GCF The Africa Integrated Climate Risk Management : Building The Resilience of Smallholder farmers to climate change impacts in 7 Sahelian Countries of the Great Green Wall (GGW) – EX-ACT Carbon Calculation Methodology

Introduction

The Ex-Ante Carbon-balance Tool (EX-ACT) is an appraisal system developed by FAO providing estimates of the impact of agriculture and forestry development projects, programmes and policies on the carbon-balance. The carbon-balance is defined as the net balance from all greenhouse gases (GHGs) expressed in CO_2 equivalent that were emitted or sequestered due to project implementation as compared to a business-as-usual scenario.

EX-ACT is a land-based accounting system, estimating C stock changes (i.e. emissions or sinks of CO_2) as well as GHG emissions per unit of land, expressed in equivalent tonnes of CO_2 per hectare and year. The tool helps project designers to estimate and prioritize project activities with high benefits in economic and climate change mitigation terms. The amount of GHG mitigation may also be used as part of economic analyses as well as for the application for additional project funds.

EX-ACT can be applied on a wide range of development projects from all AFOLU sub-sectors, including besides others projects on climate change mitigation, sustainable land management, watershed development, production intensification, food security, livestock, forest management or land use change. Further, it is cost effective, requires a compared small amount of data, and has resources (tables, maps) which can help finding the required information. While EX-ACT is mostly used at project level it may easily be up-scaled to the programme/sector level and can also be used for policy analysis.

With the above capabilities, the EX-ACT tool was selected for calculation of estimated carbon mitigation in the associated GCF Funding Proposal for Mali, Niger, Burkina Faso, The Gambia, Mauritania, Tchad and Senegal. Here, it is important to note that at the Tier 1 level data used by the EX-ACT tool is based on estimates averaged for the Sahel and are therefore not context specific. **Consequently, data included in this analysis has been adjusted to the Tier 2 level to be specific to climate resilient agricultural practices in the selected countries.** Data adjustments to the regional level have been made through expert consultation and literature review.

Methodology

Timeframe: **The implementation phase of the program will be five years, whilst the capitalisation phase of the program is estimated at a further 20 years.** This is the estimated time that the program's activities will need to achieve maturity and their full carbon sequestering capacity. This accounts for both climate resilient agricultural practices (such as maturity of woodlots) and the average life cycle of Photovoltaic solar panels.

Area coverage: EX-ACT makes calculations based on area coverage of specific project activities that will have carbon mitigation benefits or co benefits. As the proposed program is focused on providing grants to smallholder farmers to adopt mitigation and adaptation measures through an integrated climate risk management. The exact number of hectares of land that will be under implementation is estimated based on the following equation:

Number of Hectares = Input Value / Cost per Hectare

Climate resilient agricultural practices/ activities are well documented by development agencies in the region. Consequently, the costings of specific practices, such as, crop rotation, mixed cropping, improved nutrient management, improved genetic resources, agroforestry, minimum tillage, Zai and half-moon techniques are well reported for the country. Based on estimates by CILSS[1] cost per hectare of SLM in the seven selected countries was estimated at EUR 220. This figure was produced as an average cost of the proposed activities presented in the associated funding proposal.

With combined co-financing of 143 403 899.02 USD (USD GCF 82 849 900, USD IFAD 30 314 999 and ARC+ADRIFI 30 239 000 USD) and a total area of 296 000ha of land implementing climate resilient agricultural practices was estimated for the program. These figures were then split across the four major final land use categorisations to be inputted into EX-ACT, please see table 1.

Table 1: Breakdown of area coverage per adaptation activity group with mitigation co-benefits for inputting into EX-ACT calculations. Note that EX-ACT inputs are based on final land use not activity.

Program Activity Category	**EX-ACT Final Land Use**	**Area (ha)**
Sustainable forest management	Forest	40 000
Agriculture	Annual	60 000
Agriculture	perennial crop	96 000
Grassland restoration	Grassland	100 000
Total		**296 000**

List of measures introduced by the project and mitigation co-benefits:

EX ACT estimates the sequestration of carbon through a range of activities related to land restoration (as described in FP):

The three main sources of sinks identified in the EX ACT analysis per country are the following:

1/ Land use changes through land restoration:

- Promotion of agroforestry techniques on degraded land: building parkland via assisted natural regeneration, planting hedgerows around horticulture plots
- Restoring pasture on degraded land
- Restoring degraded land to convert it into cropland (cereals, sorghum and millet) through the promotion of planting pits and half-moons with organic manure and micro-dosing of urea

2/ Sustainable management and enrichment of dry Sahelian forests and shrubland having an extremely degraded initial stage (80 % of biomass lost).

[1] http://portails.cilss.bf/spip.php?article83&debut_articles=90

3/ Progressive sequestration of carbon through perennial species introduced by agroforestry techniques

These measures are listed below:

Title	**Description**	**Impact**	**Mitigation co-benefits**
Assisted natural regeneration	Protection of multipurpose trees in cereal fields (legume trees such as various acacias)	Increase in soil nitrogen levels, pods to feed cattle, cereal yield increase of at least 200 kg/ha, parkland acting as windbreak and lowering soil surface temperature	Carbon captured in tree biomass (between 20 to 100 trees per hectare). EX ACT estimates are calibrated for parkland systems in African drylands.
Hedgerows around horticulture fields	Creation of a cooler micro-climate, protection from heatwaves and sand winds	Lower evapotranspiration of vegetable crops, provision of fodder and pods for small stock	Carbon captured in tree biomass (up to 400 trees in hedgerows per hectare). EX ACT estimates are calibrated for hedgerow systems in African drylands.
Zai planting pits (used in zones receiving between 500 and 800 mm of precipitation annually)	Setting up of 10,000 planting pits per ha, to de-crust soil surface, and addition of compost or manure. 50kg of urea per hectare can be added (micro-dosing in planting pits)	At least 500 kg of cereals per hectare annually. Effective from the first year. This is an average figure across the Sahel. To run EX ACT we took the average biomass for the main cereal crop (grain plus straw), using the figures of the last 3 years in FAOSTAT, to input a tier 2 data in the land use change module.	Slight improvement of soil carbon stock in the mid-term. Not taken into account to run EX ACT because of the uncertainties.
Half Moons in crop land (used in zones receiving between 200 and 500 mm of precipitation annually)	Setting up of 300 half-moons per ha, to de-crust soil surface, and addition of compost or manure. 50kg of urea per hectare can be added (micro-dosing)	At least 500 kg of cereals per hectare annually. Effective from the first year. This is an average figure across the Sahel. To run EX ACT we took the average biomass for the main	Slight improvement of soil carbon stock in the mid-term. Not taken into account to run EX ACT because of the uncertainties.

		cereal crop (grain plus straw), using the figures of the last 3 years in FAOSTAT, to input a tier 2 data in the land use change module.	
Half Moons in pastoral land	De-crusting of the soil surface. Addition of seeds of grass. Planting of a tree behind the half-moon.	At least 300 kg of dry biomass of grass per ha, to feed cattle. Trees can produce useful non-timber products (gum, pods, fruits). To run EX ACT we took country specific data given by the Atlas du Pastoralisme au Sahel (FAO and CIRAD, 2012)	Progressive increase in soil carbon levels and capture of carbon in tree biomass. Soil carbon not estimated in our EX ACT scenario to remain conservative, only grass biomass is taken into account.
Zai forestier	Enrichment of forests by planting seedlings in pits with manure	Increase in soil cover by trees in low density Sahelian dry forests	Progressive increase in above ground carbon stocks in dry forests. EX ACT estimates the impact of shifting from extreme degradation to moderate degradation (forest zone 3)
Banquettes forestières	Planting of seedlings along earth bunds on degraded plateau zones	Increase in soil cover by trees in Sahelian degraded shrubland	Progressive increase in above ground carbon stocks in shrubland. EX ACT estimates the impact of shifting from extreme degradation to moderate degradation (forest zone 4)

Sources: CILSS, various studies and presentations (Etudes Sahel, Second UNCCD Scientific Conference, High Level Forum of the Alliance for Climate Smart Agriculture in West Africa)

The following table indicates the breakdown of these practices by country.

