Project Title:	Strengthening Land Degradation Neutrality data and decision-making through free and open access platforms		
Country(ies):	Global	GEF Project ID:	
GEF Agency(ies):	CI (select)	GEF Agency Project ID:	
Project Executing Entity(s):	Moore Center for Science at	Submission Date:	05/22/2019
GEF Focal Area (s):	Land Degradation	Expected Implementation Start	09/01/2019
		Expected Completion Date	02/28/2022
Type of Report(s):	(select) (select)	Expected Report Submission to Convention	(date)

Project Objective: To provide improved methods and tools for assessing land degradation and understanding the socio-economic conditions of vulnerable communities in affected areas through the integration of free and open platforms to support country level implementation and reporting to the UNCCD

Project Component	Project Outcomes	Project Outputs		
1.Improvement of land degradation biophysical indicators to support monitoring towards land degradation neutrality	1.1. High spatial resolution (10-30m) datasets available through Trends.Earth	1.1.1. Remotely sensed data and algorithms for assessing changes in primary productivity at high spatial resolution (10-30 m) available through Trends.Earth. 1.1.2. Global land cover products at high spatial resolution (10-30 m) available through Trends.Earth. 1.1.3. Soil Organic Carbon (SOC) degradation indicator at high spatial resolution (10-30m) available through Trends.Earth. 1.1.4. Updated documentation and step by step guidelines for using high spatial resolution indicators (10-30 m) available through project website.		
2. Understanding the socio-environmental interactions between drought, land degradation, and poverty to support	2.1. Improved understanding of the interactions between land degradation, drought, and socioeconomic factors	2.1.1. Evaluation of approaches for assessing socio economic vulnerability to drought and interplay with land degradation.		

development of monitoring frameworks for UNCCD strategic objectives 2 and 3.	as they contribute to the development of vulnerable communities.	2.1.2. Global drought and early warning datasets added to Trends.Earth for supporting analysis and visualization of analytical results. 2.1.3. Global socioeconomic datasets to support UNCCD Strategic Objective (SO) 2 added to Trends.Earth for supporting analysis and visualization of analytical results 2.1.4. Case study performed in a pilot country. 2.1.5. Documentation and step by step guidelines for using climate, and socioeconomic variables available through project website.		
3. Support planning and monitoring of land degradation neutrality (LDN) priorities from field to national scales	3.1. Approaches to support monitoring of LDN target progress integrating field data collection and remote sensing data at multiple scales developed	3.1.1. LandPKS mobile platform with functionalities to retrieve degradation assessment from Trends.Earth and collect field data on land condition to contextualize remote sensing analysis. 3.1.2. LandPKS mobile platform with functionalities to collect and distribute data on sustainable land management practices harmonized with simplified version of WOCAT SLM database. 3.1.3. Integrated workflows for assessing changes in land condition combining Trends.Earth indicators with other monitoring tools, such as Collect Earth developed. 3.1.4. Documentation and guidelines for performing integrated assessments of land condition at national and subnational scales using WOCAT, LandPKS, Trends.Earth, Collect Earth and other tools available through project website.		
	3.2. Decision support tool for identifying LDN priorities implemented into Trends.Earth	3.2.1. New version of Trends.Earth optimized for Quantum GIS software version 3 3.2.2. LDN priority setting decision support functionalities based on multi-criteria evaluation of geospatial data, field data and participatory		

	3.3. Pilot testing and capacity building completed	assessments at national level available through Trends.Earth 3.2.3. Documentation and step by step guidelines for performing prioritization of LDN activities available through project website. 3.3.1. Degradation assessment for different geographies within the pilot country using improved biophysical indicators. 3.3.2. Pilot testing of mobile platform and WOCAT integration for verifying biophysical degradation indicators and collection of land management information. 3.3.3. LDN prioritization analysis using decision support tool and participatory process with local stakeholders. 3.3.4. A capacity building workshop targeting 30 participants from key user groups (15 male and 15 female).		
4. Support the UNCCD and its signatory countries by building capacity on planning, monitoring, and reporting of LDN	4.1. Online and in-person capacity building on planning, monitoring, and reporting of LDN in support UNCCD 2021-2022 reporting cycle completed	4.1.1. Online modular training approach with videos and written materials available in three languages. 4.1.2. Implementation of a community of users' platform to mainstream and facilitate trouble shooting and sharing of experiences and continued learning. 4.1.3. Capacity building workshop on tools for supporting UNCCD 2021-2022 reporting cycle.		

