IPCC) is also provided. **The data are disseminated at: http://faostat.fao.org**

Please complete or update the contact details of the national focal point responsible for this questionnaire in your country.

National Focal Point	
Name	
Title	
Administration and Office	
Address	
City	
Email	
Tel	
Fax	
Web site address	

Structure

This questionnaire is composed of:
Three introductory sections (Cover page, Instructions, and Definitions),
Three data reporting sections (1. Land Use, 2. Irrigation and Agricultural Practices, and 3. Aquaculture and Fisheries) and
Two supplementary information sections (4. Metadata, and 5. Feedback)

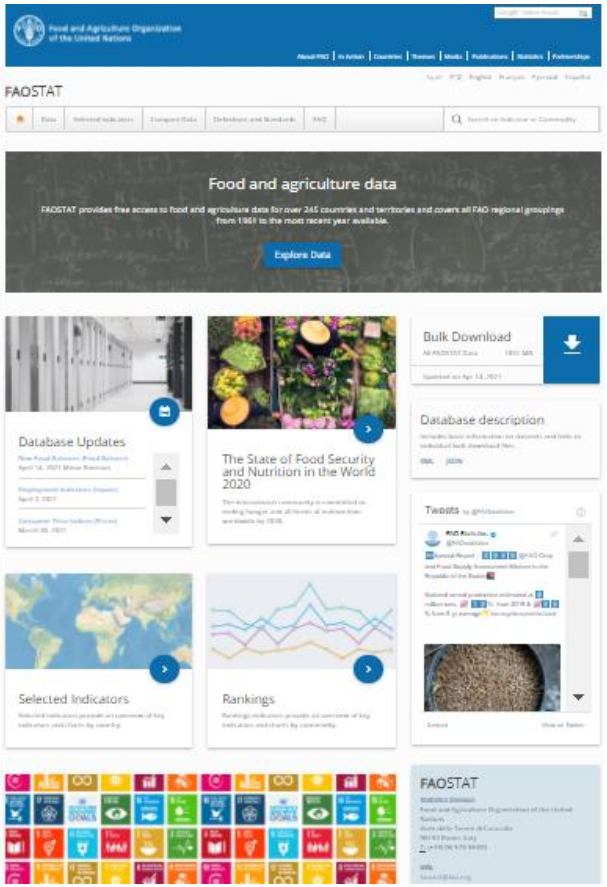
We kindly ask you to provide a reply by: _by_.

FAO takes this opportunity to thank You and Your Government for the assistance in completing this questionnaire, and looks forward to receiving your prompt reply.

Please send back your response to FAO Statistics Division (via e-mail at: Resource-statistics@fao.org, or via regular mail at: FAO Statistics Division, Viale delle Terme di Caracalla, 00153, Rome, Italy), or via the FAO Representative Office relevant for your country: _return_to_.

Contact person: Mr Francesco N. Tubiello, tel: (+39) 06 5705 2169, e-mail: francesco.tubiello@fao.org

- Regulated by FAO Constitution – Statistics a core pillar of FAO;
- Countries provide data relevant to food and agriculture via national focal points (NSOs; Min Ag; Other);
- FAO collects, analyses and disseminates national statistics in support of evidence-based decision making



http://www.fao.org/faostat/en/#home

Natural capital analysis finding and proposed next steps

Natural capital analysis finding and proposed next steps

- In performing the baseline analysis **Land accounts** have been Assessed and Accounted for Sudan

- SEEA framework defines **land** as *"unique environmental asset that delineates the space in which economic activities and environmental processes take place and within which environmental assets and economic assets are located"* (SEEA-CF Sections 5.62, p. 174).

*"**Land use** reflects both (a) the activities undertaken and (b) the institutional arrangements put in place for a given area for the purposes of economic production, or the maintenance and restoration of environmental functions "*

vs

"***Land cover*** *refers to the observed physical and biological cover of the Earth's surface and includes natural vegetation and abiotic (non-living) surfaces."*

Land accounts – Sudan

SEEA AFF Land use classes

(i) Land
Land used for agriculture
Cropland
Arable land
Temporary crops
Temporary meadows and pastures
Land temporarily fallow
Permanent crops
Permanent meadows and pastures
Land used for forestry
Land used for aquaculture
Use of built up areas
Land used for maintenance and restoration of environmental functions
Other uses of land not elsewhere classified
Land not in use
Land area (total)
(ii) Inland waters

«Land use classes» : **SEEA AFF**, p 125

Sudan, 2018 (000 ha)

(i) Land used for agriculture	
Cropland	19.991,16
Arable land	19.823,16
Temporary crops	19333,82
Land with temporary fallow	489,34
Permanent crops	6.650
Permanent meadows and pastures	48.195,00
Agricultural area total	88.009,32
(ii) Land used for forestry	18.703,87
(ii) Inland waters	487,17

Data Source: **FAOSTAT**

Land accounts – Sudan

SEEA AFF Land cover classes

Artificial surfaces
Herbaceaous crops
Woody crops
Multiple or layered crops
Grassland
Tree covered areas
Mangroves
Shrub covered areas
Shrubs regularly flooded
Sparsely vegetated areas
Terrestrial barren land
Permanent snow and glaciers
Inland water bodies
Coastal water bodies
Total area

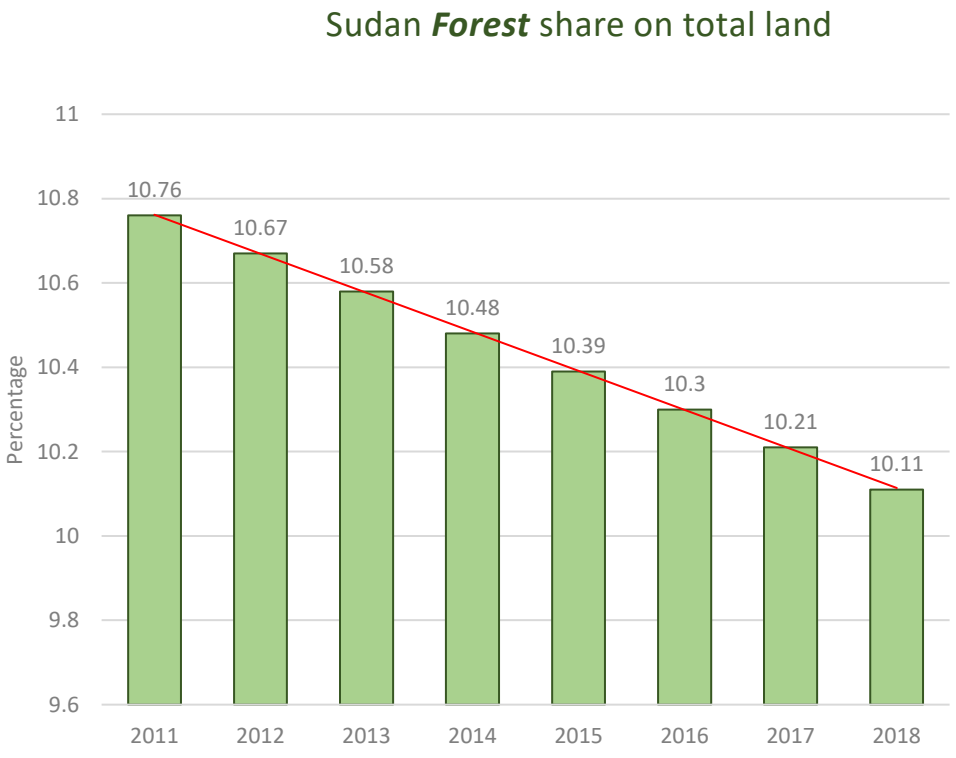
«Land cover classes» : **SEEA AFF**, p 111

Sudan, 2018 (000 ha)

Artificial surfaces (including urban and associated areas)	302,56
Herbaceous crops	7.541,62
Grassland	65.953,53
Tree-covered areas	849,17
Shrub-covered areas	1.311,22
Shrubs and/or herbaceous vegetation, aquatic or regularly flooded	4,72
Terrestrial barren land	109.224,75
Inland water bodies	216,18

Data Source: **FAOSTAT**

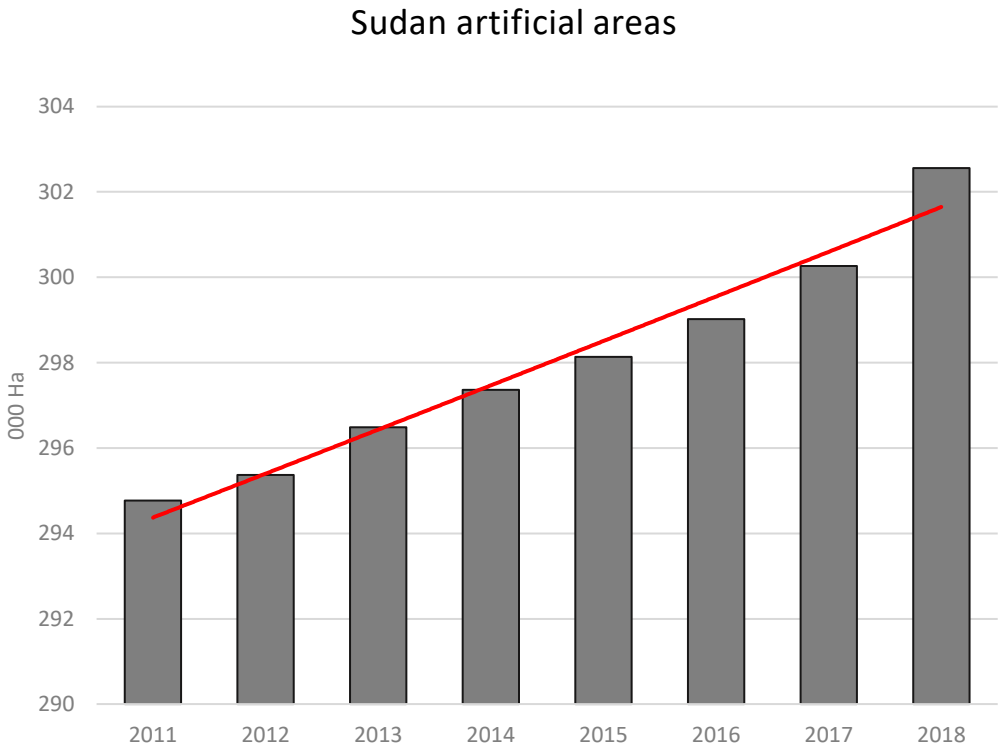
Land accounts – Findings



Area (000 ha)					
	1990	*2000*	*2005*	*2010*	*2015*
Forest	23, 570.3	21, 826.1	20, 954.08	20, 082.01	19, 209.93
Other wodded land	25, 289.7	23, 446.6	22, 523.58	21, 600.53	20, 677.48
Other land	137,805.2	141, 392.5	143, 187.6	144, 982.763	146, 777.8
Inland water bodies	1, 290. 000	1, 290. 000	1, 290. 000	1, 290. 000	1, 290. 000
Total	187, 955.312	187, 955.312	187, 955.312	187,955.312	187, 955.312

«Global Forest Resource Assessment for Sudan 2020»

Land accounts – Findings



	Area (000 ha)				
	2014	*2015*	*2016*	*2017*	*2018*
Agricultural Area	68, 186. 16	68, 186. 16	68, 186. 16	68, 186. 16	68, 186. 16
Cropland	19, 991.16	19, 991.16	19, 991.16	19, 991.16	19, 991.16

Source: FAOSTAT

SEEA AFF Physical Asset Account for Forestry

- The SEEA AFF Physical Asset Account for Forestry applied in Sudan baseline analysis is a Land account focusing on a specific land use/land cover category: Forest area (three cover)

- It records on annual basis the changes in land used for forest and other wooded land

(i) Land	
Land used for agriculture	
Cropland	
Arable land	Artificial surfaces
Temporary crops	Herbaceaous crops
Temporary meadow	Woody crops
Land temporarily fal	Multiple or layered crops
Permanent crops	Grassland
Permanent meadows	Tree covered areas
Land used for forestry	Mangroves
Land used for aquaculture	Shrub covered areas
Use of built up areas	Shrubs regularly flooded
Land used for maintenance and r	Sparsely vegetated areas
Other uses of land not elsewhere	Terrestrial barren land
Land not in use	Permanent snow and glaciers
Land area (total)	Inland water bodies
(ii) Inland waters	Coastal water bodies
	Total area