Number of hectares of climate resilient practices by country and by type of practice:

country	Assisted natural regeneration (parkland)	hedgerows	Zai on cropland and half moons	Pastoral half moons	Zai forestier (in forest zone 3, dry tropical forest	Banquettes forestières (forest zone 4, tropical shrubland)
Burkina	10,000	4,000	9,000	15,000	6,000	
Chad	10,000	4,000	8,500	15,000		5,600
Mali	10,000	3,600	8,500	15,000	5,600	
Mauritania	10,000	3,600	8,500	15,000		5,600
Niger	10,000	3,600	9,000	15,000		5,600
Senegal	10,000	3,600	8,500	15,000		6,000
The Gambia	10,000	3,600	8,500	10,000	5,600	

GWP:

As agreed with the GCF, we have used the IPCC AR5 values on GWP, which are the most recent ones, and allow for comparison between countries. They also lead to more conservative figures in terms of carbon sequestration, with lower amounts of CO2e linked to the avoidance of nitrous oxide emissions. The project will promote agro-ecological techniques, through farmer field schools, leading to lower the use of N2O (micro-dosing, compost). Moreover, countries are currently supported by FAO and others to update their GHG inventory and NC using the latest IPCC AR5 values.

Baseline for the EX ACT analysis:

Our assumption is that the hectares of degraded land and of extremely degraded forests will remain degraded land and extremely degraded forests without the project. The baseline is neutral, the level of degradation are the same in the long term. The reason is the very high level of degradation. On degraded land in Sahel countries the level of biomass is around zero on crusted soils.

Degraded land in northern Burkina Faso	Degraded shrubland in southern Niger

Smallholders who are present in these areas face lot of constraints to restore this kind of land by their own means (see barriers in FP p.x):

- Lack of knowledge on the relevant practices, due to the absence of extension services in remote areas
- Lack of income to implement the practices: more than 50% of the farmers of these zones are very poor and poor, with less than 2ha and are suffering from food insecurity with incomes and yields covering only a few months to feed the family
- Low organization at the community level
- Policies and NDCs aiming at promoting these practices at scale only if additional external funding is available

Land degradation trends are often negative in the Sahel. Below is a sample of regions of the Sahel showing neutral or negative trends in terms of land degradation monitored through land cover changes between 1995 and 2015 (average areas of 5000 km2, data generated from www.geofolio.org)

Senegal: Kaffrine Area (Neutral trend)

Table 1. Land Cover Classification

Coverage [%]	Classification	Change
62.2%	Cropland (rainfed)	▲0.0%
19.9%	Herbaceous	▲0.2%
15.8%	Shrubland	▼0.3%
0.7%	Mosaic tree and shrub	▼0.0%
0.6%	Mosaic cropland and natural vegetation	▲0.0%

Note: Only classes with more than 0.5% area are listed in this table to prevent listing classes with very few pixels. Source: ESA Climate Change Initiative. [2]

The Gambia: Upper River Region – Gorowol area: loss of shrubland and cropland expansion on low fertile land

Table 1. Land Cover Classification

Coverage [%]	Classification	Change
48.1%	Cropland (rainfed)	▲7.9%
28.4%	Shrubland	▼13.6%
8.6%	Tree cover, broadleaved, deciduous, open	▲0.7%
6.5%	Mosaic cropland and natural vegetation	▲0.5%
3.3%	Herbaceous	▲3.2%
1.9%	Mosaic natural vegetation	▲0.3%
1.0%	Cropland (irrigated or post-flooding)	▼0.0%
0.8%	Tree cover, broadleaved, deciduous, closed to open	▲0.8%
0.7%	Shrubland deciduous	▼0.1%

Note: Only classes with more than 0.5% area are listed in this table to prevent listing classes with very few pixels. Source: ESA Climate Change Initiative. [2]

Mauritania: Nema area in Hodh el Chargui region: expansion of bareland and loss of grassland

Table 1. Land Cover Classification

Coverage [%]	Classification	Change
34.5%	Grassland	▼16.5%
28.7%	Bare areas	▲10.1%
20.2%	Sparse vegetation (tree, shrub, herbaceous cover)	▲3.0%
9.5%	Sparse herbaceous cover	▲3.2%
3.0%	Shrubland	▼0.0%
1.5%	Cropland (rainfed)	▼0.0%
0.9%	Mosaic herbaceous cover	▲0.1%

Note: Only classes with more than 0.5% area are listed in this table to prevent listing classes with very few pixels. Source: ESA Climate Change Initiative. [2]

Mali: Eastern Mopti: loss of grassland and expansion of cropland on low fertile land

Table 1. Land Cover Classification

Coverage [%]	Classification	Change
55.6%	Grassland	▾7.0%
25.3%	Cropland (rainfed)	▴4.3%
7.5%	Mosaic cropland and natural vegetation	▴0.9%
3.6%	Herbaceous	▴1.7%
3.2%	Mosaic natural vegetation	▾0.1%
1.9%	Shrubland	▾0.0%
1.5%	Mosaic tree and shrub	▴0.1%
1.0%	Cropland (irrigated or post-flooding)	▴0.1%

Note: Only classes with more than 0.5% area are listed in this table to prevent listing classes with very few pixels. Source: ESA Climate Change Initiative. [2]

Burkina Faso: area of Arbinda (Sahel region): expansion of cropland on low fertile lands against grassland

Table 1. Land Cover Classification

Coverage [%]	Classification	Change
76.8%	Grassland	▾4.2%
8.2%	Cropland (rainfed)	▴0.1%
5.3%	Sparse vegetation (tree, shrub, herbaceous cover)	▴2.7%
2.9%	Bare areas	▴1.3%
2.6%	Mosaic natural vegetation	▴0.0%
2.4%	Mosaic cropland and natural vegetation	▾0.0%
0.5%	Herbaceous	▴0.1%

Note: Only classes with more than 0.5% area are listed in this table to prevent listing classes with very few pixels. Source: ESA Climate Change Initiative. [2]

Tchad: area of Moussoro: slight degradation with an increase of bareland against grassland

Table 1. Land Cover Classification

Coverage [%]	Classification	Change
79.7%	Grassland	▾1.3%
14.0%	Sparse herbaceous cover	▴0.0%
2.6%	Sparse vegetation (tree, shrub, herbaceous cover)	▴0.3%
1.6%	Bare areas	▴1.1%
0.8%	Shrubland	▾0.0%
0.6%	Cropland (rainfed)	▾0.0%

Note: Only classes with more than 0.5% area are listed in this table to prevent listing classes with very few pixels. Source: ESA Climate Change Initiative. [2]

Niger: Central Tahoua: increase in bareland area and loss of grassland cover

Table 1. Land Cover Classification

Coverage [%]	Classification	Change
36.0%	Bare areas	▲3.1%
25.3%	Grassland	▼1.4%
21.0%	Sparse vegetation (tree, shrub, herbaceous cover)	▼0.8%
4.7%	Sparse herbaceous cover	▲0.1%
2.9%	Shrubland	▼0.0%
2.4%	Cropland (rainfed)	▲0.0%
2.3%	Mosaic natural vegetation	▲0.0%
2.0%	Mosaic cropland and natural vegetation	▲0.2%
1.5%	Cropland (irrigated or post-flooding)	▲0.2%
1.1%	Mosaic tree and shrub	▼0.0%

Note: Only classes with more than 0.5% area are listed in this table to prevent listing classes with very few pixels. Source: ESA Climate Change Initiative. [2]

Leakage issues:

This project will not lead to leakage issues because additional income will be produced by restored land (cereals, grass to feed cattle) and sustainably managed forests (non-timber forest products). It is very unlikely than the beneficiaries cut or degrade neighbouring residual forests. The additional income expected is a good incentive to avoid leakages and improves their livelihoods.

Monitoring:

IFAD already experimented a monitoring system in Chad, in partnership with ICRAF, to follow up biomass levels through a combination of remote sensing tools (NDVI and SATVI) and observations on the ground in sentinel sites. The methodology is presented in the specific annex provided by ICRAF at the end of this document.