PART II: ENABLING ACTIVITY JUSTIFICATION

A. ENABLING ACTIVITY BACKGROUND AND CONTEXT (Provide brief information about projects implemented since a country became party to the convention and results achieved):

A.1. Enabling Activity Context

Land degradation – the reduction or loss of the productive potential of land – is a global challenge. Over 20% of the Earth's vegetated surface is estimated to be degraded, affecting over 1.3 billion people[1], with an economic impact of up to US$10.6 trillion[2]. Land degradation reduces agricultural productivity and increases the vulnerability of those areas already at risk of impacts from climate variability and change. Addressing land degradation, Sustainable Development Goal (SDG) target 15.3 and a key component of the 2030 Agenda for Sustainable Development, is essential to improve the livelihoods of those most affected, and to build resilience to safeguard against the most extreme effects of climate change.

To support Parties in addressing this challenge, the 13th Conference of the Parties (COP.13) of the United Nations Convention to Combat Desertification (UNCCD) adopted the Strategic Framework for 2018-2030 (Decision 7/COP.13). The Strategic Framework acknowledges the global challenges of desertification/land degradation and drought (DLDD), and their contribution to "economic, social, and environmental problems" that "pose serious challenges to sustainable development" and notes that Parties aim to: "develop, implement, revise and regularly monitor, as appropriate, national, sub-regional and regional action programmes and/or plans as effective tools for UNCCD implementation" and achievement of land degradation neutrality (LDN).

Land Degradation Neutrality (LDN) was identified in Decision 3/COP.12 as a key objective of the convention and one that, if achieved, would be a major contributor to the realization of the broader sustainable development agenda. Decision 3/COP.12 defined LDN as "a state whereby the amount and quality of land resources necessary to support ecosystem functions and services and enhance food security remain stable or increase", and invited parties to establish national LDN targets. Further, the COP.12 invited Parties to adopt monitoring and evaluation approaches linked to these targets and requested the UNCCD secretariat to support these efforts through continued development of indicators for monitoring progress towards national targets.

Consistent with these goals, the UNCCD secretariat has worked closely with partner organizations and with the Inter-agency and Expert Group on SDG Indicators (IAEG-SDGs) to

[1] United Nations Convention to Combat Desertification. 2017. The Global Land Outlook, first edition. Bonn, Germany.
[2] Le, Q. B., A Mirzabaev, E. Nkonya, and G. W. J. van Lynden. "The Extent and Cost of Land Degradation." In Land Degradation and the Sustainable Development Goals: Threats and Potential Remedies. CIAT Publication No. 440. Nairobi, Kenya, 2017.

finalize the metadata for the SDG indicator 15.3.1, to develop good practice guidance on its measurement, and to provide default global datasets to support Parties in reporting to the Convention.

At COP.13, the Parties adopted a set of indicators for monitoring progress towards the strategic objectives of the 2018-2030 Strategic Framework (Error! Reference source not found.). COP.13 also adopted the scientific conceptual framework (ICCD/COP(13)/CST/2) for LDN. The goal of the framework is "to maintain or enhance the natural capital of the land and associated land-based ecosystem services" through minimizing losses and counterbalancing unavoidable losses with gains through restoration. The indicators adopted by the LDN framework (trends in land cover, trends in land productivity, and trends in carbon stocks above and below ground) mirror those of Strategic Objective 1 (SO1) of the 2018-2030 Strategic Framework, and the SDG indicator15.3.1.

Table 1. Strategic objectives and associated indicators agreed to at COP.13 in support of the 2018-2030 Strategic Framework