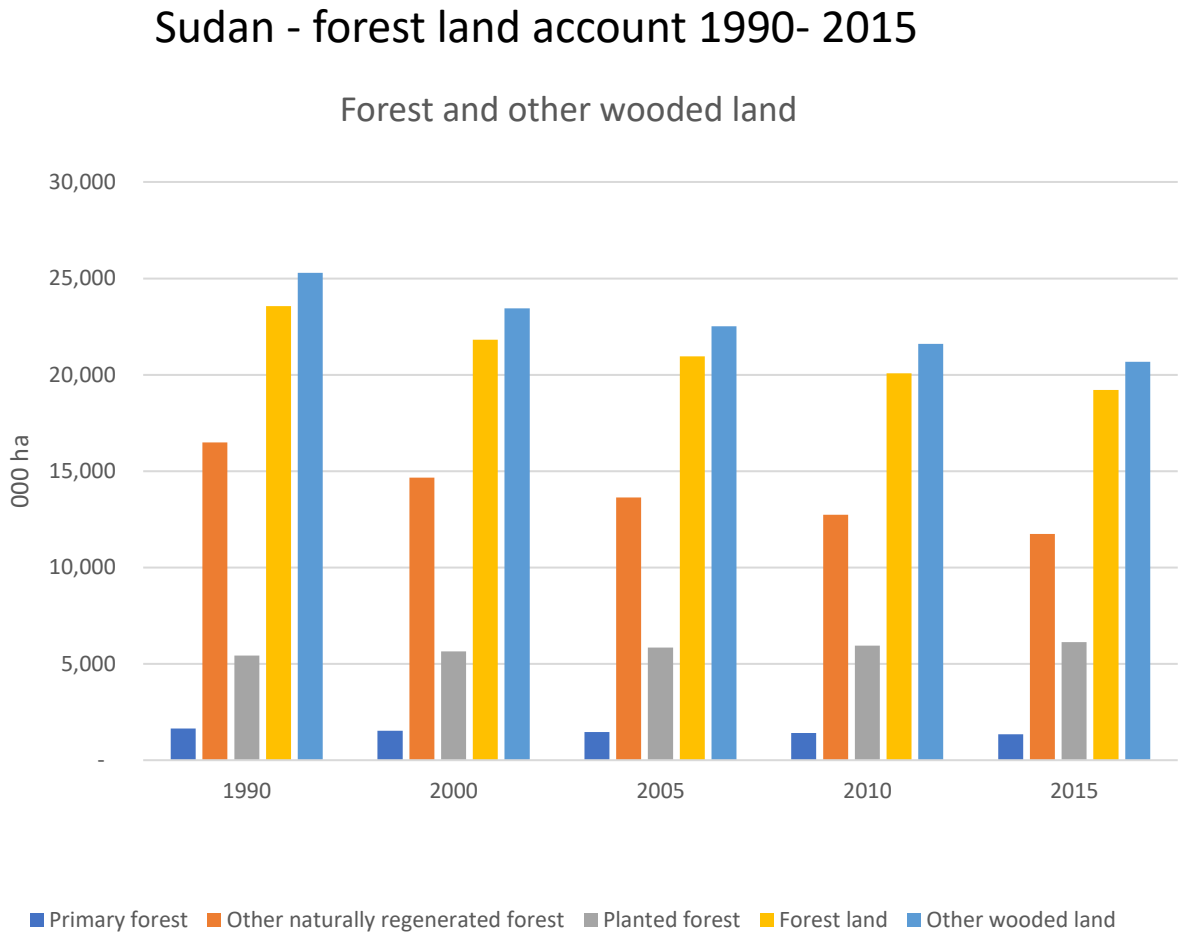
Forest and other wooded land
Primary regenerated forest
Other naturally regenerated forest
Planted forest
Forest land (total)
Other wooded land

Source: FAO and UNSD, The System of Environmental Economic - Accounting for Agriculture, Forestry and Fisheries (SEEA AFF)

SEEA AFF forest and other wooded land physical account – Land accounts

	1990	2000	2005	2010	2015
Forest and other wooded Land					
Primary forest	1.649	1.527	1.466	1.405	1.344
Other naturally regenerated forest	16.496	14.659	13.633	12.736	11.744
Planted forest	5.424	5.639	5.854	5.940	6.121
Forest land	23.569	21.825	20.953	20.081	19.209
Other wooded land	25.289	23.446	22.523	21.600	20.677

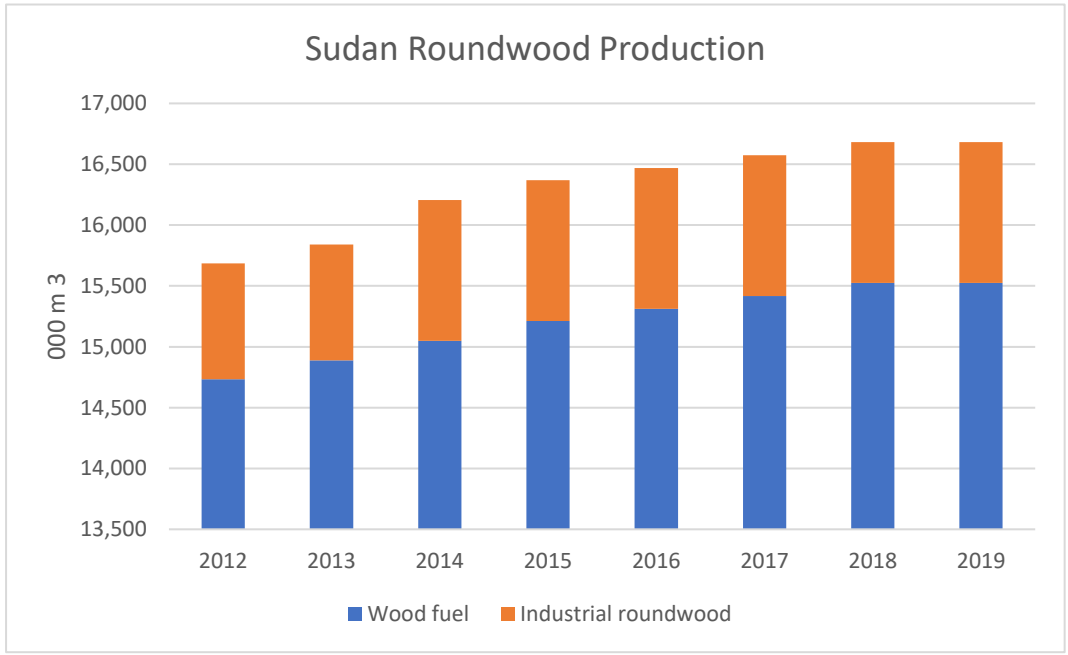
Forest area as a percentage of total land area;

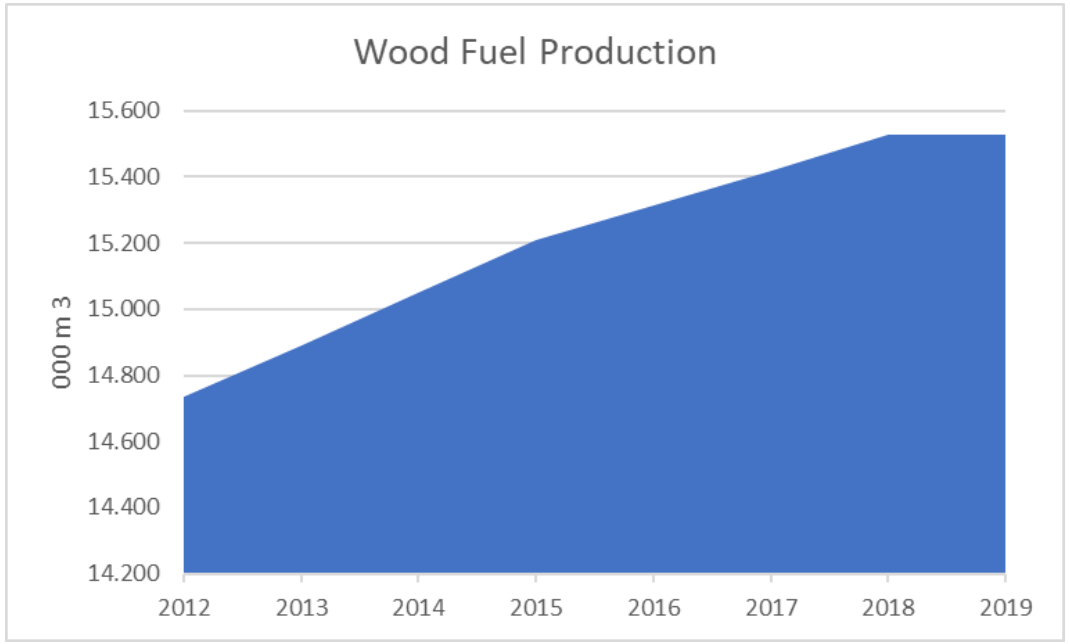


The SEEA AFF Accounts for Timber and Forestry Products - Provisioning service

Physical flow account for wood forestry products records the supply and use of forestry products in physical terms

It includes variables as wood and derived products use:
Data for Sudan Roundwood and wood fuel are shown below



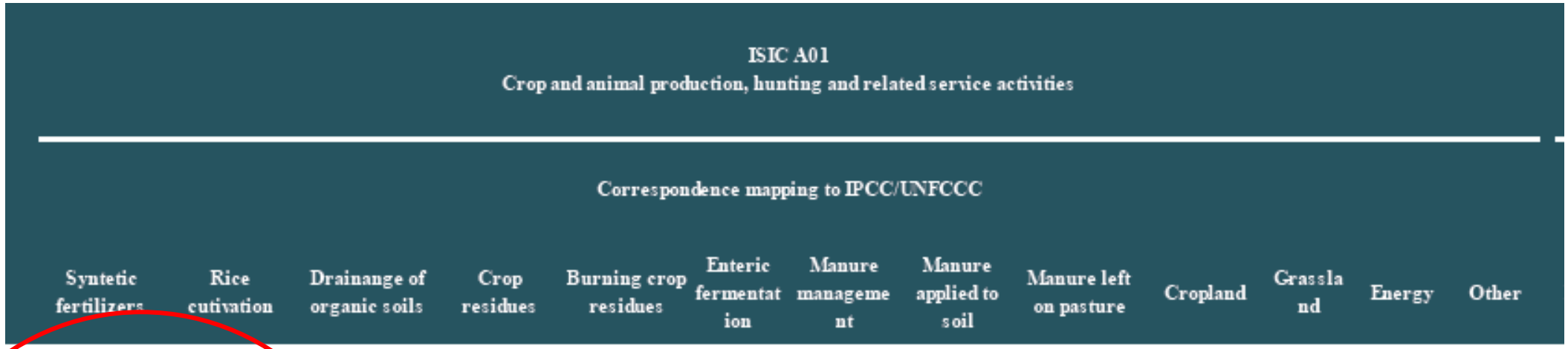


Non Wood Forestry Products (NWFPs) – Provisioning service

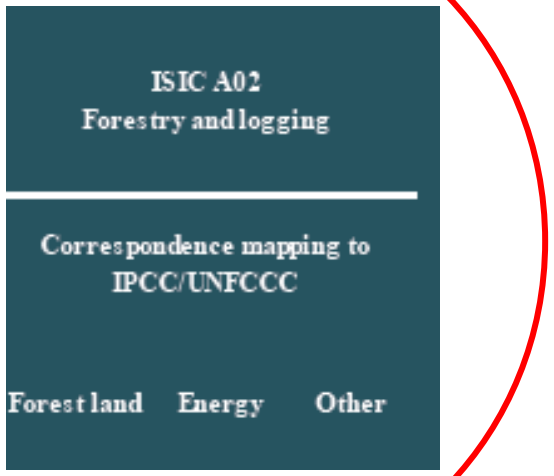
Name of NWFP product	Key species	Quantity	Unit	Value (1000 local currency)	NWFP category
Gum Arabic	Acacia senegal	60 000	ton	60 000	7 Exudates
Tabaldi fruits	Adansonia digitata	50 000	ton	100 000	1 Food
Dom fruits	Hyphaene thebaica	90 000	ton	20 000	1 Food
Aradeib (Tamarind) fruits	Tamarindus indica	10 000	ton	50 000	1 Food
Goddeim fruits	Grewia tenax	20 000	ton	150 000	1 Food
Hegglig fruits	Balanites aegyptiaca	80 000	ton	15 000	9 Living animals
Living animals	Gazelles	50	unit	25 000	9 Living animals
Jilood	Gazelles, big cats, pythons ..etc.		unit	80 000	10 Hides skins and trophies
Asal Nahal	African honey bees	2	ton	400 000	11 Wild honey and bee wax
Laham sayed	Gazelles, antelopes, buffaloes, birds, fish ...etc.	10	ton	10 000	12 Wild meat

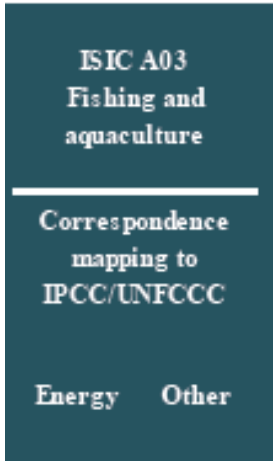
Source: FRA Sudan country Report 2020

The SEEA AFF and the Air Emissions Accounts – Regulating services



Source: SEEA AFF, Table 4.4 *Physical flow account for air emissions (gigagrams of carbon dioxide equivalent),* p. 103





FAOSTAT data for Sudan show a **Pearson Index of - 0,9** between *Forest Land Surface* and *GHGs emissions*: it implies an almost perfect indirect correlation (time series 2012 -2020).