The system developed by ICRAF provides throughout the project lifetime dashboard on a range of indicators agreed with project teams which will include:

- Mapping of project interventions (land restoration, forest areas, farmer field schools, mini-grids)
- Monitoring and mapping of land use changes
- Monitoring and mapping of biomass increases or decreases (for cropland, forests and grassland)
- Monitoring and mapping of carbon stocks, based on NDVI/SATVI and on the ground observations for above ground biomass, litter, below ground biomass, soil carbon, in a network of sentinel sites

The dashboard will include thresholds with an alert system when negative trends should happen.

For this, partnerships will be set up with relevant entities within the countries, such as observatories on environment, academies and public services (services supported by the Agrhymet Centre in Niamey and ICRAF on monitoring systems and geospatial use).

Timeline of carbon sequestration:

The results are currently provided over 20 years with the possibility to estimate amounts for mid-term and project completion. We do not think that it is realistic to provide a table by year regarding carbon sequestration linked to land use. The reason is that the trends cannot be anticipated accurately and will not be linear. Implementation of the activities will depend on the time needed for social studies and dialogues with community members. Clarity on land tenure, collective management of restored land and rules to be applied takes time and depends on the local context. Providing expected figures at mid-term and completion seems more realistic.

	3 yrs	**6 yrs**	**20 yrs**
Senegal	-689 694	-903 449	-2 898 496
Gambia	-948 225	-1 224 704	-3 805 172
Burkina Faso	-962 635	-1 209 094	-3 509 377
Chad	-616 609	-787 717	-2 384 726
Mali	-895 585	-1 124 465	-3 260 678
Mauritania	-596 527	-752 392	-2 207 135
Niger	-611 730	-779 058	-2 340 788
Total	-5 321 005	-6 780 879	**-20 406 372**

Tier 2 conversions: Due to the dry ecosystems and degraded land exhibited in the selected countries, Tier 2 data have been used for a range of biomass or carbon stocks estimates to ensure that results were not overestimated based on the EX-ACT tool tier one data for African drylands. The sources of tier 2 data are described in detail below in table 2.

Table 2: Summary of conversion factors for climate resilient agricultural practices specific to the selected countries.

The Gambia

Program Activity Category	**Sources for EX-ACT Tier 2**
ZAI and half-moons	to crop cereals: 1.35 ton of carbon in first year (2.7 tons of biomass, grain and straw, FAOSTAT average figure for the last 3 years), and 50 kg urea per hectare (microdosing)
Pasture along nomadic routes	at least 1000 kg of dry matter per hectare meaning 500 kg of carbon (FAO, Atlas du pastoralisme au Sahel)
soil carbon under cropland and pasture	25 tons per ha according to FAO Global soil carbon map

Burkina Faso

Program Activity Category	**Sources for EX-ACT Tier 2**
ZAI and half-moons	to crop cereals: 1.425 tons of carbon in first year (2.85 tons of biomass, grains and straw, average FAOSTAT figure for the last 3 years), and 50 kg urea per hectare (microdosing)
Pasture along nomadic routes	at least 450 kg of dry matter per hectare meaning 225 kg of carbon (FAO, Atlas du pastoralisme au Sahel)
soil carbon under cropland and pasture	20 tons per ha according to FAO Global soil carbon map

Chad

Program Activity Category	Sources for EX-ACT Tier 2
ZAI and half-moons	to crop cereals: 0.9 tons of carbon in first year (1.8 tons of biomass, grains and straw, FAOSTAT average figure for the last 3 years), and 50 kg urea per hectare (microdosing)
Pasture along nomadic routes	at least 300 kg of dry matter per hectare meaning 150 kg of carbon (FAO, Atlas du pastoralisme au Sahel)
soil carbon under cropland and pasture	15 tons per ha according to FAO Global soil carbon map

Mali

Program Activity Category	Sources for EX-ACT Tier 2
ZAI and half-moons	to crop cereals: 1.35 ton of carbon in first year (2.7 tons of biomass in first year, grain and straw, FAOSTAT average figure for the 3 last years), and 50 kg urea per hectare
Pasture along nomadic routes	at least 300 kg of dry matter per hectare meaning 150 kg of carbon (FAO, Atlas du pastoralisme au Sahel)
soil carbon under cropland and pasture	20 tons per ha according to FAO Global soil carbon map

Mauritania

Program Activity Category	Sources for EX-ACT Tier 2
ZAI and half-moons	to crop cereals: 1.5 ton of biomass in first year (grains and straw, average FAOSTAT figure for the last 3 years) meaning 0.75 t of carbon, and 50 kg urea per hectare (microdosing)
Pasture along nomadic routes	at least 150 kg of dry matter per hectare meaning 75 kg of carbon (FAO, Atlas du pastoralisme au Sahel)
soil carbon under cropland and pasture	15 tons per ha according to FAO Global soil carbon map

Niger

Program Activity Category	Sources for EX-ACT Tier 2
ZAI and half-moons	to crop cereals: 0.81 ton of carbon in first year (1.62 tons of biomass, grains and straw, in first year, FAOSTAT average figure for the 3 last years), and 50 kg urea per hectare (microdosing)
Pasture along nomadic routes	at least 300 kg of dry matter per hectare meaning 150 kg of carbon (Atlas du pastoralisme au Sahel)

soil carbon under cropland and pasture	15 tons per ha according to FAO Global soil carbon map

Senegal

Program Activity Category	**Sources for EX-ACT Tier 2**
ZAI and half-moons	to crop cereals: 1.05 ton of carbon in first year (2.1 tons of biomass, grains and straw, FAOSTAT average figure for the last 3 years), and 50 kg urea per hectare (microdosing)
Pasture along nomadic rountes	at least 300 kg of dry matter per hectare meaning 150 kg of carbon (Atlas du pastoralisme au Sahel)
soil carbon under cropland and pasture	20 tons per ha according to FAO Global soil carbon map

Results

Utilising the above inputs the EX-ACT tool estimates that through the funding of the previously mentioned climate resilient agricultural techniques the program is estimated to have a mitigation co-benefit of -20 406 372tCO_2eq over the program's capitalisation timeframe. This amount is then going to be added to the total of the mitigation emission (1 264 243 tCO_2eq) from the renewable energy from mini grids for the 7 countries and the breakdown per country is presented below. For more details please refer to the individual country EX-ACT Calculations and Annex on renewable energy calculation.

A breakdown of the tCO^2eq by individual activity is presented below in table 3.

Table 3: Breakdown of estimated mitigation of tCO2eq by individual activity

	Senegal	**Mauritania**	**Gambia**	**Mali**	**Chad**	**Niger**	**Burkina Faso**	**Grand total**
Other LUC	-1 054 041	-616 300	-1 443 267	-1 064 638	-631 927	-631 214	-1 098 295	-6 539 682
Annual Agriculture	-9 183	-9 183	-8 672	-9 183	-9 183	-9 183	-9 183	-63 768
Perennial Agriculture	-1 346 494	-1 144 726	-1 687 714	-1 521 339	-1 306 690	-1 268 146	-1 687 840	-9 962 948
Forest degradation	-568 348	-516 495	-745 089	-745 089	-516 495	-516 495	-798 310	-4 406 322
Inputs & Investments	79 570	79 570	79 570	79 570	79 570	84 250	84 250	566 348
Total per country	-2 898 496	-2 207 135	-3 805 172	-3 260 678	-2 384 726	-2 340 788	-3 509 377	**-20 406 372**