Strategic objective 1: *To improve the condition of affected ecosystems*	
SO 1-1	Trends in land cover
SO 1-2	Trends in land productivity or functioning of the land
SO 1-3	Trends in carbon stocks above and below ground
Strategic objective 2: *To improve the living conditions of affected populations*	
SO 2-1	Trends in population living below the relative poverty line and/or income inequality in affected areas
SO 2-2	Trends in access to safe drinking water in affected areas
Strategic objective 3: *To mitigate, adapt to, and manage the effects of drought in order to enhance resilience of vulnerable populations and ecosystems*	
	Monitored through qualitative information
Strategic objective 4: *To generate global environmental benefits through effective implementation of the United Nations Convention to Combat Desertification*	
SO 4-1	Trends in carbon stocks above and below ground
SO 4-2	Trends in abundance and distribution of selected species
Strategic objective 5: *To mobilize substantial and additional financial and non-financial resources to support the implementation of the Convention by building effective partnerships at global and national level*	
SO 5-1	Trends in international bilateral and multilateral official development assistance
SO 5-2	Trends in domestic public resources
SO 5-3	Trends in number of co-financing partners
SO 5-4	Resources mobilized from innovative sources of finance, including from the private sector

To support countries in reporting to the Convention, and in monitoring SDG indicator 15.3.1, the secretariat and the Global Mechanism, in cooperation with UN Environment, and the Global Environment Facility, conducted in the context of the Global Support Programme II a series of five capacity-building workshops from March to May 2018 at which Parties were trained on reporting requirements, the PRAIS reporting interface, the indicators for Strategic Objective 1,

and Trends.Earth, a new tool produced by the GEF-funded Land Degradation Monitoring Project that supported countries in analyzing datasets to assess status and trends of land degradation. The UNCCD secretariat also provided Parties with default datasets for the indicators for SO1, allowing Parties the option to use this pre-processed data in support of their reporting.

Following the completion of the reporting process, the UNCCD submitted a report (ICCD/CRIC(17)/2) to the 17th session of the Committee for the Review of the implementation of the Convention (CRIC) on the data country Parties reported to the UNCCD on SO1. Given the experience gained in the reporting process, the secretariat noted that Parties may wish to work with partner organizations such as the Group on Earth Observations (GEO) and the GEO LDN Initiative to continue to support the development of open-source tools and plugins like Trends.Earth to facilitate consistency in reporting, and to "ensure progress indicator data are up-to-date, replicable, globally applicable, and enabling for country Parties". In a similar analysis of data submitted for Strategic Objective 3 (drought mitigation and adaptation) the secretariat recommended the UNCCD secretariat develop guidance on drought vulnerability and assessment methods so as to support parties in "enhance[ing] the role of land in drought response" (ICCD/CRIC(17)/5). To support the achievement of these goals, some parties at the 17th session of the CRIC recommended that the secretariat and Global Mechanism (GM) "ensure that existing tools, methods, and databases should be better used", specifically mentioning Trends.Earth, WOCAT, Collect Earth, and the Carbon Benefits Project (ICCD/CRIC(17)/L.3).

A.2. Results achieved: the baseline scenario or any associated baseline projects

Trends.Earth:

Trends.Earth is an output of the Land Degradation Monitoring Project (LDMP), a project funded by the Global Environment Facility (GEF) under the sixth replenishment to provide guidance on robust methods and a toolbox for assessing, monitoring status, and estimating trends in land degradation using remote sensing and other datasets. The LDMP piloted products and tools in four countries (Kenya, Tanzania, Uganda, and Senegal) through a partnership between Lund University in Sweden, the National Aeronautics and Space Administration (NASA) of the United States, and the Vital Signs program coordinated by Conservation International.

The project was inspired by a review commissioned by the Scientific and Technical Advisory Panel (STAP) of the GEF on the use of NDVI[3] to monitor land degradation. Numerous

[3] The Normalized Difference Vegetation Index (NDVI) is an indicator of vegetation "greenness" (a proxy for photosynthetic capacity) that can be derived from remotely sensed imagery and can be used as one indicator of land degradation. The NDVI relies on information from bands in the red and near-infrared wavelengths, which are available from a range of satellite-based sensors and is defined as the ratio of the difference between the near-infrared band and the red band, and the sum of these two bands. Further information on the NDVI and its application

international processes, including the UNCCD, the Convention on Biological Diversity (CBD), the United Nations Framework Convention on Climate Change (UNFCCC), and the Sustainable Development Goals (SDGs), have highlighted land degradation as a key development challenge, and that a lack of reliable information and cost-effective methods for collecting and analyzing data hampers the development of policies to address that challenge. The STAP approached Vital Signs, NASA, and the European Space Agency (ESA) to develop a proposal to address the issue, ultimately resulting in the LDMP project.