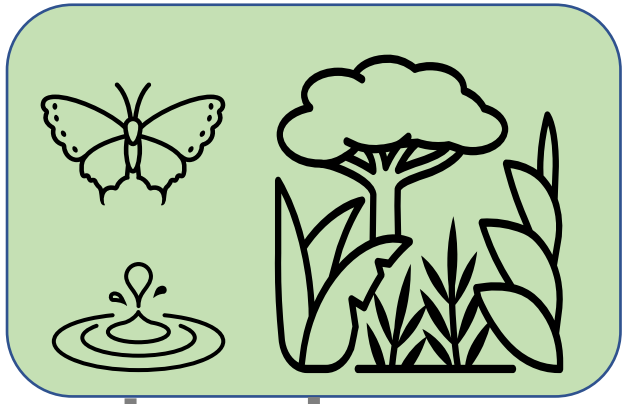
Definitively we can define **carbon sequestration** as a key forest ecosystem service.

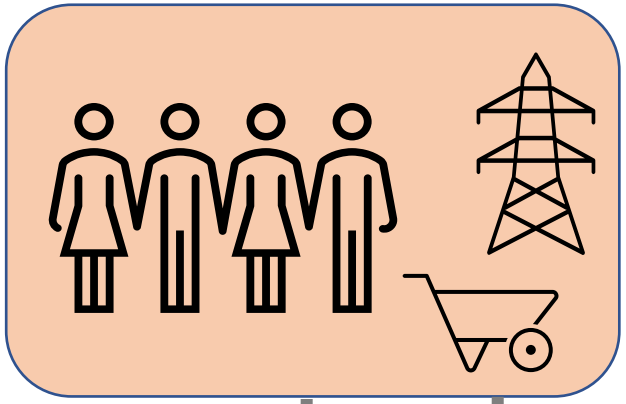
Item	Year	Unit	Value
Forest land	2012	1000 ha	19732,67
Forest land	2013	1000 ha	19558,43
Forest land	2014	1000 ha	19384,18
Forest land	2015	1000 ha	19209,93
Forest land	2016	1000 ha	19039,85
Forest land	2017	1000 ha	18869,78
Forest land	2018	1000 ha	18699,7
Forest land	2019	1000 ha	18529,63
Forest land	2020	1000 ha	18359,55
Forest land	2012	gigagrams	-74,096
Forest land	2013	gigagrams	-74,096
Forest land	2014	gigagrams	-74,096
Forest land	2015	gigagrams	-74,096
Forest land	2016	gigagrams	0
Forest land	2017	gigagrams	0
Forest land	2018	gigagrams	0
Forest land	2019	gigagrams	0
Forest land	2020	gigagrams	0

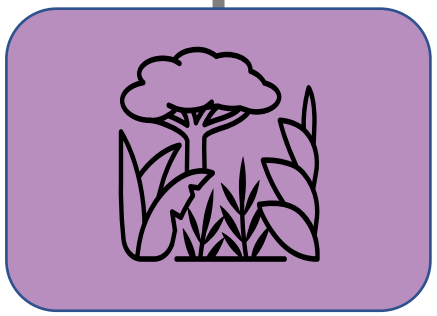
Carbon sequestration - Regulating services

Ecosystem Service Potential

Ecosystem Service Demand

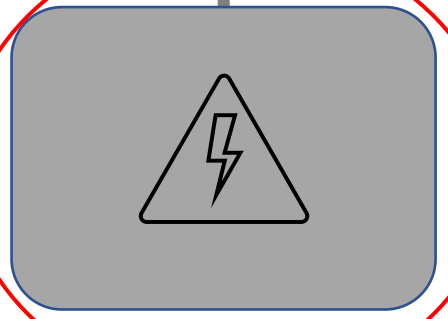






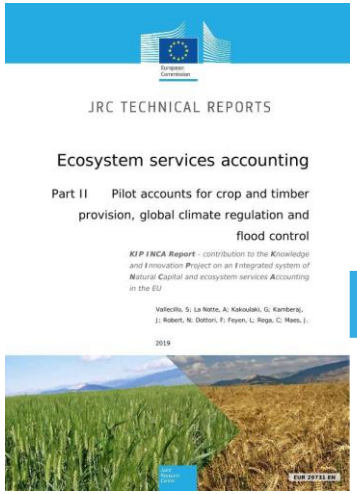
Ecosystem Service Unused Potential

Ecosystem Service Actual Flow



Ecosystem Service Unmet Demand

FAO – JRC collaboration



http://www.fao.org/food-agriculture-statistics/capacity-development/seea-aff/en/

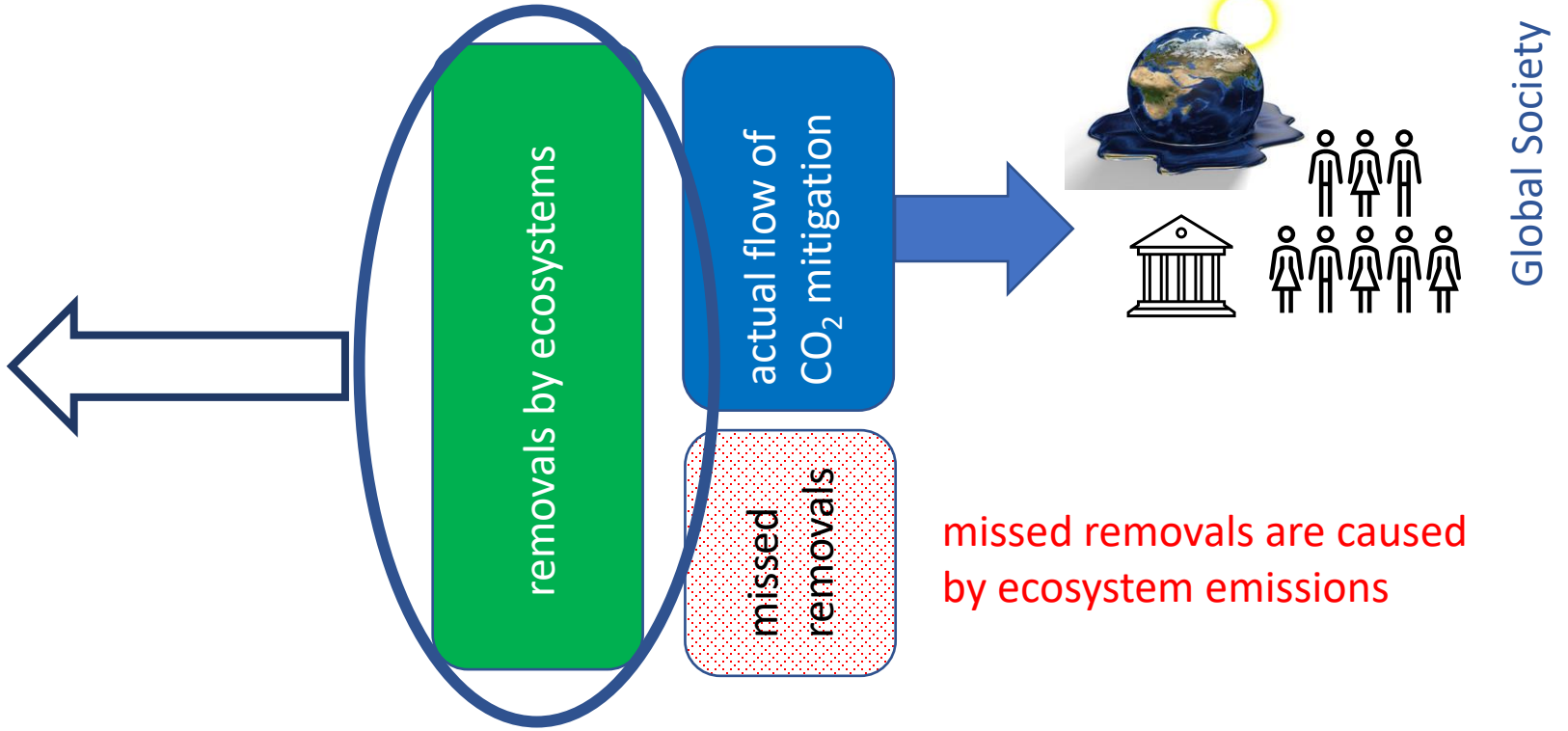
Carbon sequestration - Regulating services

Sudan, 2015:

74 mlln tonne of C uptake (source FAO)

2.2 billion EURO* (source FAO - JRC)

…the more we reduce the missed removals, the more we increase the actual flow of CO2 mitigation.



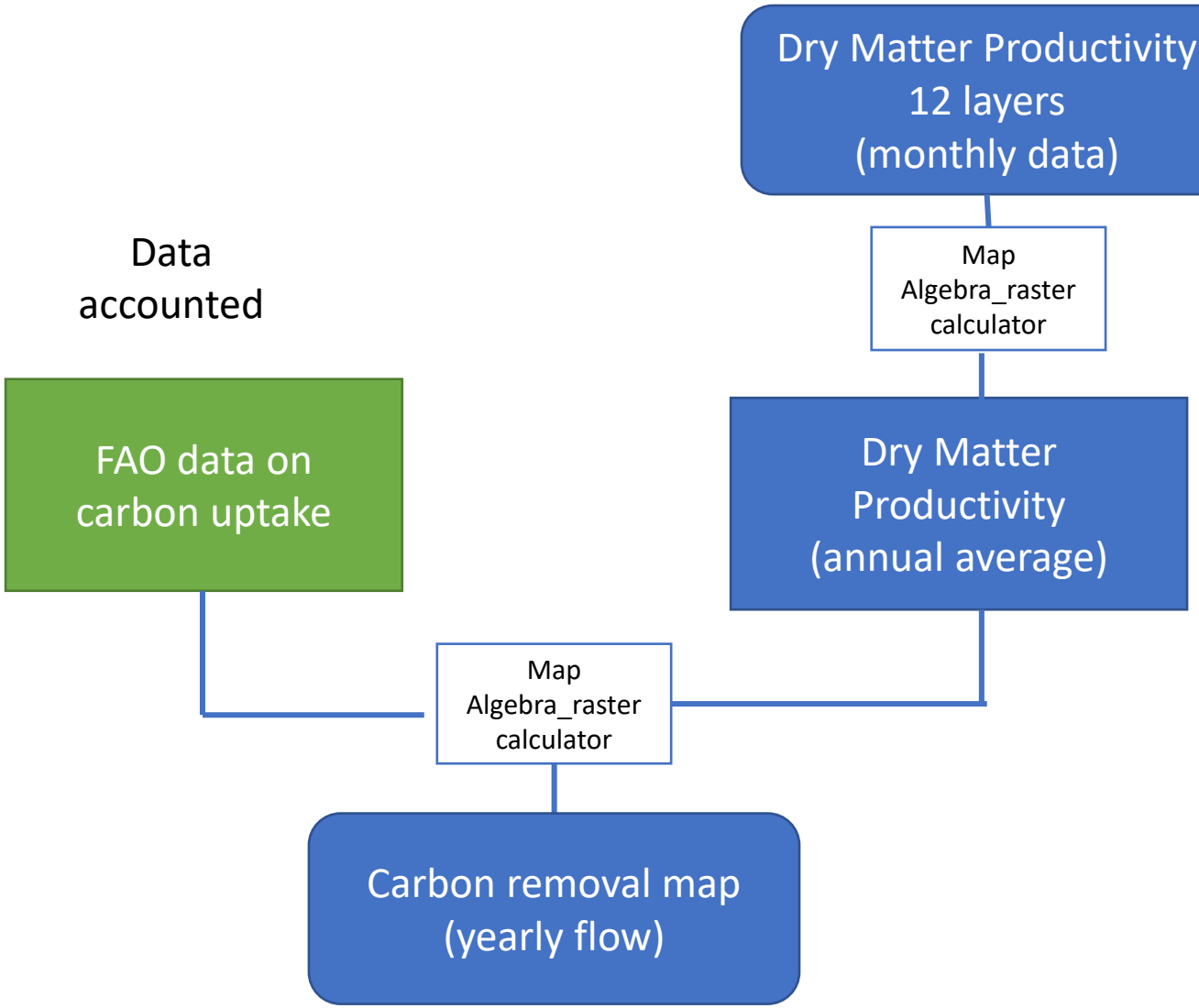
missed removals are caused by ecosystem emissions

*GDP per capita Sudan/2015 = 1 500 Euro
2.2 billion euro = income for 147 mil Sud. people