Annex 1

The Gambia

Components of the project	Gross fluxes Without	With	Balance	Share per GHG of the Balance CO_2 Biomass	Soil	Other	N_2O	CH_4	Result per year Without	With	Balance
	All GHG in tCO2eq			All GHG in tCO2eq							
	Positive = source / negative = sink										
Land use changes											
Deforestation	0	0	**0**	**0**	**0**		**0**	**0**	0	0	**0**
Afforestation	0	0	**0**	**0**	**0**		**0**	**0**	0	0	**0**
Other LUC	0	-1 443 267	**-1 443 267**	**-97 662**	**-1 345 605**		**0**	**0**	0	-72 163	**-72 163**
Agriculture											
Annual	0	-8 672	**-8 672**	**0**	**-8 901**		**229**	**0**	0	-434	**-434**
Perennial	0	-1 687 714	**-1 687 714**	**-1 611 418**	**-76 296**		**0**	**0**	0	-84 386	**-84 386**
Rice	0	0	**0**	**0**	**0**		**0**	**0**	0	0	**0**
Grassland & Livestocks											
Grassland	0	0	**0**	**0**	**0**		**0**	**0**	0	0	**0**
Livestocks	0	0	**0**				**0**	**0**	0	0	**0**
Degradation & Management											
Forest degradation	0	-745 089	**-745 089**	**-622 916**	**-122 173**		**0**	**0**	0	-37 254	**-37 254**
Peat extraction	0	0	**0**		**0**		**0**	**0**	0	0	**0**
Drainage organic soil	0	0	**0**		**0**		**0**	**0**	0	0	**0**
Rewetting organic soil	0	0	**0**		**0**		**0**	**0**	0	0	**0**
Fire organic soil	0	0	**0**		**0**			**0**	0	0	**0**
Coastal wetlands	0	0	**0**	**0**	**0**		**0**	**0**	0	0	**0**
Inputs & Investments	0	79 570	**79 570**			**45 760**	**33 809**	**0**	0	3 978	**3 978**
Fishery & Aquaculture	0	0	**0**			**0**	**0**	**0**	0	0	**0**
Total	0	-3 805 172	**-3 805 172**	**-2 331 995**	**-1 552 976**	**45 760**	**34 038**	**0**	0	-190 259	**-190 259**

Mauritania

Components of the project	Gross fluxes Without	With	Balance	Share per GHG of the Balance CO_2 Biomass	Soil	Other	N_2O	CH_4	Result per year Without	With	Balance
	All GHG in tCO2eq			All GHG in tCO2eq							
	Positive = source / negative = sink										
Land use changes											
Deforestation	0	0	**0**	**0**	**0**		**0**	**0**	0	0	**0**
Afforestation	0	0	**0**	**0**	**0**		**0**	**0**	0	0	**0**
Other LUC	0	-616 300	**-616 300**	**-64 753**	**-551 547**		**0**	**0**	0	-30 815	**-30 815**
Agriculture											
Annual	0	-9 183	**-9 183**	**0**	**-9 425**		**242**	**0**	0	-459	**-459**
Perennial	0	-1 144 726	**-1 144 726**	**-1 068 430**	**-76 296**		**0**	**0**	0	-57 236	**-57 236**
Rice	0	0	**0**	**0**	**0**		**0**	**0**	0	0	**0**
Grassland & Livestocks											
Grassland	0	0	**0**	**0**	**0**		**0**	**0**	0	0	**0**
Livestocks	0	0	**0**				**0**	**0**	0	0	**0**
Degradation & Management											
Forest degradation	0	-516 495	**-516 495**	**-408 285**	**-108 211**		**0**	**0**	0	-25 825	**-25 825**
Peat extraction	0	0	**0**		**0**		**0**	**0**	0	0	**0**
Drainage organic soil	0	0	**0**		**0**		**0**	**0**	0	0	**0**
Rewetting organic soil	0	0	**0**		**0**		**0**	**0**	0	0	**0**
Fire organic soil	0	0	**0**		**0**			**0**	0	0	**0**
Coastal wetlands	0	0	**0**	**0**	**0**		**0**	**0**	0	0	**0**
Inputs & Investments	0	79 570	**79 570**			**45 760**	**33 809**	**0**	0	3 978	**3 978**
Fishery & Aquaculture	0	0	**0**			**0**	**0**	**0**	0	0	**0**
Total	0	-2 207 135	**-2 207 135**	**-1 541 468**	**-745 479**	**45 760**	**34 052**	**0**	0	-110 357	**-110 357**

Senegal

Components of the project	Gross fluxes Without	With	Balance	Share per GHG of the Balance CO_2 Biomass	Soil	Other	N_2O	CH_4	Result per year Without	With	Balance
	All GHG in tCO2eq			All GHG in tCO2eq							
	Positive = source / negative = sink										
Land use changes											
Deforestation	0	0	**0**	**0**	**0**		**0**	**0**	0	0	**0**
Afforestation	0	0	**0**	**0**	**0**		**0**	**0**	0	0	**0**
Other LUC	0	-1 054 041	**-1 054 041**	**-76 982**	**-977 059**		**0**	**0**	0	-52 702	**-52 702**
Agriculture											
Annual	0	-9 183	**-9 183**	**0**	**-9 425**		**242**	**0**	0	-459	**-459**
Perennial	0	-1 346 494	**-1 346 494**	**-1 270 198**	**-76 296**		**0**	**0**	0	-67 325	**-67 325**
Rice	0	0	**0**	**0**	**0**		**0**	**0**	0	0	**0**
Grassland & Livestocks											
Grassland	0	0	**0**	**0**	**0**		**0**	**0**	0	0	**0**
Livestocks	0	0	**0**				**0**	**0**	0	0	**0**
Degradation & Management											
Forest degradation	0	-568 348	**-568 348**	**-437 448**	**-130 900**		**0**	**0**	0	-28 417	**-28 417**
Peat extraction	0	0	**0**		**0**		**0**	**0**	0	0	**0**
Drainage organic soil	0	0	**0**		**0**		**0**	**0**	0	0	**0**
Rewetting organic soil	0	0	**0**		**0**		**0**	**0**	0	0	**0**
Fire organic soil	0	0	**0**		**0**			**0**	0	0	**0**
Coastal wetlands	0	0	**0**	**0**	**0**		**0**	**0**	0	0	**0**
Inputs & Investments	0	79 570	**79 570**			**45 760**	**33 809**	**0**	0	3 978	**3 978**
Fishery & Aquaculture	0	0	**0**			**0**	**0**	**0**	0	0	**0**
Total	0	-2 898 496	**-2 898 496**	**-1 784 627**	**-1 193 680**	**45 760**	**34 052**	**0**	0	-144 925	**-144 925**

Mali

Components of the project	Gross fluxes: Without	With	Balance	Share per GHG of the Balance: CO_2 Biomass	CO_2 Soil	Other	N_2O	CH_4	Result per year: Without	With	Balance
	All GHG in tCO2eq; Positive = source / negative = sink			All GHG in tCO2eq							
Land use changes											
Deforestation	0	0	0	0	0		0	0	0	0	0
Afforestation	0	0	0	0	0		0	0	0	0	0
Other LUC	0	-1 064 638	-1 064 638	-87 578	-977 059		0	0	0	-53 232	-53 232
Agriculture											
Annual	0	-9 183	-9 183	0	-9 425		242	0	0	-459	-459
Perennial	0	-1 521 339	-1 521 339	-1 445 043	-76 296		0	0	0	-76 067	-76 067
Rice	0	0	0	0	0		0	0	0	0	0
Grassland & Livestocks											
Grassland	0	0	0	0	0		0	0	0	0	0
Livestocks	0	0	0				0	0	0	0	0
Degradation & Management											
Forest degradation	0	-745 089	-745 089	-622 916	-122 173		0	0	0	-37 254	-37 254
Peat extraction	0	0	0		0		0	0	0	0	0
Drainage organic soil	0	0	0		0		0	0	0	0	0
Rewetting organic soil	0	0	0		0		0	0	0	0	0
Fire organic soil	0	0	0		0			0	0	0	0
Coastal wetlands	0	0	0	0	0		0	0	0	0	0
Inputs & Investments	0	79 570	79 570			45 760	33 809	0	0	3 978	3 978
Fishery & Aquaculture	0	0	0			0	0	0	0	0	0
Total	0	-3 260 678	-3 260 678	-2 155 536	-1 184 954	45 760	34 052	0	0	-163 034	-163 034