A major output of the project included a free and open-source tool – Trends.Earth (http://trends.earth) – for monitoring land degradation trends, and the creation of a set of guidance documents to support its use. Trends.Earth allows non-technical users to integrate national data and information with global datasets to track changes in the indicators of land degradation. The Project's guidance and tools can be employed to inform land management and investment decisions, as well as to improve reporting to the UNCCD and to the GEF. Trends.Earth is an open data platform that is freely available as a global public good.

A novel feature of Trends.Earth is its use of cloud-computing – by using Google Earth Engine the toolbox makes it possible for users with limited computing capacity and without expert knowledge of cloud computing to perform complex calculations on large datasets (enabling analyses of land degradation on national-global scales) in minutes. While the benefits of the cloud-based approach are clear (and to date over 2,000 users have registered to use the tool), the project team also recognized that in many regions internet connectivity limits the use of cloud-based tools. For that reason, Trends.Earth also supports offline computation of indicators (for areas where internet connectivity may be limited). This two-pronged approach allowed the project to maximize its reach by meeting the needs of most stakeholders.

Throughout the project, the team maintained contact with other ongoing efforts in the land degradation monitoring community, including with the ESA, Joint Research Centre (JRC) of the European Commission, Group on Earth Observations (GEO), Commonwealth Scientific and Industrial Research Organisation (CSIRO), World Overview of Conservation Approaches and Technologies (WOCAT), Regional Centre For Mapping Resource For Development (RCMRD), and other stakeholders to ensure that the project is linked with current and past efforts and draws on existing datasets and the existing body of knowledge. The project team led or participated in 30 scientific meetings, trainings, and expert group meetings, and worked with the Google Earth Engine team to link the project to the latest developments in cloud computing.

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for monitoring land degradation is in the first report from this project: "Using Spectral Vegetation Indices to Measure Gross Primary Productivity as an Indicator of Land Degradation", available online at: http://vitalsigns.org/sites/default/files/VS_GEFLDMP_Report1_C1_R3_WEB_HR.pdf.

The final activities of the Land Degradation Monitoring project concluded in March 2018. The project successfully implemented all three components of the project and enjoyed an excellent reception for Trends.Earth, its key output. Trends.Earth supports the calculation of all three of the indicators for monitoring the achievement of LDN. Trends.Earth enables the community to use a set of standardized, recommended methods for estimating the indicators of land degradation, while providing the flexibility for users to customize the methods depending on local circumstances and the availability of national data. The project team led three workshops on land degradation monitoring and Trends.Earth during the project period, and in addition, participated at the request of the UNCCD in the five regional workshops on reporting from March-May 2018. All 196 UNCCD signatories were invited to the workshops, at which over 378 participants were trained on Trends.Earth. In total, the team trained over 700 users from 142 countries on Trends.Earth during the project period.

As of July 2019, there are already 8 peer reviewed published scientific articles using or citing Trends.Earth contributions, with further articles under development. Given the positive reception Trends.Earth has experienced, there have been numerous requests to expand the tool beyond the core LDN indicators to allow for mapping against other indicators, the application of the tool at sub-national scales, and for planning and implementation of restoration efforts. Since the completion of the first phase of the project, the Trends.Earth team has worked with partners (including NASA, IUCN, UN Habitat, and others) to incorporate additional indicators on urban expansion, carbon sequestration, and deforestation to the tool, and is continuing to engage the community around Trends.Earth.

Trends.Earth is a tool which has proven its value for facilitating the assessment of land condition at national scale using Earth observation data, with potential to inform at sub-national scales. Based on feedback received from users, stakeholders, and partners we have also been able to identify key areas of improvement, which would greatly benefit planning and monitoring for LDN. Those areas of improvement could be summarized as: 1) Improved spatial resolution of the data, 2) Capabilities for linking remote sensing analysis with field and in-situ data for verification purposes, 3) Linking remote sensing with participatory assessment processes to include local knowledge and increase the sense of ownership over the outcomes, and 4) inclusion of decision support tools to assess the trade-offs in different proposed activities and inform LDN planning. These are the primary objective we propose to pursue in this project, through close collaborations with leading global partners like WOCAT, LandPKS and the UCGHI Planetary Health Center.