Carbon sequestration - Regulating services

Sudan, 2015

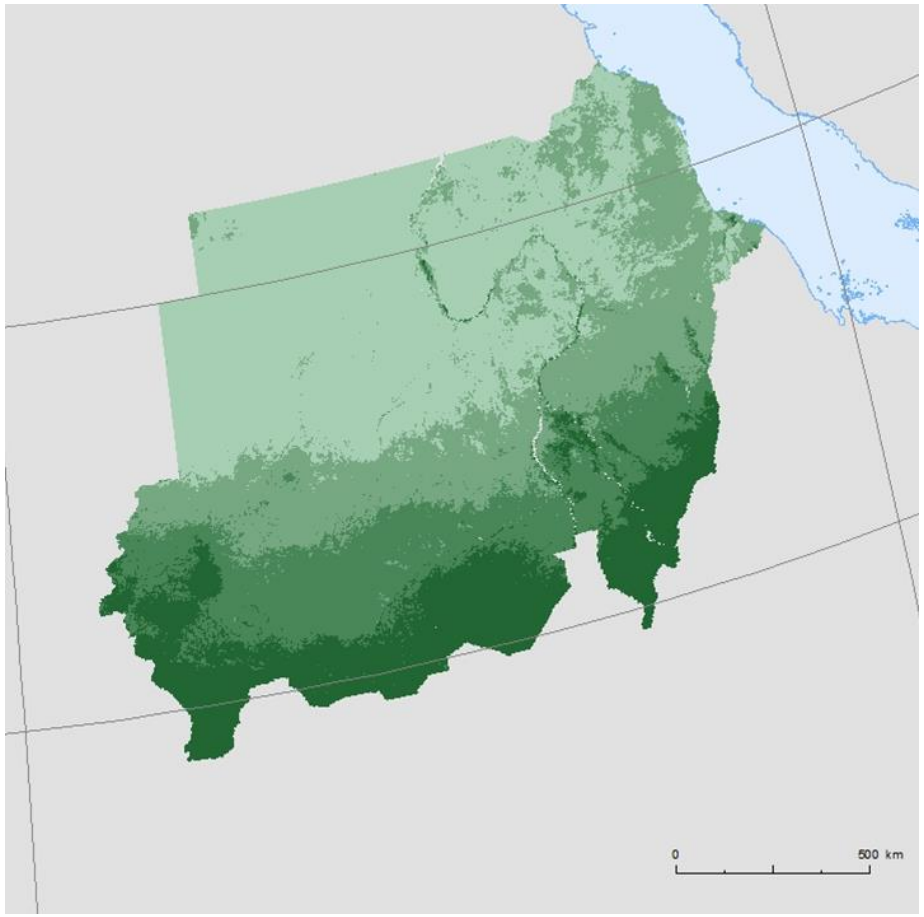
Proxy used for spatial mapping



Dry Matter Productivity represents the overall growth rate or dry biomass increase of vegetation, expressed in kilograms of dry matter per hectare per day

Carbon sequestration - Regulating services

Sudan, Carbon sequestration removals map 2015



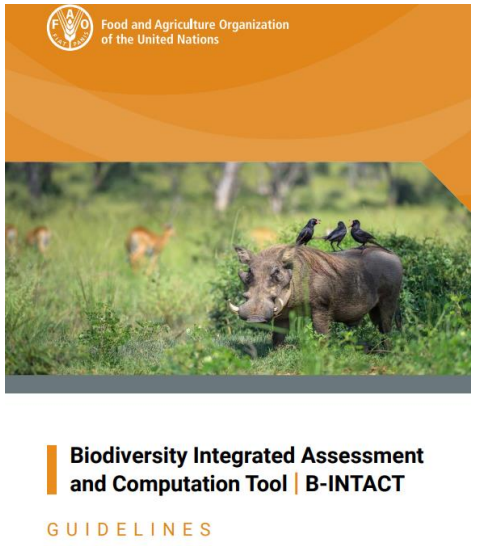
spatial layer-> ICPAC GMES: Dry Matter Productivity;
Source: FAO JRC

SEEA AFF accounts implementation: challenges and next steps

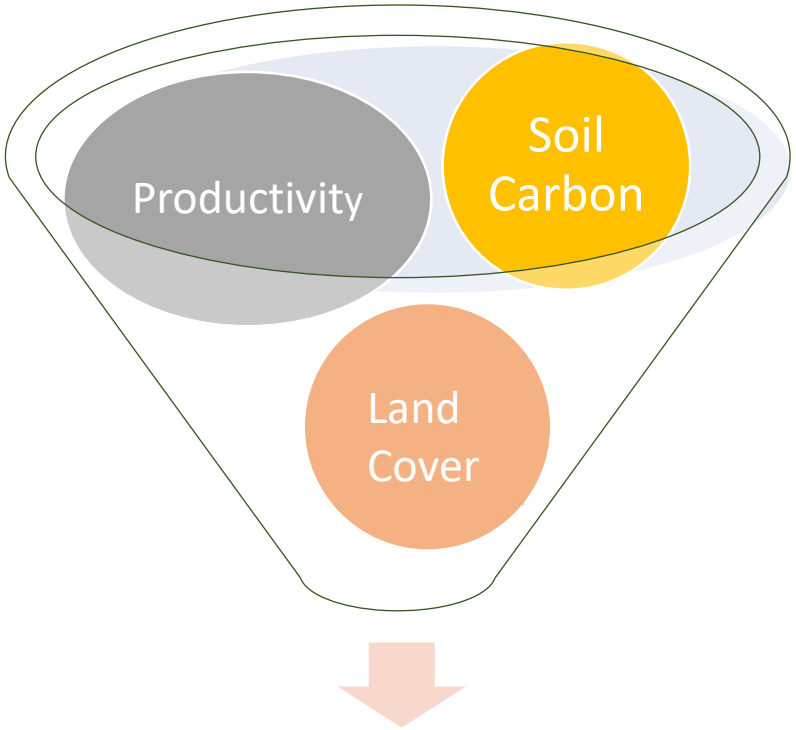
- Lack of data as main challange in account compilation /opportunity to improve national data quality and flow

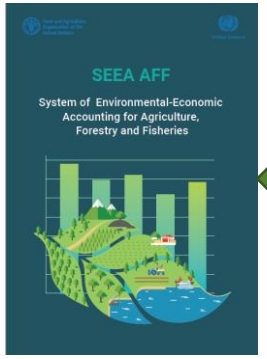
- To this end collaboration with FAO Sudan, Ministry of Agriculture, NSOs, GEF collegues in the field and Universities is essential

- Additional information have been gathered trought B-INTACT and Trends.earth, as geospatial platfroms and tools



SDG indicators 15.3.1





http://trends.earth/docs/en/

https://seea.un.org/events/london-group-environmental-accounting-26th-meeting

Annex II- Land cover classes

SEEA classes	SEEA Definitions	ARIES Classes	Trends.Earth
Artificial surfaces (including urban and associated areas)	The category is composed of any type of artificial surfaces	Artificial surfaces	**Artificial areas**
Herbaceous crops	The category is composed of a main layer of cultivated herbaceous plants.	Agricultural land	**Croplands**
Woody crops	The category is composed of a main layer of cultivated tree or shrub plants.	Shrubland	**Croplands**
Multiple or layered crops	The category is composed of at least two layers of cultivated woody and herbaceous plants or different layers of cultivated plants combined with natural vegetation.	Agricultural land	**Croplands**
Grassland	The category is composed of a main layer of natural herbaceous vegetation with a cover from 10 to 100 per cent.	Grassland / Savanna	**Grasslands**
Tree-covered areas	The category is composed of a main layer of natural trees with a cover from 10 to 100 per cent.	Forest	**Tree-covered areas**
Mangroves	The category is composed of natural trees with a cover from 10 to 100 per cent in aquatic or regularly flooded areas in salt and brackish water.	Mangrove	**Wetlands**
Shrub-covered areas	The category is composed of a main layer of natural shrubs with a cover from 10 to 100 per cent.	Shrubland	**Croplands**
Shrubs and/or herbaceous vegetation, aquatic or regularly flooded	The category is composed of natural shrubs or herbs with a cover from 10 to 100 per cent in aquatic or regularly flooded areas with water persistence from 2 to 12 months per year.	Wetland	**Wetlands**
Sparsely natural vegetated areas	The category is composed of any type of natural vegetation (all growth forms) with a cover from 2 to 10 per cent.	Spare vegetation	**Other lands**
Terrestrial barren land	The category is composed of abiotic natural surfaces.	Bare area	**Other lands**
Permanent snow and glaciers	The category is composed of any type of glacier and perennial snow with persistence of 12 months per year.	Glacier and perpetual snow	**Other lands**
Inland water bodies	The category is composed of any type of inland water body with a water persistence of 12 months per year.	Inland swamp	**Water bodies**
Coastal water bodies and intertidal areas	The category is composed on the basis of geographical features in relation to the sea (lagoons and estuaries) and abiotic surfaces subject to water persistence (intertidal variations).	Water bodies	**Water bodies**

SDG indicators 15.3.1

Gezira State: Land Cover change

As land cover analysis we compared land cover **baseline year** 2001-2010 with the reference **targeted period** (2011-2018) in UNCCD (and SEEA compliant) Land Cover Classes using a reference matrix

Land cover in target year

Land cover in baseline year	Forest	Grassland*	Cropland	Wetland	Artificial area	Bare land	Water body
Forest	0	-	-	-	-	-	0
Grassland*	+	0	+	-	-	-	0
Cropland	+	-	0	-	-	-	0
Wetland	-	-	-	0	-	-	0
Artificial area	+	+	+	+	0	+	0
Bare land	+	+	+	+	-	0	0
Water body	0	0	0	0	0	0	0

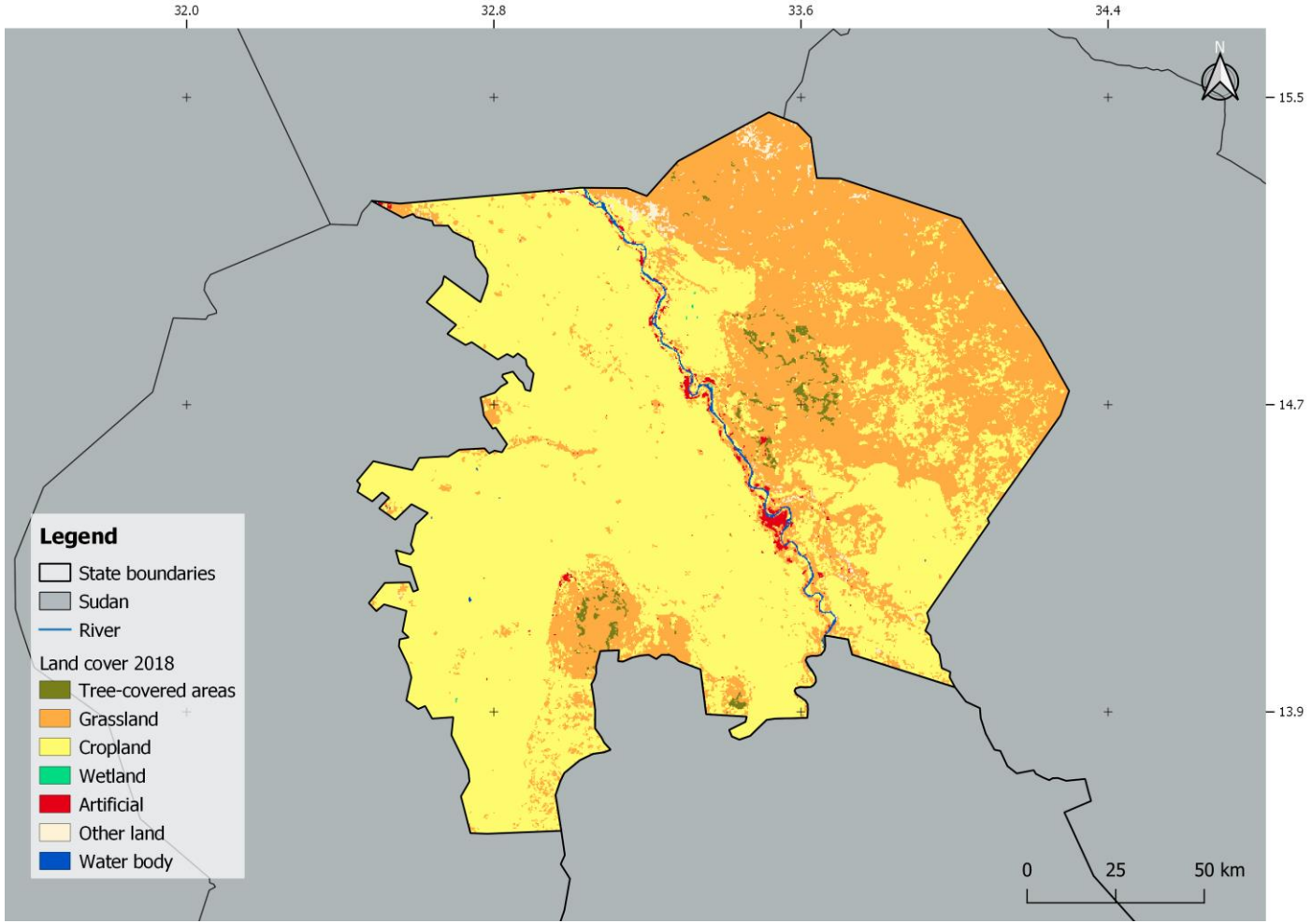
Legend

Degradation	Stable	Improvement
-	0	+

*The "Grassland" class consists of grassland, shrub, and sparsely vegetated areas (if the default aggregation is used).