Chad

Components of the project	Gross fluxes: Without	With	Balance	Share per GHG of the Balance: CO_2 Biomass	CO_2 Soil	Other	N_2O	CH_4	Result per year: Without	With	Balance
	All GHG in tCO2eq; Positive = source / negative = sink			All GHG in tCO2eq							
Land use changes											
Deforestation	0	0	0	0	0		0	0	0	0	0
Afforestation	0	0	0	0	0		0	0	0	0	0
Other LUC	0	-631 927	-631 927	-74 433	-557 494		0	0	0	-31 596	-31 596
Agriculture											
Annual	0	-9 183	-9 183	0	-9 425		242	0	0	-459	-459
Perennial	0	-1 306 690	-1 306 690	-1 228 150	-78 540		0	0	0	-65 335	-65 335
Rice	0	0	0	0	0		0	0	0	0	0
Grassland & Livestocks											
Grassland	0	0	0	0	0		0	0	0	0	0
Livestocks	0	0	0				0	0	0	0	0
Degradation & Management											
Forest degradation	0	-516 495	-516 495	-408 285	-108 211		0	0	0	-25 825	-25 825
Peat extraction	0	0	0		0		0	0	0	0	0
Drainage organic soil	0	0	0		0		0	0	0	0	0
Rewetting organic soil	0	0	0		0		0	0	0	0	0
Fire organic soil	0	0	0		0			0	0	0	0
Coastal wetlands	0	0	0	0	0		0	0	0	0	0
Inputs & Investments	0	79 570	79 570			45 760	33 809	0	0	3 978	3 978
Fishery & Aquaculture	0	0	0			0	0	0	0	0	0
Total	0	-2 384 726	-2 384 726	-1 710 868	-753 669	45 760	34 052	0	0	-119 236	-119 236

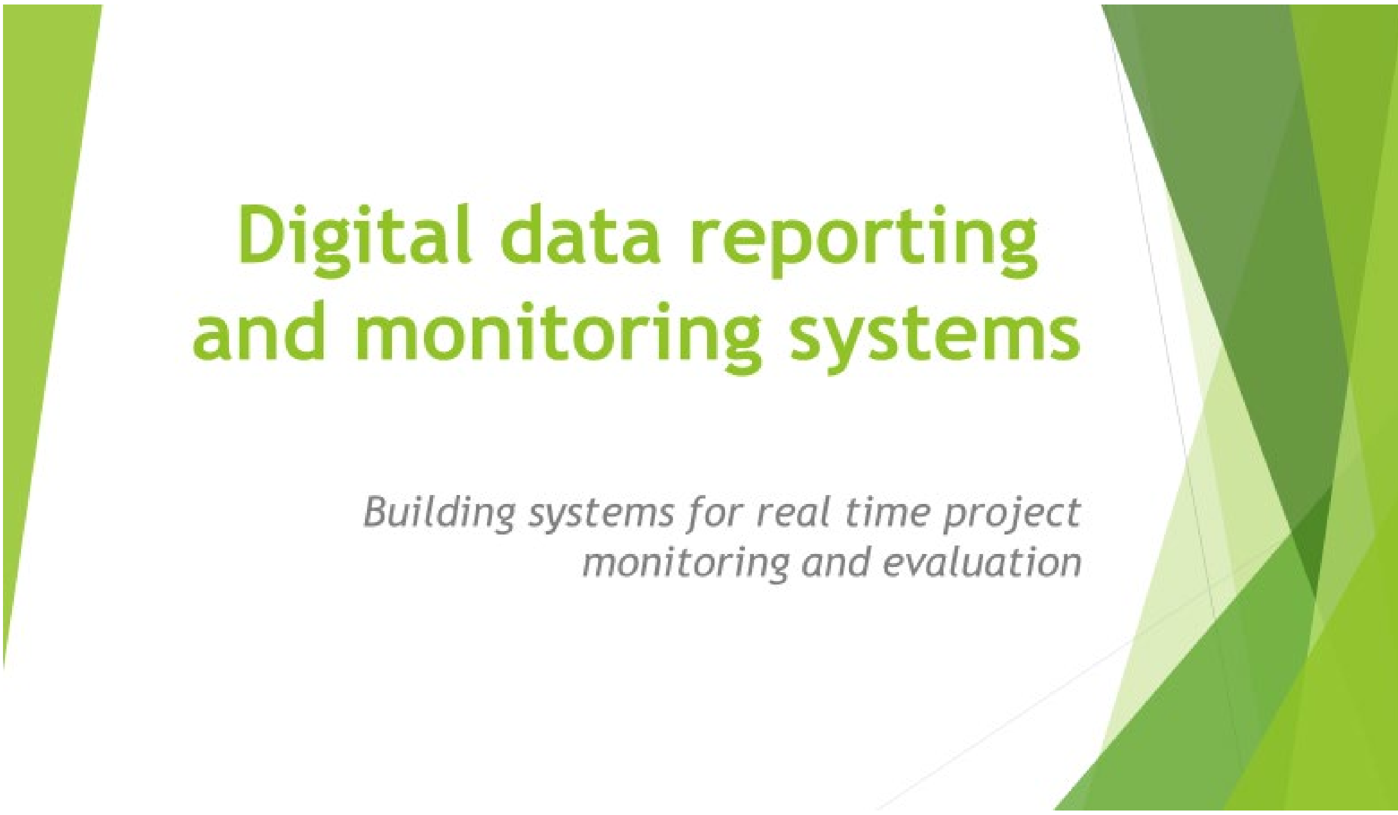
Niger

Components of the project	Gross fluxes: Without	With	Balance	Share per GHG of the Balance: CO_2 Biomass	CO_2 Soil	Other	N_2O	CH_4	Result per year: Without	With	Balance
	All GHG in tCO2eq; Positive = source / negative = sink			All GHG in tCO2eq							
Land use changes											
Deforestation	0	0	0	0	0		0	0	0	0	0
Afforestation	0	0	0	0	0		0	0	0	0	0
Other LUC	0	-631 214	-631 214	-72 233	-558 980		0	0	0	-31 561	-31 561
Agriculture											
Annual	0	-9 183	-9 183	0	-9 425		242	0	0	-459	-459
Perennial	0	-1 268 146	-1 268 146	-1 191 850	-76 296		0	0	0	-63 407	-63 407
Rice	0	0	0	0	0		0	0	0	0	0
Grassland & Livestocks											
Grassland	0	0	0	0	0		0	0	0	0	0
Livestocks	0	0	0				0	0	0	0	0
Degradation & Management											
Forest degradation	0	-516 495	-516 495	-408 285	-108 211		0	0	0	-25 825	-25 825
Peat extraction	0	0	0		0		0	0	0	0	0
Drainage organic soil	0	0	0		0		0	0	0	0	0
Rewetting organic soil	0	0	0		0		0	0	0	0	0
Fire organic soil	0	0	0		0			0	0	0	0
Coastal wetlands	0	0	0	0	0		0	0	0	0	0
Inputs & Investments	0	84 250	84 250			48 452	35 798	0	0	4 213	4 213
Fishery & Aquaculture	0	0	0			0	0	0	0	0	0
Total	0	-2 340 788	-2 340 788	-1 672 368	-752 912	48 452	36 040	0	0	-117 039	-117 039