WOCAT:

The World Overview of Conservation Approaches and Technologies (WOCAT) is a global network of specialists on Sustainable Land Management (SLM), established in 1992, with the aim to combat land degradation and support knowledge sharing and evidence-based decision-making for promoting the implementation and upscaling of SLM and contributing to the achievement of Land Degradation Neutrality (LDN). The standardized methods and tools, developed by the WOCAT network over the past 25 years provide a framework that allows for comparison and sharing, which covers bio-physical and socio-economic aspects, and integrates knowledge of experts and land users with the support of quantitative and scientific data. The WOCAT methods and tools have been widely used in different countries around the world to map land degradation, document and evaluate field-tested land management practices, and spread SLM practices. This has led to a rich repository on SLM practices for sharing knowledge, and for advocating and promoting SLM.

In 2014, the global SLM database of WOCAT was officially recognized by the UNCCD as the primary recommended database for reporting SLM best practices by the UNCCD Parties. At the same time, Parties were invited to continue compiling cases of such best practices and reporting them to the WOCAT Secretariat. Under an agreement between the Centre for Development and Environment (CDE) of the University of Bern, hosting the WOCAT Secretariat, and the UNCCD Secretariat, WOCAT, as the executive agency, was mandated to improve accessibility to information on best practices on sustainable land management (SLM) technologies, including adaptation, according to the guidance provided by Parties. WOCAT's global SLM database offers free access to over 1900 SLM practices from more than 120 different countries.

Apart from the sharing of SLM practices through the WOCAT database, a mapping method has also been developed jointly with the FAO LADA project and applied in several countries around the world. It is a participatory expert assessment assisting countries and regions to compile spatial information on land degradation (LD), SLM and impacts of LD and SLM practices on the natural resources and livelihoods of people. Over the past years, WOCAT methods and tools have been widely applied and integrated into efforts to better understand and address land degradation. Some examples are the EU funded research projects CASCADE and RECARE, the IFAD funded project on scaling-up SLM by smallholder farmers (Cambodia, Lao PDR, and Uganda), and the GEF funded and FAO coordinated project on Decision Support for Mainstreaming and Scaling Out SLM (DS-SLM) in 15 countries. Additionally, it has also been included in over 30 initiatives developed at regional and national level around the world, including Afghanistan, Bangladesh, China, Ethiopia, Mongolia, Nepal, Senegal, Tajikistan, and Tunisia. Further, a decision support framework has been developed by FAO and WOCAT to establish evidence-based decision-making processes with the objective to support countries in

scaling out SLM and achieve LDN targets. The modular framework is based on existing WOCAT and FAO tools and methods and allows a flexible approach that fits best to the countries' needs.

The experiences and the use of the WOCAT tools, database and network for the reporting on SDG 15.3. on Land Degradation Neutrality has been compiled in several papers[4][5][6]. They demonstrate the achievements made so far combining WOCAT tools and its database with Trends.Earth and identifies the need for further inclusion of field data into national and global assessments. WOCAT has site specific information for location where SLM practices are reported, these allow the assessment of LD and the comparison with other practices. WOCAT also developed a participatory expert assessment for mapping the state and trends of LD and SLM and their impacts. However, a combination with remote sensing-based assessments, like the ones performed by Trends.Earth, and ground data has not yet to date been done. Through this project, we will further explore the integration of WOCAT approaches with the Trends.Earth analysis, adding also ground truthing capabilities by developing a joint smartphone application with LandPKS, allowing for integrated assessments of land management practices, the assessment of the soil, vegetation and water health.

LandPKS:

The global Land-Potential Knowledge System (LandPKS) is a mobile app supported by cloud computing that allows site-specific land-use planning, management and monitoring. LandPKS allows non-soil scientist to complete rapid, local assessments of key soil properties using its core module (*LandInfo*). This information is used by the app to automatically calculate other soil properties (plant-available water-holding and infiltration capacity) and determine the Land Capability Class. Automated soil identification is scheduled for the March 2019 update. This update will also include a *LandManagement* module for on-farm recordkeeping of inputs, management and yields. This module, together with the existing *LandCover* module (for monitoring pasture, rangeland, crop and crop residue cover) and a future *SoilHealth* module will together provide a free, global system for site-specific application, evaluation and adaptation of SLM practices. LandPKS is already available for both Android and iPhone. It has been

[4] Garcia, C.L., Teich, I., González-Roglich, M., Kindgard, A.F., Ravelo, A.C., Liniger, H., 2019. Land degradation assessment in the Argentine Puna region: Expert knowledge and participatory mapping vs. satellite-derived information. Environtal Sci. Policy 70–80.