SDG indicators 15.3.1

Land cover transition analysis



Gathered results are shown below:

	Area (sq km)	Percent of total land area
Total land area:	24.127,0	100,00%
Land area with improved land cover:	352,0	1,46%
Land area with stable land cover:	23.701,0	98,23%
Land area with degraded land cover:	73,9	0,31%

SDG indicators 15.3.1

Changes in soil organic carbon (SOC) over the reporting period.

- In measuring SOC the UNFCCC and the UNCCD recommend coefficients for changes in land use, management and inputs.
- However, spatially explicit information on management and C inputs is not available for most regions. As such, only land use conversion coefficient can be applied for estimating changes in C stocks (using land cover as a proxy for land use).
- The coefficients used were the result of a literature review performed by the UNCCD and represent the proportional in C stocks after 20 years of land cover change.

SDG indicators 15.3.1

Changes in soil organic carbon (SOC) over the reporting period.

LU coefficients	Forest	Grasslands	Croplands	Wetlands	Artifical areas	Bare lands	Water bodies
Forest	1	1	f	1	0.1	0.1	1
Grasslands	1	1	f	1	0.1	0.1	1
Croplands	1/f	1/f	1	1/0.71	0.1	0.1	1
Wetlands	1	1	0.71	1	0.1	0.1	1
Artifical areas	2	2	2	2	1	1	1
Bare lands	2	2	2	2	1	1	1
Water bodies	1	1	1	1	1	1	1

Source: Conservation International, Lund University, National Aeronautics and Space Administration (NASA), Trends.Earth Documentation, Release 0.67, 2019

Gathered results are shown below:

	Area (sq km)	Percent of total land area
Total land area:	24.127,0	100,00%
Land area with improved soil organic carbon:	57,2	0,24%
Land area with stable soil organic carbon:	23.652,7	98,03%
Land area with degraded soil organic carbon:	406,5	1,68%
Land area with no data for soil organic carbon:	10,6	0,04%

Land Productivity

- Land productivity is the biological productive capacity of the land; Net primary productivity (NPP) can be defined as the net amount of carbon assimilated after photosynthesis and autotrophic respiration over a given period of time (Clark et al. 2001) and is typically represented in units such as kg/ha/yr.

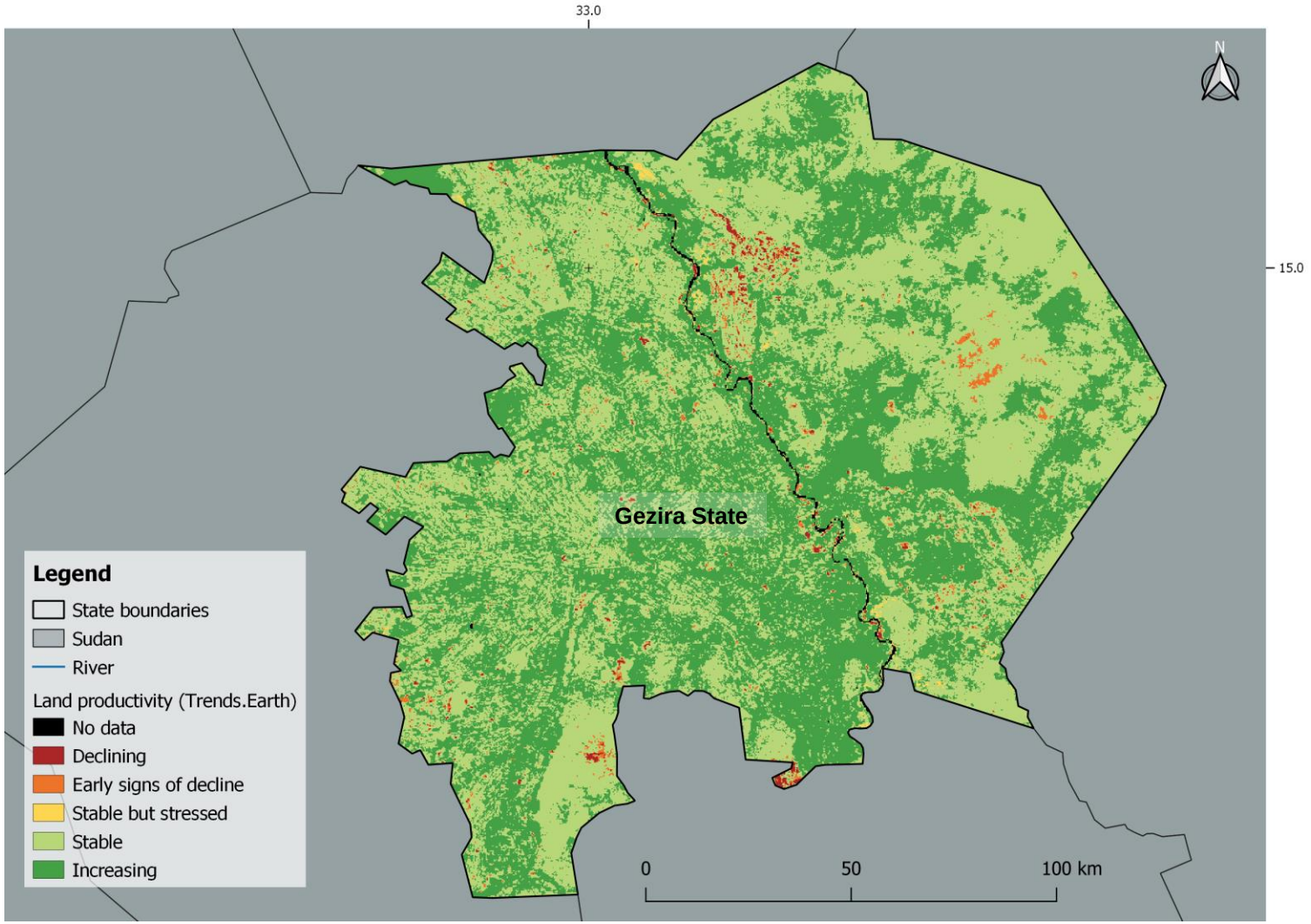
- However, NPP requires time and resources beyond the scope of our project, and for that reason, we relied on spatial and remotely sensed information to derive indicators of NPP as the Normalized Difference Vegetation Index (NDVI); once again geospatial data and tool were essential for our analysis

- Thought Trendsearth 3 NDVI dimensions were analyzed:

  - ✓ *Productivity state* which measures the detection of recent changes in primary productivity as compared to the baseline period.
  - ✓ *Productivity performance* which measures local productivity relative to other similar vegetation types in similar land cover types or bioclimatic regions throughout the study area
  - ✓ *Productivity trajectory* measures the rate of change in primary productivity over time.

SDG indicators 15.3.1

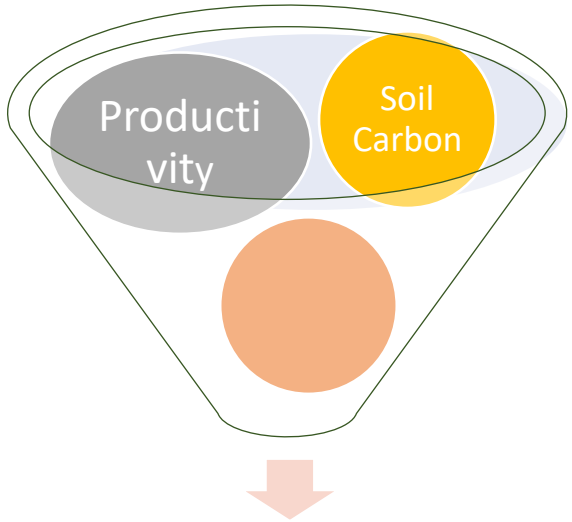
Land Productivity



Gathered results are shown below:

	Area (sq km)	Percent of total land area
Total land area:	24.127,0	100,00%
Land area with improved productivity:	11.084,9	45,94%
Land area with stable productivity:	12.553,1	52,03%
Land area with degraded productivity:	458,9	1,90%
Land area with no data for productivity:	30,1	0,12%

SDG indicators 15.3.1



Indicator 15.3.1

Proportion of land that is degraded over total land area

15 LIFE ON LAND

Gezira State Proportion of land that is degraded over total land area – Indicator 15.3.1

	Area (sq km)	Percent of total land area
Total land area:	24.127,0	100,00%
Land area improved:	10.921,3	45,27%
Land area stable:	12.360,6	51,23%
Land area degraded:	812,4	3,37%
Land area with no data:	32,7	0,14%

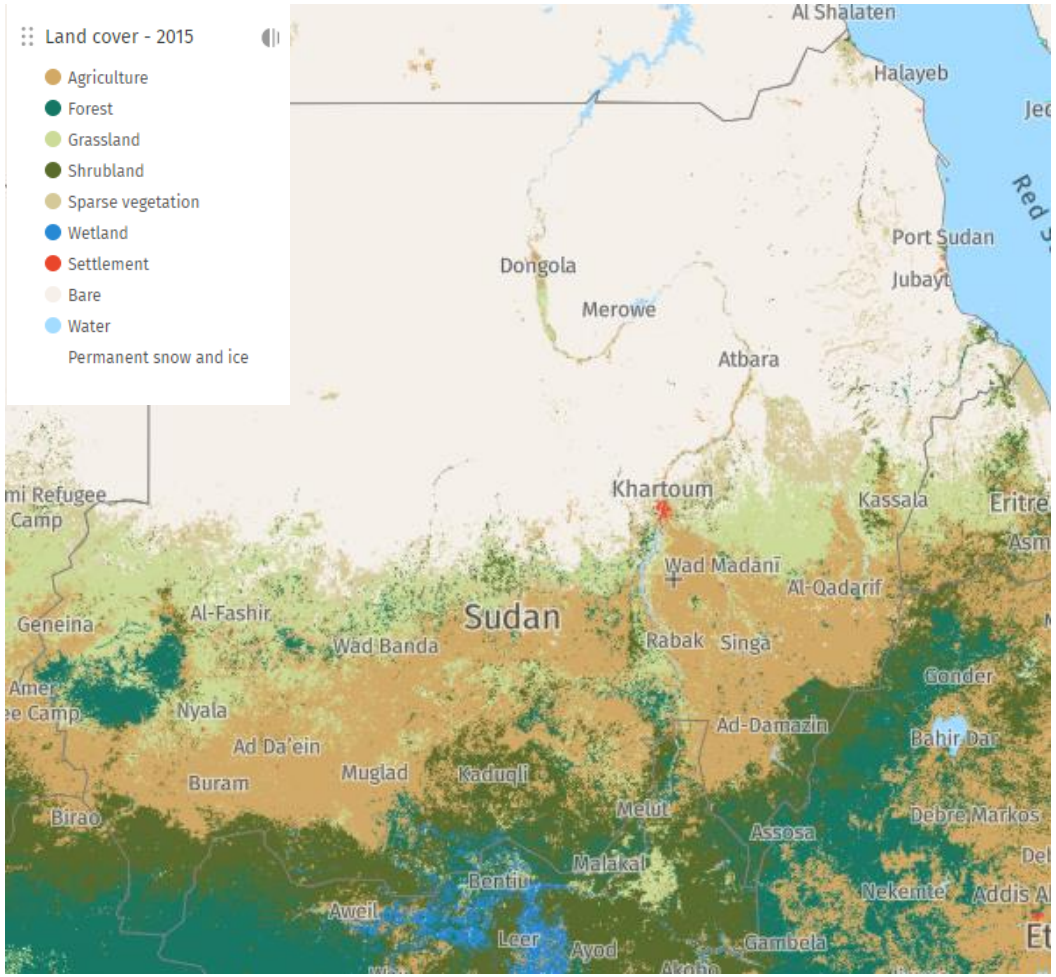
Forest ecosystem services modelling - Biodiversity