Burkina Faso

Components of the project	Gross fluxes Without	 With	 Balance	Share per GHG of the Balance All GHG in tCO2eq CO_2 Biomass	 Soil	 Other	 N_2O	 CH_4	Result per year Without	 With	 Balance
	All GHG in tCO2eq Positive = source / negative = sink										
Land use changes											
Deforestation	0	0	**0**	**0**	**0**		**0**	**0**	0	0	**0**
Afforestation	0	0	**0**	**0**	**0**		**0**	**0**	0	0	**0**
Other LUC	0	-1 098 295	**-1 098 295**	**-97 533**	**-1 000 762**		**0**	**0**	0	-54 915	**-54 915**
Agriculture											
Annual	0	-9 183	**-9 183**	**0**	**-9 425**		**242**	**0**	0	-459	**-459**
Perennial	0	-1 687 840	**-1 687 840**	**-1 609 300**	**-78 540**		**0**	**0**	0	-84 392	**-84 392**
Rice	0	0	**0**	**0**	**0**		**0**	**0**	0	0	**0**
Grassland & Livestocks											
Grassland	0	0	**0**	**0**	**0**		**0**	**0**	0	0	**0**
Livestocks	0	0	**0**				**0**	**0**	0	0	**0**
Degradation & Management											
Forest degradation	0	-798 310	**-798 310**	**-667 410**	**-130 900**		**0**	**0**	0	-39 915	**-39 915**
Peat extraction	0	0	**0**		**0**		**0**	**0**	0	0	**0**
Drainage organic soil	0	0	**0**		**0**		**0**	**0**	0	0	**0**
Rewetting organic soil	0	0	**0**		**0**		**0**	**0**	0	0	**0**
Fire organic soil	0	0	**0**	**0**				**0**	0	0	**0**
Coastal wetlands	0	0	**0**	**0**	**0**		**0**	**0**	0	0	**0**
Inputs & Investments	0	84 250	**84 250**			**48 452**	**35 798**	**0**	0	4 213	**4 213**
Fishery & Aquaculture	0	0	**0**			**0**	**0**	**0**	0	0	**0**
Total	0	-3 509 377	**-3 509 377**	**-2 374 243**	**-1 219 626**	**48 452**	**36 040**	**0**	0	-175 469	**-175 469**

<u>Annex on digital data reporting and monitoring systems for the GCF Africa Integrated Climate Risk Management Programme</u>



Contents

Introduction and context

For many development organizations, front and back office project integration systems will prove to be a dominant strategic issue for many years to come. Some institutions are already feeling the pressure to improve the monitoring and evaluation processes as well as the reporting systems of their projects. Integrating projects means that organizations need to take a portfolio approach to management of projects and that means consolidating performance reporting, to streamline the process and minimize the time commitment for management oversight. Two significant components of project integration lie in the areas of project management collaboration and project management metrics and reporting, both across projects and upward/downward from project managers to implementing partners. It seems to many organizations that all that is preventing the next sea change in project performance, is simply a concise and timely method for monitoring project progress and sharing project and portfolio metrics, without the need to congregate project teams in the same room, or to schedule executives and project managers to meet, either around a video conference or the same conference table.

Project partners are becoming more inquisitive about the way data are been collected and reported, and there is a need to modernize the way project information is collected, organized, disseminated and used in day-to-day project management. There are more and more largescale and multiparters projects that are facing the challenging of real time reporting. The managers of such projects will like to be able to have systematic oversight of the project implementation and measure progress toward meeting the targeted objectives. The concept of utilizing "digital data reporting and monitoring systems" as a tool for reporting performance metrics and collaborating on project decision making, has begun to attract more attention nowadays. Additionally, project planning and management, which includes comprehensive planning and control for all of project phases, could be assisted with the use of Digital data reporting and monitoring systems (DRMS) that combine digital dashboards and geoportals.

Digital data reporting and monitoring systems are based on the metaphor of an automobile instrument panel and are a new project management tool that can be used to get a bird's eye view of a projects health and performance. They are simple and powerful data-driven software solutions that are used to visually ascertain the status and key performance indicators of a project, or a portfolio of projects. DRMS provide digital at-a-glance displays of critical data pulled from different databases to provide warnings, action notices, and summaries of project conditions.

DRMS can be set up to track the information flows inherent in projects that they monitor. Graphically, users can monitor high level processes and if necessary, drill down into low level data. The success of DRMS depends mostly on the proper selection of project metrics (key performance indicators) to monitor. In the past, this information was typically unavailable to senior managers, outside of attending a slide presentation, thumbing through massive activity and financial reports, or scrolling endlessly through screen-formatted reports. The benefits of DRMS are numerous for project teams and partners at various level. The key is to have all activities contributing to the overall project success be connected so that all project functions can be monitored, and management is able to access the progress of each activity et will. This is a type of executive information system that allows managers to gauge how well the project is performing. It allows the organization to capture and report specific data points from each activity within the project so as to provide a "snapshot "of performance. Managers can see key changes in their operations almost immediately and can take quick corrective action.

Digital data reporting and monitoring systems in the context of the Sahel AICRM

Digital data reporting and monitoring systems (DRMS) will be repositories designed and developed to collect, consolidate treat, analyze and visualize data collected within the frame of project implementation. Depending on project objectives and specificities, DRMS will have the potential to 1) enable data entry for regulated entities/projects/institutions, 2) review data, consolidate and analyze for categories of stakeholders based on interests, 3) increase data accuracy, completeness, and consistency, 4) centralize data collection, facilitate interaction between partners, regulate entities and verifiers, as well as efficient communication with key stakeholders, 5) track time series of project milestones and measure progress against targets and strategies, 6) visualize and share spatial outputs at various levels through dashboards and geoportals

The system will help project and partners demonstrate achievements, compliance, leadership, and transparency to shareholders and the public, as well as publicly track information such as emission reductions and carbon stocks. The systems will also be effective for government to advance to a paperless form of collecting emissions information, and secures more accurate, consistent data in a centralized repository. Project stakeholders will have access to data more easily so they can make informed decisions about the projects and implementation partners. By disseminating information that is easily understood, these systems will contribute to empowering project partners and beneficiaries to function as informal evaluators and promote accountability to those being evaluated.

3. Key considerations in designing and implementing digital data reporting and monitoring systems

Putting in place a DRMS require the consideration of non-technology-related activities that underpin the development and implementation of an effective DRMS. There will be a need to define the legal and regulatory framework for DRMS and establish the institutional framework for systems to provide proper governance and oversight. This will support effective communication among partners, ensure accountability and support system development, maintenance, and use, and data verification. Ensuring that the roles and responsibilities of each institution are clearly defined is essential in the instance of multiparters project. One other consideration is the stakeholder engagement and consultation. The system put lots of emphasizes on the value of early and continued engagement with stakeholders, particularly reporters in each country. Stakeholder engagements are expected to improve system design and yield multiple benefits, including facilitating the development of a system that addresses national priorities and circumstances; obtaining early buy-in from and engagement with key user groups, such as reporters and verifiers; building capacity and improving preparedness within key user groups, ensuring fewer errors when data is entered into the system; and raising and maintaining public support. Engaging stakeholders is also expected to gauge the system-specific needs and to solicit feedback on system functional components, provide user-specific feedback that can help to refine the system, and build familiarity with the system so that—once the system is operational—users submit higher-quality data. The third consideration is the capacity building at various level to ensure that the system is used effectively and reduces user errors. Providing support to and building the capacity of DRMS users are key to ensuring smooth reporting cycles and accurate data input. Available resources, reporting timeliness, and accuracy requirements are important considerations when determining the appropriate type and level of support and training activities. Options for user support include a help desk, dedicated telephone line or email address, and/or website; training options include user guides, frequently asked questions documents, in-person trainings, and webinars. Verifiers should also be trained in order to increase their understanding of how the system works and support the verification process.

4. The legal and regulatory frameworks that determine DRMS

The legal and regulatory frameworks will help frame the design and development of the DRMS.

The primary and enabling legislation, will broadly address overall intent, quality control (QC) and quality assurance (QA) (i.e., internal checks, audit requirements and verification approaches), data use, transparency, and disclosure (i.e., how will the data be used and who will access which information), data sensitivity and confidentiality, and the significance or value of reported data (which will be dependent on the policy objectives of a program). These dictate key program design decisions that need to be considered in data system design. The legal and regulatory frameworks will also address specific roles and responsibilities/authorities of programs and regulations; however, the primary purpose of the regulation is to set standards for how to implement a data reporting program, and outline the specific monitoring, reporting, and verification protocols to be followed.

Since a DRMS is an actualization of the project reporting guidance, establishing clear parameters, indicators, rules/guidelines, and processes that the system will support is an essential first step.

Design elements and decision points include:

- Defining coverage in terms of applicable entities and emissions sources and GHGs (who reports which emissions).