[5] Gonzalez-Roglich, M., Zvoleff, A., Noon, M., Liniger, H., Fleiner, R., Harari, N., Garcia, C., 2019. Synergizing global tools to monitor progress towards land degradation neutrality: Trends.Earth and the World Overview of Conservation Approaches and Technologies sustainable land management database. Environ. Sci. Policy 93, 34–42. https://doi.org/10.1016/j.envsci.2018.12.019

[6] Liniger, H., Harari, N., van Lynden, G., Fleiner, R., de Leeuw, J., Bai, Z., Critchley, W., 2019. Achieving land degradation neutrality: The role of SLM knowledge in evidence-based decision-making. Environ. Sci. Policy 94, 123–134. https://doi.org/10.1016/j.envsci.2019.01.001

downloaded and used on six continents. App downloads and data uploads are increasing exponentially.

The LandPKS application is smartphone based and therefore most heavily used by professionals with access to more expensive handsets. At present, these users include land user planners, project planners and evaluators (for inventory, monitoring & evaluation, including for on-farm research), and remote sensing product developers (for calibration & validation). In the future we expect increased use by input suppliers, extension and other consultants. As smartphone use becomes more common among smallholders, more users will be able to use the app for on-farm decision making and this will represent a major opportunity for continued user growth.

UCSB

The mission of the University of California Global Health Institute (UCGHI) Planetary Health Center of Expertise (PHCOE) is to lead the world in research, education, and policy to coupled population-environment health challenges. The PHCOE provides a platform and network to galvanize scientists, stakeholders, educators, policy makers, and global partners. The PHCOE is organized into three working groups commensurate with the majority of global health research: infectious disease, food and nutrition, and environmental exposure-related diseases. The major cross-cutting themes are climate change and cross-sectoral and interdisciplinary transformative discovery with girls and women at the center of novel solutions. The PHCOE brings together highly skilled teams that match the demand for integrated solutions to seemingly intractable health-environment problems.

The PHCOE works in dozens of countries with a particular focus in Latin America, sub-Saharan Africa and southern Asia, in collaboration with USAID, Gates Foundation, Conservation International, and many others. Especially pertinent to this proposal is a close partnership with the USGS' Famine Early Warning Systems Network (FewsNet) based at UCSB.

B. ENABLING ACTIVITY GOALS, OBJECTIVES, AND ACTIVITIES

B.1. Enabling Activity Goals, Objectives and Activities

Countries are striving to make the world land degradation neutral by 2030[7] and more than 120 countries have already committed to define LDN targets to achieve these goals. The United Nations Convention to Combat Desertification (UNCCD) defines land degradation neutrality as "a state whereby the amount and quality of land resources necessary to support ecosystem functions and services and enhance food security remain stable or increase within specified

[7] Decision 7/COP.13. The future strategic framework of the Convention
https://www.unccd.int/sites/default/files/relevant-links/2018-08/cop21add1_SF_EN.pdf

temporal and spatial scales and ecosystems"[8]. The achievement of LDN requires a set of political, financial, and technical conditions to be met, in order to make resources available, and to plan, execute and monitor on-the-ground management and conservation (also known as sustainable land management, or SLM) activities to avoid, reduce and reverse land degradation. Over the last two years, Trends.Earth was developed to streamline and minimize the technical requirements for countries working on their land degradation assessments, as a first step towards planning for LDN. Through close collaborations with the UNCCD, NASA, CSIRO, and other partners, Trends.Earth became the first dedicated tool to support land degradation assessment at national and sub-national scales in a spatially explicit way using Earth Observation data. Computing the three sub-indicators using standardized methods and using the best globally available data was a huge step forward for setting baselines and starting to plan interventions, and it also was critical for identifying further technical needs to better support the LDN process.