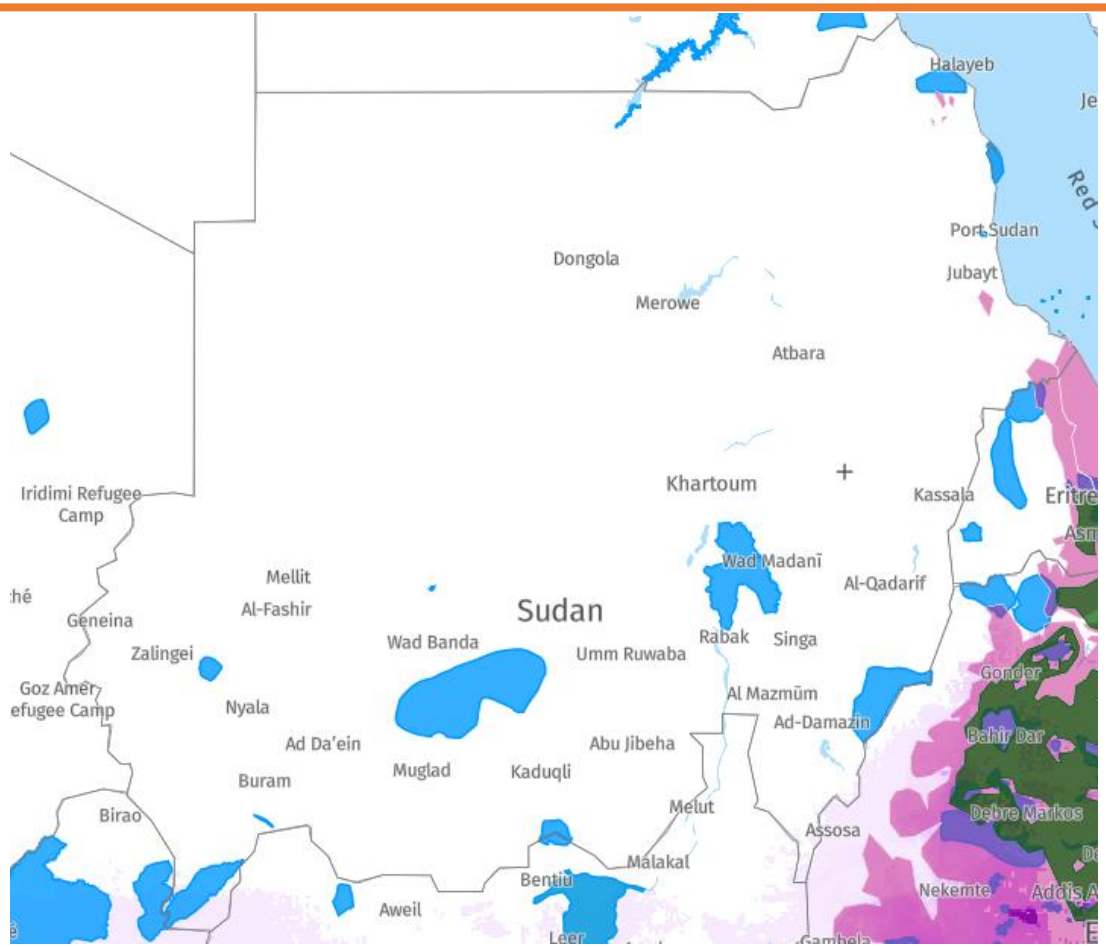
- **"Biodiversity** is the variability that exists among all living organisms on land, in freshwater bodies and in the oceans. It also includes the ecological complexes in which these organisms interact. It encompasses the diversity within species, the diversity between species and the diversity of ecosystems" – Art. 2 Convention on Biological Diversity (CBD), 1992

- In its "State of the World's Biodiversity for Food and Agriculture" publication of 2019, FAO emphasizes that "biodiversity underpins the capacity of farmers […] to produce food and a range of other goods and services in a vast variety of different biophysical and socio-economic environments. It increases resilience to shocks and stresses, provides opportunities to adapt production systems to emerging challenges and is a key resource in efforts to increase output in a sustainable way."

- Therefore we assume in our analysis that *a complete loss of biodiversity corresponds to an equivalent complete loss of the supply of ecosystem services* from a given area of intervention.

Forest ecosystem services modelling - Biodiversity





Key Biodiversity Areas - 2019

Key Biodiversity Areas

Source: https://www.globalforestwatch.org/

The relationship between forest and biodiversity is quite intuitive

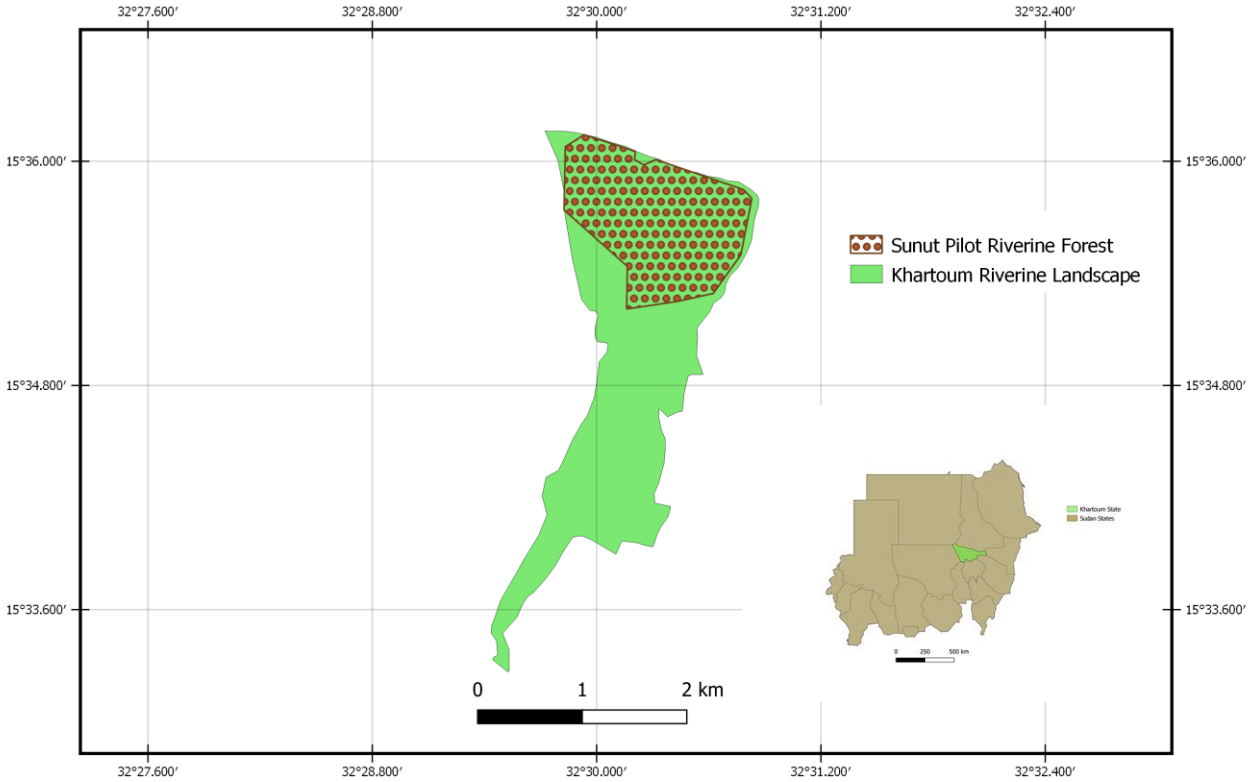
Forest ecosystem services modelling - Biodiversity

- We try to quantify biodiversity and the social project value for 195 ha of forest in Khartum by the **Biodiversity Integrated Assessment and Computation Tool** (B-INTACT), a tool developed by FAO and The Agence Française de Développement (AFD), in collaboration with a number of international experts and organization.

- It has to be noticed that we run our analysis for a sample area: it implies that we could reach much higher values when assessing upscaled GEF project intervention areas or districts or provinces level.

- This biodiversity assessment is integrated as it applies **quantitative** as well as **qualitative** approaches.

Sample area – (green) with pointed out Sunut forest



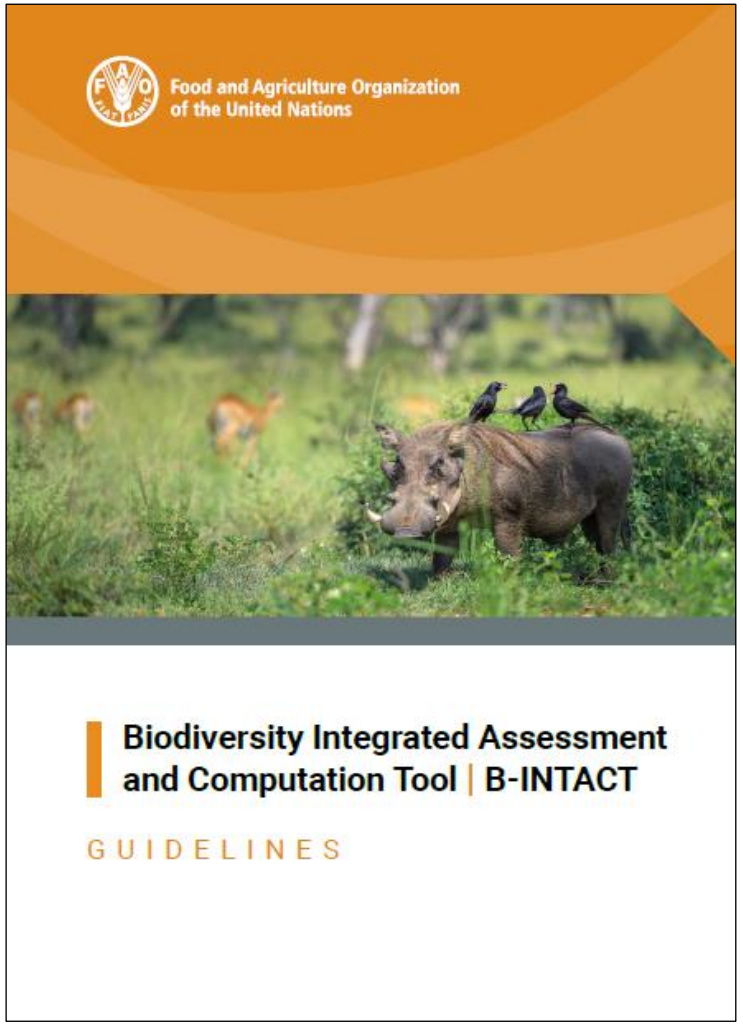
Forest ecosystem services modelling - Biodiversity

The QUANTITATIVE approach

- B-INTACT the quantitative approach considers a set of relationships for anthropogenic impacts on biodiversity as land-use changes, habitat fragmentation, infrastructure and human encroachment.

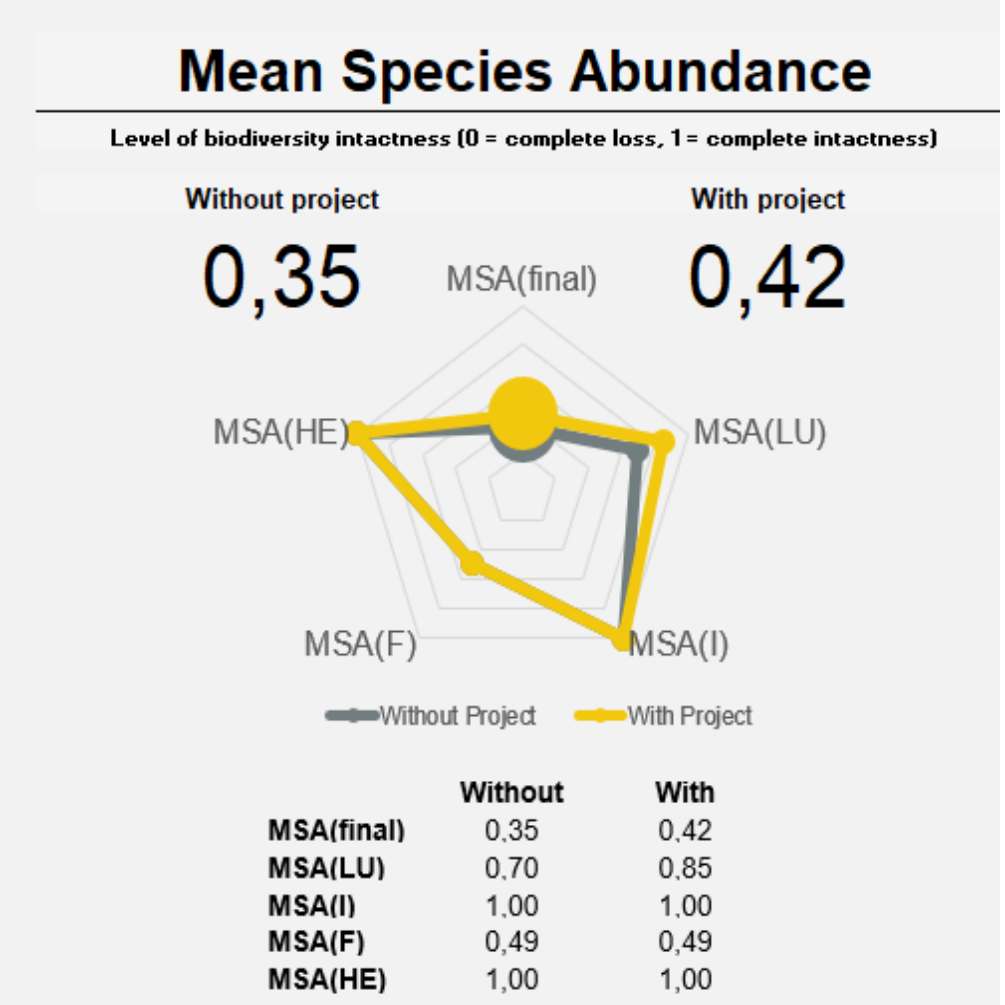
- Biodiversity responses are quantified in the mean species abundance (MSA) metric, which expresses the mean abundance of original species in disturbed conditions relative to their abundance in an undisturbed habitat (where MSA = 1 highlights an entirely intact ecosystem and MSA = 0 highlights a fully destroyed ecosystem).