- Providing calculation methodologies for different emissions sources and data monitoring requirements (how to calculate and measure emissions).
- Determining reporting requirements and schedules (what to report and how often).
- Developing reporting platforms and data disclosure rules (where to report and who has access to reported information).
- Deciding on verification procedures for QA and control (who verifies what and how).
- Establishing enforcement rules (what measures to apply in case of noncompliance).
- Determining which, if any, documents and reports are public and if this decision is made by the program or by the reporter.

Solidifying key decisions as part of the legal and regulatory frameworks for the DRMS in advance of developing a data system is critical in terms of efficiency and outcomes. The design of various functional components of the tracking system (e.g., online calculations, QA and QC measures, public reporting) are directly related to the reporting and verification guidance of the program that the system is being designed to support. When developing the regulatory guidance and protocols for the DRMS, the following decision points will shape key inputs into the system design and development process:

- Program coverage and scope: What sectors are covered under the program in each country and are there specified reporting or program inclusion thresholds.
- Level of reporting: Is data reported at the project level or country levels?
- Data types and formats: What types of data are required to be collected? What are the methods and tools for data collection? What units of measure and conversion factors are required?
- Calculation methodologies: What methodologies are required, and which emission factors (e.g., Intergovernmental Panel on Climate Change (IPCC) default emissions factors or country-specific), carbon contents of fuel and raw materials, and global warming potentials (GWPs) are specified?
- Data accuracy: How accurate does the data need to meet the project objective? What verification and QA/QC approaches are required to ensure the level of accuracy?
- Consistency: Are consistent carbon stocks or GHG calculation methodologies required?

- Multiple objectives/adaptability: Do multiple policy objectives need to be met through one program, and are there different data collection requirements to meet these different objectives?
- Frequency: At what frequency does data need to be provided to meet the stated policy objective(s) (e.g., quarterly, annually)?
- Access: Which users may need access to what data?
- Confidentiality: Is there any information being collected that should be kept confidential? What is the level of public access to data being collected?
- Security: how to ensure the security of the data collected?
- Flexibility: Are changes in policies or regulations expected?

5. Establishing the Institutional Framework and clearly defined institutional roles and responsibilities

Prior to its implementation, the project will 1) assess the capacity of existing institutions (including related data systems) and the legal framework they support. These institutions could include agencies that are currently collecting information on non-GHG air pollutants, compiling GHG national inventories, or administering existing voluntary GHG reporting programs at the national and subnational levels; 2) evaluate which established legal and institutional frameworks could align and, where possible, seek to leverage technical capacity, expertise, and available resources and 3) establish the roles and responsibilities of all relevant institutions, if shared ownership is possible. Clearly defining the roles and responsibilities of each institution will be critical. Establishing a framework for DRMS governance and oversight will support effective communication, ensure accountability and support system development, maintenance, and use.

6. Collaboration with existing data management system

For the Sahel XX project, the project will explore in each participating country the existing data collection mechanisms in place to support various policies. Some of these systems may have been put in place by the government to have oversight of various environmental problems (e.g. pollution control, energy systems, GHG emission) reporting programs and systems, and therefore could give opportunity for synergies. Collaboration between government ministries, pollution control, energy and climate/carbon departments or agencies will be beneficial for the implementation of the DRMS, given the increasing imperative to collect corporate/facility-level data and the potential opportunity to leverage existing expertise and infrastructure—it is not always necessary to "reinvent the wheel."

Existing data collection systems and databases within the climate and environment arena in the participating counties may include 1) non-GHG/criteria air pollutant databases collected on non-GHG or criteria air pollutants (such as PM, ground-level ozone, carbon monoxide, sulfur oxides, nitrogen oxides, and lead) because they are regulated under air quality standards; 2) energy databases collected on energy production and consumption data in centralized databases, 3) data management systems and registries related to GHG policies that support a range of GHG policies and actions, such as national GHG inventories under the UNFCCC, the Nationally Appropriate Mitigation Actions (NAMA) Registry operated by the UNFCCC Secretariat for developing countries to register domestic actions to reduce GHG emissions, or carbon asset registries supporting market-based mechanisms.

7. Key steps for the development and implementation of the DRMR

The development and the implementation of the DRMS is made up of key 8 interconnected steps to ensure its proper functionalities and efficiency. The key steps that illustrate the main decision points are: Step 1: Gathering and analyzing system requirements; Step 2: Developing functional requirements; Step 3: Deciding on in-house development or outsourcing; Step 4: Developing technical requirements; Step 5: Developing the software; Step 6: Integrating the system; Step 7: Testing and QA and Step 8: Deploying and launching the system. A brief description of each step is presented below.

7.1 Step 1: Gathering and Analyzing System Requirements

Before initiating software development, it is important to understand and clearly articulate what is being built, and to ensure that the system supports and is aligned with the objectives of the project. Gathering and analyzing system requirements is a critical first step in this process. Considerations in the requirements gathering process may include:

- Analyzing relevant regulation(s) and legislation that will inform the system's functionality, and the applicability of those to various types of users.
- Consideration of anticipated regulatory changes that could impact the program: To ensure the system and requirements documents are as responsive as possible to the evolving regulatory environment, it is important to include information on potential changes, such as changing thresholds, additional sectors, additional gases, etc.
- Future linkages with other jurisdictions: Future linkages can be enabled by aligning GHG reporting program design decisions, e.g., sector definitions; reporting thresholds; level of reporting (facility- or source-level); similar data types and formats (UOMs), metrics, conversion factors; calculation methodologies, including values for default emission factors[5] and GWPs; and, common standards for verification. These considerations can then feed into the requirements for the DRMS.
- Gathering input from relevant stakeholders: Surveying potential users of the system (e.g., regulators, reporters, verification bodies) on their needs and challenges can provide key inputs into system design.
- Research and analysis of similar systems: Analyzing similar systems can yield valuable information on a range of best practices and lessons learned from those with experience in DRMS.
- Assessing existing data systems for re-purposing: In some instances, it may be possible to leverage or re-purpose existing data management systems when building a new system. This may have several benefits, including lowering costs related to software development and licensing, potentially increasing speed to market, leveraging in-house capacity, and reducing the need for capacity-building among reporters (if they are already familiar with the system).
- Assessing data exchange and integration needs: In some cases, it may be desirable to build a data management system that can exchange data with another system, such as a non-GHG pollutant system or an energy management or fuel tracking system, which may already contain much of the data needed to produce GHG emissions inventories. DRMS will be built to allow for the automated exchange of data from these existing data sets via interchanges such as application programming interfaces (APIs), XML feeds, or other web services. In order for this exchange to be successful, it needs to be

well defined from the outset. Failure to plan and define data exchanges may result in data appearing in the wrong field, data failing to reach the destination database, or a host of other data errors.

- Prototyping: Prototyping is the process of developing and testing initial screen shots, system appearance, user experience, or functionality with stakeholders to further refine the system requirements. Ideally, there will be several iterations of early prototyping and user feedback to inform subsequent decisions on the system's functional requirements.

7.2 Step 2: Developing Functional Requirements

Once system requirements are gathered and analyzed, detailed functional requirements can be developed. Defining the functional requirements of the DRMS in advance of development will yield a number of benefits, including: 1) helping to inform the "build" or "buy" decision on the development of the system, 2) reducing implementation risks. 3) lowering development costs, leading to the delivery of an end product that matches policy, user, and other requirements.

7.3 Step 3: Making the Decision on the type of system to be developed

The type of system to be put in place depends on the project objectives, the activities, the data generated, the reporting system envisaged and the frequency and the level of reporting. The system could be incorporated in the project monitoring and evaluation or built as a stand-alone system.

7.4 Step 4: Developing Technical Requirements

The technical requirements document/s will provide system developers guidance on system performance, architecture, hardware, software, security, and hosting. Technical requirements can also clarify processes related to software development, integration, testing, and deployment.

7.5 Step 5: Developing the Software

While the functional requirements define what the software must do, software development itself

is a process comprised of several key steps. These include configuring an appropriate development

environment for the development team, developing a clear database architecture for the system, adhering to best practices to coding/programming the system, and developing the front end of the system to be consistent with the programs brand/style requirements.

7.6 Step 6: Integrating the System

System integration is the process of bringing together the various functional, user interface, and data components into one cohesive system. The technical requirements may include a concise written plan that defines how code produced by multiple developers will be integrated in the evolving system, taking into consideration version control management with source control software, frequency of internal releases where code is compiled and "pushed" to the test server should also be defined. it is important to commit to a release schedule in order to stay on time and on budget.

7.7 Step 7: Testing

The test of every scenario for each functional component on every major OS and every major browser version are critical to ensuring a functional system. Conducting testing throughout development minimizes the risk of error and to flag issues early on so that they can be addressed during development. Testing is the key to a smooth deployment, and that allowing adequate time for testing and subsequent redesign and fixes makes for a more successful release. The testing system tool will list all possible use-variations of a given function across different operating systems and browsers. Each of these variations is called a "test case." The testing system tool includes manual test cases, to be carried out on a case-by-case basis by individual testers; as well as automated testing via scripts written by testing engineers, which can automatically and quickly conduct many test cases. testing system tool can be managed via spreadsheets or off-the-shelf test suite management applications.

7.8 Step 8: Deploying and Launching the System

Once the hosting provider is selected, production servers can be configured with the relevant

software stack (e.g., OS, database [DB], web). This is typically undertaken several weeks before

actual deployment to ensure that everything is working before the system itself is deployed. Actual

deployment consists of copying compiled files to the production server and installing the database.

A first-time install is often completed with a database back-up and restore. For subsequent releases, changes must be scripted using tools such as SQL Delta, which compare source and destination databases. Optimizing the release and deployment process based on lessons learned from the first deployment and documenting and automating the process where possible will help make the process more efficient, build institutional capacity and to remove the risk of human error.

8. Providing support to and building the capacity of DRMS users

Providing support to and building the capacity of DRMS users are key to ensuring smooth reporting cycles and accurate data input. Available resources, reporting timeliness, and accuracy requirements are important considerations when determining the appropriate type and level of support and training activities.

8.1 User Support

Access to customer support for the DRMS is crucial for the primary users: reporters and verifiers. Support for verifiers and reporters could include addressing both system and policy questions. Common questions from reporters include:

- Do I have to report? If yes, what do I have to report?
- How do I correct a mistake within the system?

- How do I change the user who must input the data?
- How do I reset my password?

Other questions about data requirements and/or how to interpret the program requirements, such as: 1) I understand that I need to report this piece of data, but I don't understand how to report it within the system, 2) my reported values are now under the threshold that is required for reporting. How can I disengage from the system? There are a number of mechanisms for addressing user questions and supporting their needs. Considerations for determining the type of support include the (a) complexity of regulations, (b) complexity of the DRMS, and (c) the available resources.

8.2 Help Desk

A help desk system will be provided to support the system users' needs. It provides a central location for user inquiries, if necessary, can re-route the request to an appropriate point of contact. This type of dedicated support system is especially helpful for new or large programs, allowing for timely support, more in-depth discussion on user questions, and ongoing education.

8.3 Telephone and Email

Telephone, email, notifications, and online chat/secure messaging systems will also be utilized to address user questions and to disseminate important system-related communications. For example:

- A dedicated telephone number could be established and promoted, which could be accessed by staff who would then connect the user with the appropriate point of contact.
- A dedicated email address can be set up to which users can send questions. Emails can also be sent from the address to notify users of relevant news, such as the launch of a reporting cycle or system updates. An important consideration is whether resources are available to respond to email queries in a timely manner and setting an expectation among users accordingly.

If needed, customer service could be provided through a combination of telephone support (via a call center), email and an instant message system within the DRMS.

8.4 Website

The DRMS website can be an effective way to engage with users and communicate updates and new features, information, and help services. Updates can also be linked to an RSS feed, allowing users to have the updates pushed to them. The website can include instructions to guide users

through the registration and reporting process; guidance documents that support these processes, such as frequently asked questions (FAQs); training materials (including pre-recorded webinars); and relevant contact details if they require additional information. The website could be used extensively as a central repository for all information relating to the reporting program and DRMS

8.5 Training and capacity building for DRMS users

The development of guidelines and training materials for users is an important component of managing a successfully used of DRMS. The level of training required will likely be dictated by how familiar the users are with the system. Activities and materials may include:

- FAQs documents.
- System user guides/manuals by user type, with step-by-step instructions and associated screen shots.
- Tool tips and other in-application instructions.
- Training materials and sessions, which may include live or pre-recorded webinars, in-person sessions, and videos.

9. Tools and data collection approaches

9.1 Data collection

DRMS has an in build systematic data collection approaches and tools that facilitate field data collection and uploading into the system. Systematic approaches are able to collect real time data and information from the field with minimum bias and the process of uploading is also straightforward. Data related to changes in landscapes are best collected using systematic approaches in such a way that it is possible to establish long-term and rigorous monitoring systems to monitor the status of natural resources in the landscape such as the change in land use/land cover. The ground-based methods are complemented with the use of remote sensing data to establish for instance relationships between aboveground vegetation and soil health. Remote sensing, in addition to assessing spatial data, allow for the establishment of monitoring systems at larger spatial scales.

9.2 Sample data to be collected under the XXX Sahel project

GHG emissions data

DRMS used data collection and reporting are foundational to a wide variety of GHG policies, and

allow regulators and policy makers to meet or analyze progress toward stated policy objectives. Policy objectives may include improving national GHG inventories, emissions trading systems, carbon taxes, crediting approaches; energy and energy efficiency initiatives, energy consumption taxes, energy balance, emissions standards, carbon targets or commitments (e.g., NAMAs), and national and regional analyses.

Ex-Ante Carbon-balance Tool (EX-ACT)

The DRMS will support the implementation of EX-ACT by facilitating data collection for the various phases of its implementation. Whether data for parameterization/calibration or for running calculation, DRMS will upload the spreadsheet of each project or country to facilitate monitoring and reporting at various levels. An integrated DRMS and EX-ACT will strengthen the land-based accounting system that summarize all the data (tier 1 and tier 2) related to the estimated values of the five carbon pools: above ground biomass, below ground biomass, dead wood, litter and soil organic carbon, as well as estimated coefficients of CH_4, N_2O and selected other CO_2 emissions. Then the derived values of carbon stocks, stock changes as well as CH_4, N_2O and CO_2 emissions, which are the basis of the overall carbon-balance will be projected through digital dashboard.

Electrification and renewable energy in rural communities

Digital dashboard will also be created for each country to capture the net amount of renewable electricity delivered to each consumer connected to the project renewable electricity generation system(s). Data will be collected and uploaded on the monthly basis. Alternatively, the net amount of renewable electricity delivered to all the consumers connected to the project renewable electricity generation system(s) could be calculated and used for analyses. For solar photovoltaic electricity systems, the annual average value for availability will be obtained by assuming a conservative default value of twelve per cent for the annual average value for availability, or by calculating the annual average value for availability based on local site conditions and system characteristics. In the case where there are multiple electricity generation systems with different characteristics, the data collection, and the calculation will be done separately for each system and the weighted average value will be taken. In this case, sub system dashboards will be created for the various systems then the weighted average will be visualized in the country dashboard.

10. Linking the various dashboard with the project geoportal

The project will also collect a range of spatial data that need to be analyzed and visualized for the benefits of the stakeholders. A geoportal will be created to establish the link between the spatial data and the various project databases in such a way that there is interaction between the various component of the project. The objectives of the geoportal are to 1) establish regional spatial data infrastructure that provides and integrates geographically-referenced data generated by project activities, various stakeholders, government agencies/offices, and the universities; 2) provide a customer-friendly portal 24/7 web/online access to spatial data; and 3) provide an ICT platform for collaboration, data and resource sharing, integration, transparency and resource optimization. The project geoportal will above all be a spatial database management system capable of managing localized data, and therefore capable of entering, storing and extracting, querying analyzing them, and finally visualize them in form of maps for interest of various users.