- MSA is assessed by main pressure: land-use change (LU), infrastructure (I), natural area fragmentation (F), and human encroachment impact (HE)



Forest ecosystem services modelling - Biodiversity

The QUANTITATIVE approach for Khartum selected area



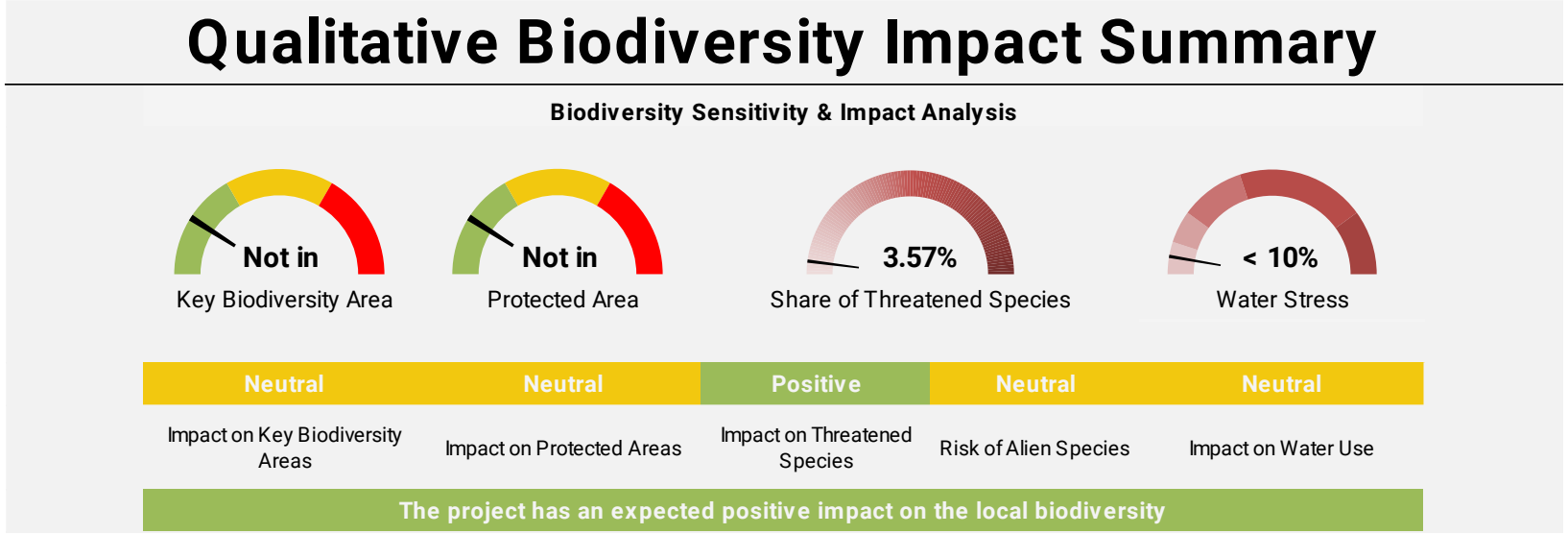
	Without	With
MSA(final)	0,35	0,42
MSA(LU)	0,70	0,85
MSA(I)	1,00	1,00
MSA(F)	0,49	0,49
MSA(HE)	1,00	1,00

- The project will significantly e positively impact on biodiversity, increasing the MSA index of 20 per cent in 3 Years time.
- Major improvements will concern the land-use change with MSA (LUI) estimated to move from 0.7 to 0.85 with the project.
- These findings are in line with the project main intervention purposes, focucing on improving forest resource management.

Forest ecosystem services modelling - Biodiversity

The NON QUANTITATIVE assessment for Khartum selected area

- Nonquantifiable impacts to biodiversity from project activities are assessed with a qualitative appraisal of the biodiversity sensitivity, management activities and agrobiodiversity practices, to complement the quantitative assessment



Forest ecosystem services modelling - Biodiversity

The monetary assessment for Khartum selected area

- Assuming that MSA is an indicator reflecting the level of damage to an ecosystem, it is possible to assign a monetary value per hectare to the MSA indicator.

- It is safe to presume that a complete loss of biodiversity corresponds to an equivalent complete loss of the supply of ecosystem services from a given area of intervention.

- The measurement of ecosystem services implies the attempt of recording the “output” generated by ecosystems, and thus the monetary values which represent exchange values consistent with the principles of national accounting given current uses of ecosystem.

- The measurement of ecosystem services values is challenging and several approaches are possible: this analysis we chose to refer to ecosystem service values as reported in the Ecosystem Services Valuation Database (ESVD), which is a follow-up to the “The Economics of Ecosystems and Biodiversity” (TEEB) database and contains over 1 300 data points from 267 case studies on monetary values of ecosystem services across all biomes

Forest ecosystem services modelling - Biodiversity

The monetary assessment for Khartum selected area

- Based on these assumptions and expanding MSA analysis we derive the social value of biodiversity from the project as follows:

$$SV_p = \left(\sum_{i=1}^{i=n} (MSA_{i,p} * S_{i,p} * ESV_{i,p}) \times MSA_{HE,p} \right) - \left(\sum_{i=1}^{i=n} (MSA_{i,b} * S_{i,b} * ESV_{i,b}) \times MSA_{HE,b} \right)$$

Where:

SV_p is the added or lost social value of biodiversity due to project implementation
$MSA_{i,p}$ is the MSA of project activity patch i (*or land-cover/ecosystem functional units (**LCEUs**)*
$S_{i,p}$ is the surface area of project activity patch i,
$ESV_{i,p}$ is the ecosystem service value of project activity patch I
$MSA_{HE,p}$ is the project MSA corresponding to the impacts of human encroachment (HE),
$MSA_{i,b}$ is the MSA of baseline activity patch i,
$S_{i,b}$ is the surface area of baseline activity patch i,
$ESV_{i,b}$ is the ecosystem service value of baseline activity patch I
$MSA_{HE,b}$ is the baseline MSA corresponding to the impacts of human encroachment (HE)

Forest ecosystem services modelling - Biodiversity

The monetary assessment for Khartum selected area

- Applying the above-described methodology to sample area we get:

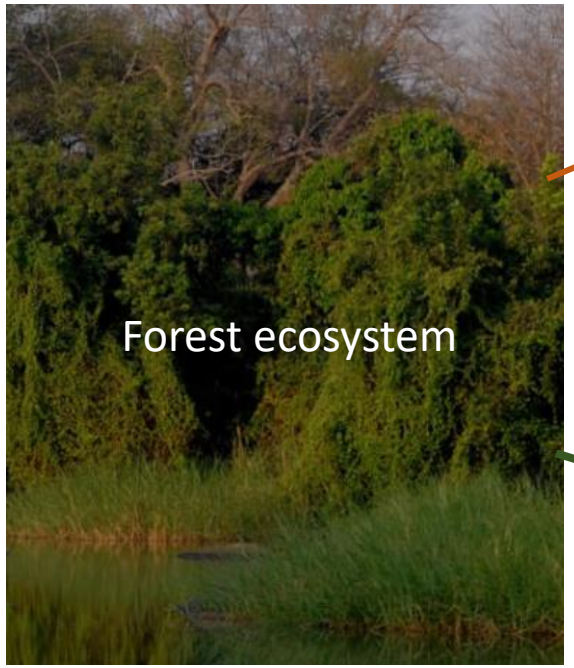
II. Added Social Value of Biodiversity

USD 1.705.626

- We could derive a much bigger number when upscaling at all project area, state level, national level (to have a meaninful comparison with GDP).

- However at this level of the project we can simply state that measuring biodiversity as ecosystem services in terms of biodiversity is feasible and show related preliminary results.

Ecosystem and natural capital analysis - Summary



Current natural resource management:

Deforestation
Overlogging
Biodiversity loss
Short term policy

Proposed natural resource management:

Natural capital driven
Sustainable forest management
Forest ecosystem are reinforced
Biodiversity is protected
NWFPs are source of income
Sustainable and long term policy

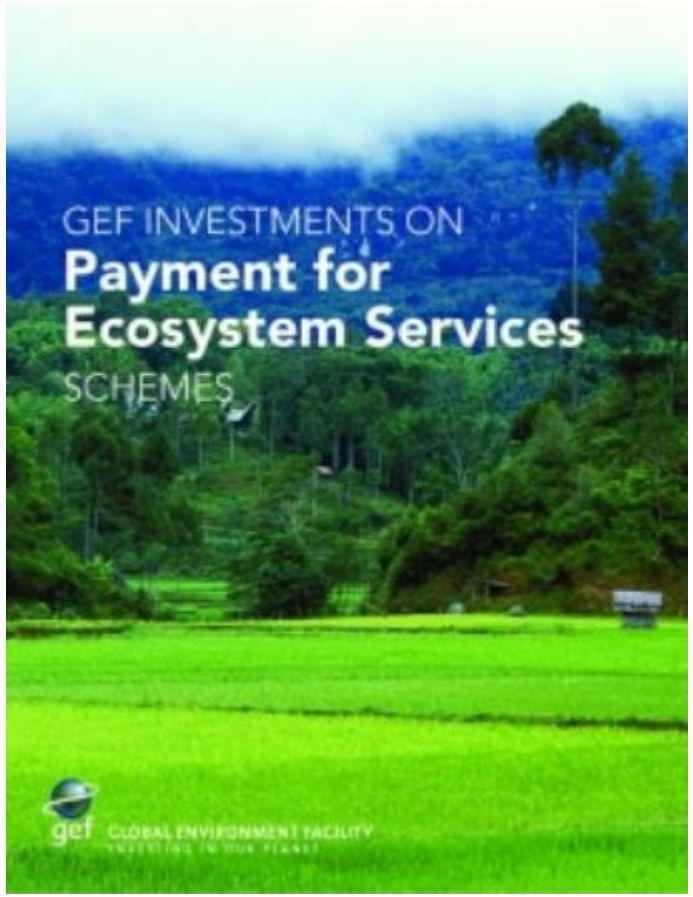
What next?

- The Global Environment Facility (GEF) has engaged in pioneering development of mechanisms that reward good stewardship of natural resources, including the structuring of Payment for Ecosystem Services (PES) schemes.

- For the GEF, the concept of PES includes a variety of arrangements through which the beneficiaries of ecosystem services compensate those providing the services.

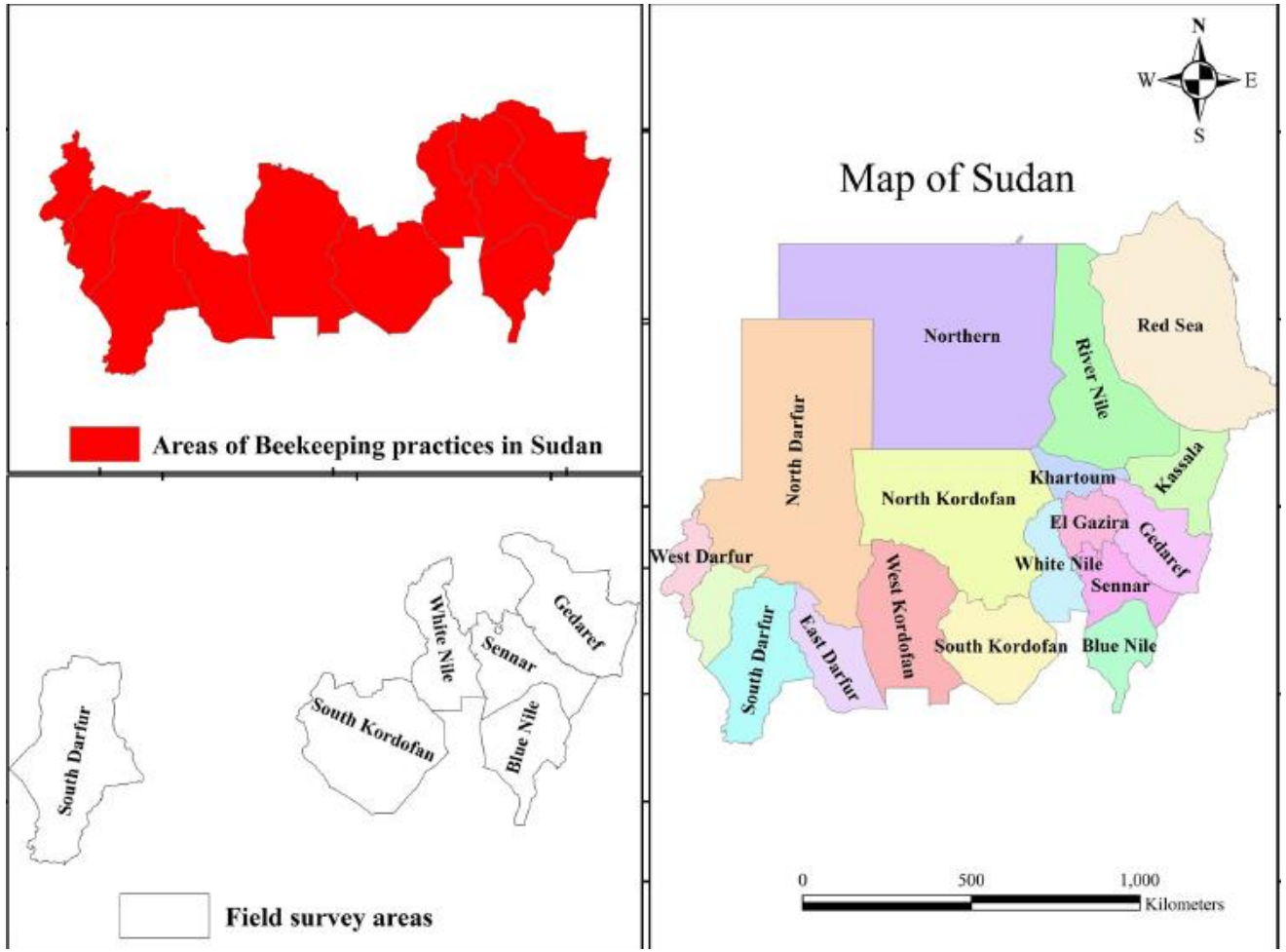
- GEF Investments in PES have ranged from global projects aiming at building the human and institutional capacity necessary to establish PES schemes, to stand-alone agreements between buyers and sellers in watersheds of high biodiversity value.

- It has been applied up to now in more than 60 GEF projects all over the world, from Asia to South America



What next?

PES Schemes for pollination and honey product ecosystem services in Sudan project area



Source:

Agroforest Syst (2020) 94:1037–1045
https://doi.org/10.1007/s10457-019-00478-1

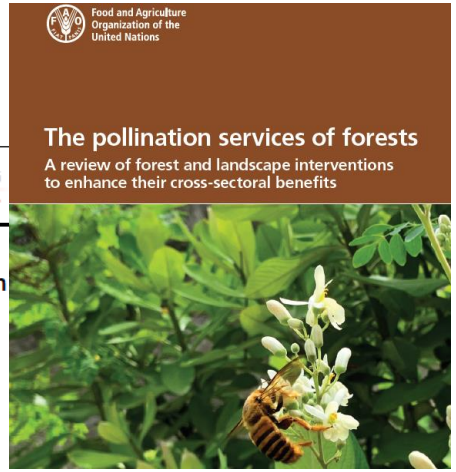
Economic evaluation of the honey yield from four forest tree species and the future prospect of the forest beekeeping in Sudan

Elsamoal Elzaki · Gang Tian

International Journal of Agricultural Economics
2020; 5(5): 187-196
http://www.sciencepublishinggroup.com/j/ijae
doi: 10.11648/j.ijae.20200505.16
ISSN: 2575-3851 (Print); ISSN: 2575-3843 (Online)

Introducing Beekeeping Within Microfinance Mechanisms to Combat Poverty Through the Agricultural Bank of Sudan (Case Study River Nile State)

Yasir Ahmed Abdalla Eltoum[1], Yasein Hassan Ajeb Mohammed Nour[2]
[1]Department of Agricultural Economics, Faculty of Agriculture, Alzaiem Alazhari University, Khartoum North, Sudan
[2]Agricultural Bank of Sudan, Khartoum, Sudan



What next?

PES Schemes for pollination and honey product ecosystem services as financially viable option

- Data from Agricultural Bank of Sudan related beeking activities in River Nile State show beekeeping as most promising industry of high economic feasibility
- An average production of colony per year of 19.3 Kg and
- Rate of return on investment of 46.2% which confirms the feasibility of these project activities

Table 7. Budget for honey production.

Cost items	Pound/Colony
Labour	34.6
Maintenance	14.4
Artificial Feeding	26.3
Water	5.2
Mobilization Vessel	14.4
Bottles and labels	25
Other	5.3
Total Variable Cost	125.2
Total Fixed Cost	3299
Yield per Colony (kg)	19.3 (Kg)
Prices / k	95
Gross Return	1833.5
Gross Margin	1583.1

Source: Yasir Ahmed Abdalla Eltoum, Yasein Hassan Ajeb Mohammed Nour; Introducing Beekeeping Within Microfinance Mechanisms
to Combat Poverty Through the Agricultural Bank of Sudan (Case Study River Nile State)

What next?

PES Schemes for pollination and honey product ecosystem additional advantages

Table 4. Effect of bee pollination on the yield of the different cultivated crops.

Crop	Av of production/Kg/f		No. of hives	Increase
	Before	After		
Orange	6875	10312	4	49.9%
Faba bean	1000	1437.5	4	43.7%
Onion seeds	55.5	288.5	2	423%
Coriander	1750	2800	2	60%

Table 2. Bees affectthe weight of the seeds.

Pollinators	The crops		
	Sun flower	Cotton	Alfa alfa
	Weight of 100seed (g)	Weight of 100seed (g)	Weight of 1000seed (g)
Bees + insects	8.1	14	2
Bees	6.7	13.2	1.9
without bees	4.1	10.4	1.2

(Source: Abdella, 1991).

Table 1. Bees effect on the seeds production.

Pollinators	The crops		
	Sun flower	Cotton	Alfa alfa
	Yield K/F	Yield K/F	Yield K/F
Bees+insects	652.3	867.2	121
Bees	566.1	769.4	109
without pollinators	72.5	585.8	33.3

(Source: Abdella, 1991).

Source: Yasir Ahmed Abdalla Eltoum, Yasein Hassan Ajeb Mohammed Nour; Introducing Beekeeping Within Microfinance Mechanisms
to Combat Poverty Through the Agricultural Bank of Sudan (Case Study River Nile State)

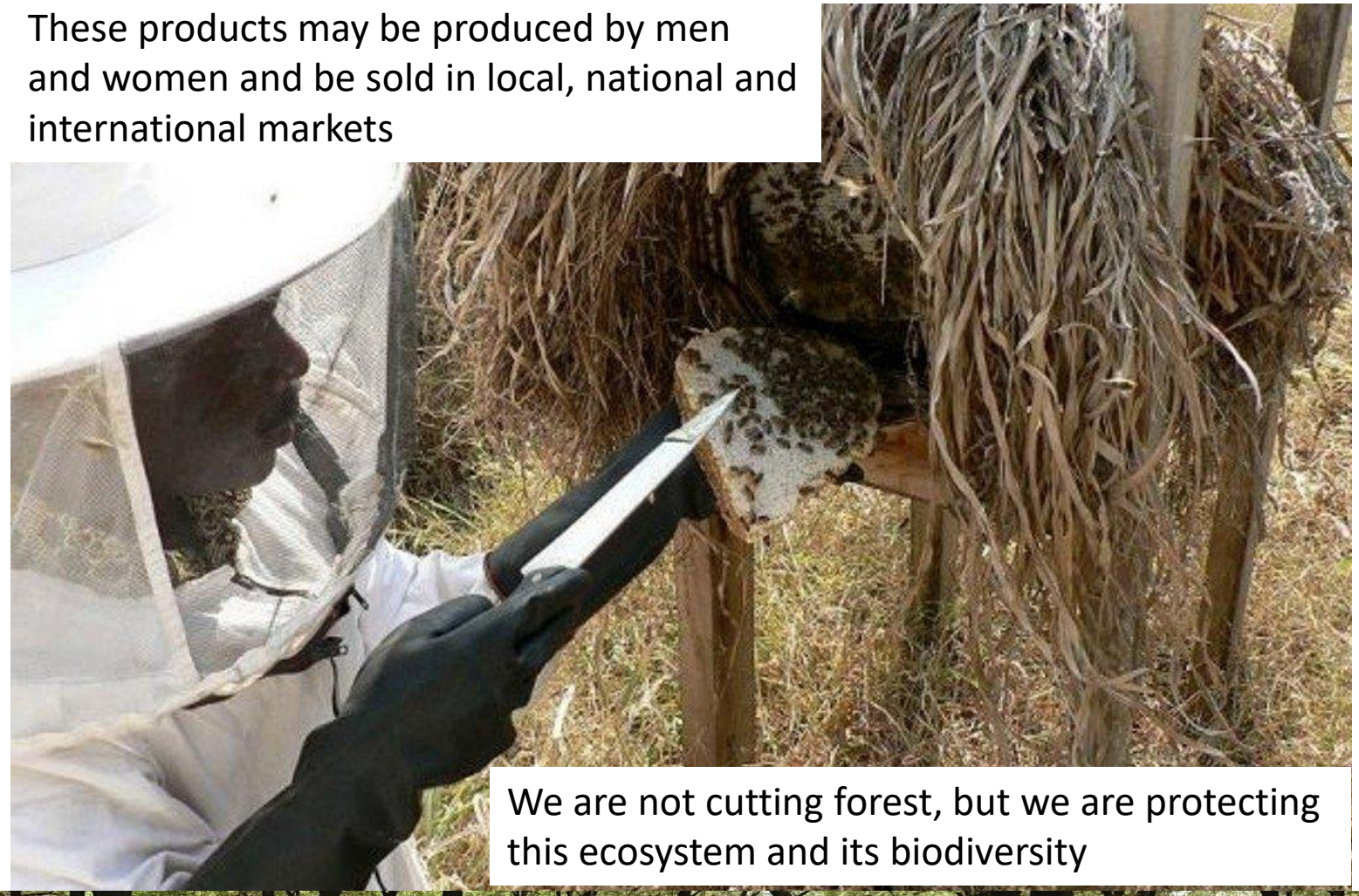
What next?

PES Schemes for pollination and honey product ecosystem additional advantages

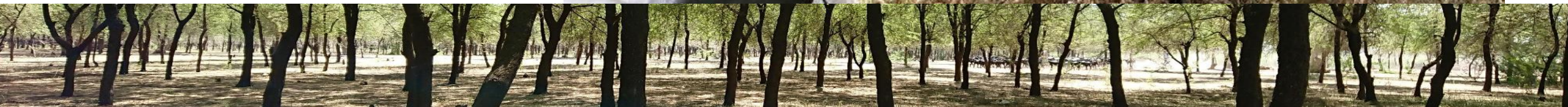
Not only honey…

- ✓ Bee wax
- ✓ Royal jelly
- ✓ Propolis
- ✓ Bee venom
- ✓ Pollen grains
- ✓ Pollen as food for humans

These products may be produced by men and women and be sold in local, national and international markets



We are not cutting forest, but we are protecting this ecosystem and its biodiversity



What next?

PES Schemes implementation

Key requirements:

- Involvement of local communities - FNC
- Support of GEF and FAO and Universities
- Local communities and farmers that are reaching an income throught invasive agriculture could be involved in beekeeping activities; they could be made aware of ALTERNATIVE source of income and of the VALUE of biodiversity and natural resources;
- FNC could contribute to the cost of implementing these activities and at the same time receiving an income from beekeeping revenues.
- Additional data and information should be collected to estimate the precise cost and potential revenues for our project areas.

What next?

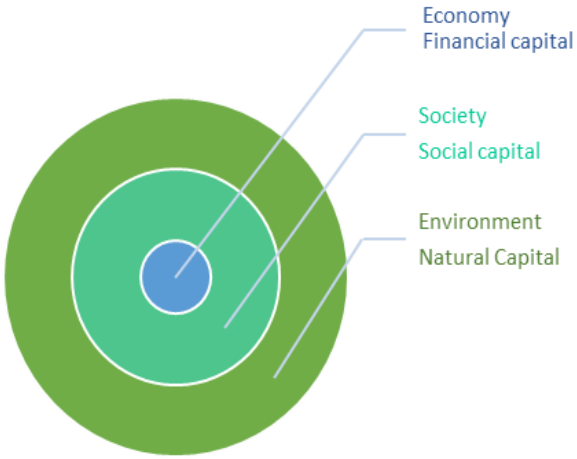
Additional proposal

- The Nile which flows through the capital Khartoum is a major migration corridor and **birdwatching** in this area will provide a good range of species;

- Sudan and project selected areas are rich in biodiversity, natural resources, three, plant and animals species: all these resources may be protected by facilitating **eco-tourism** activities

- The goal is to consider nature as an economic resource, an asset to protect, valorize and …enjoy!

Q & A – Time for discussion



THANK YOU!

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