With the current project, and through collaboration with partners, we plan to address what the UNCCD, the LDN community, and the Trends.Earth team have identified as key technical challenges for LDN implementation: 1) Technical improvement in the biophysical indicators provided by default in Trends.Earth, 2) Added data sources for supporting the assessments of strategic objectives 2 and 3, in relation to human vulnerability and drought, 3) Integration of datasets on land management and their impacts on the LDN indicators at local level and national level and the integration to a mobile application for verification and data collection, and 4) Capacity building resources to facilitate the uptake and continued support of the different tools, and for development of on the ground projects to support LDN. By addressing the main technical limitations for reporting identified by the UNCCD Secretariat and signatory countries, this project will support the 2021-2022 reporting process to the UNCCD by signatory countries and to Sustainable Development Goal 15.3 in the form of technology development and deployment and capacity building.

Project Objective: To provide improved methods for assessing land degradation and understanding the socio-economic conditions of vulnerable communities in affected areas through the integration of free and open platforms to support country level reporting to the UNCCD

[8] Decision 3/COP.12. Integration of the Sustainable Development Goals and targets into the implementation of the United Nations Convention to Combat Desertification and the Intergovernmental Working Group report on land degradation neutrality https://www.unccd.int/sites/default/files/relevant-links/2017-03/Decision_3_COP_12_GM.pdf

The project will be structured under four main outcomes:

Outcome 1: Improvement of land degradation biophysical indicators to support monitoring towards land degradation neutrality: Trends.Earth currently provides global datasets at resolutions of 250-300m. Even when Trends.Earth supports the usage of higher spatial resolution datasets provided by the user, the majority of UNCCD parties used default data to report on the land-based progress indicators, underscoring the utility, suitability and need for data prepared in a globally consistent manner, lowering the barriers to reporting for many countries[9].
Under this component, new datasets and algorithms will be added to Trends.Earth to provide enhanced spatial resolution indicators for the three land-based indicators: changes in primary productivity, land cover, and soil organic carbon (10-30m). Higher spatial resolution data will be critical for tracking changes in land condition as a result of on-the-ground activities and to facilitate monitoring of different land management activities implemented to support LDN.

Outcome 2: Understanding the socio-environmental interactions between drought, land degradation, and poverty to support development of monitoring frameworks for UNCCD strategic objectives 2 and 3: Under this component we will evaluate, in close collaboration with the UNCCD, World Meteorological Organization, and other key stakeholders, datasets and approaches for evaluating the socio environmental interactions between drought, land degradation and poverty. Global datasets (biophysical and socioeconomic) and approaches will be integrated into Trends.Earth to allow users to run national level assessments to understand the risks drought and poverty could pose to the most vulnerable communities in order to enhance their resilience and wellbeing. Global datasets to support reporting of SO 2 and 3 will be evaluated and made available to users through Trends.Earth.

Outcome 3: Support planning and monitoring of land degradation neutrality (LDN) priorities from field to national scales: Up to now, Trends.Earth has provided functionalities for assessing historical changes in land condition. Relating those satellite-based assessments to on-the-ground information is key; however, many users have indicated that they lack the knowledge and resources to perform such analysis. Trends.Earth is partnering for this project with WOCAT and LandPKS to facilitate the integration of remotely sensed analysis with land management information collected though a mobile application. This will allow not only for systematic verification of degradation trends and monitoring of progress made under the LDN Target Setting Program, but also collecting land condition and management information on the ground

[9] ICCD/CRIC(17)/2 - Preliminary analysis – strategic objective 1: To improve the condition of affected ecosystems, combat desertification/land degradation, promote sustainable land management and contribute to land degradation neutrality. https://www.unccd.int/sites/default/files/sessions/documents/2019-02/newCRIC2%20-%20advance.pdf

which will be critical for posterior planning processes. Other freely available tools to assess land condition and change, such as Collect Earth, will be evaluated and integrated workflows will be developed to support user uptake. These assessments will be input for a simple decision support tool which will allow users to identify priorities for intervention at national and subnational scales. These tools and approaches will be tested in different geographies within a pilot country, providing case studies that will provide example applications for scaling the tool to a larger user base. A capacity building workshop, with equitable participation by women and men, focused on the integrated assessments using Trends.Earth, WOCAT, and LandPKS will take place in the pilot country.

Outcome 4: Support UNCCD and its signatory countries by building capacity to support planning, monitoring, and reporting: Since it was launched in late 2017, Trends.Earth has supported a user base of over 2,000 participants. With the enhancements and new modules to be added to the tool under the current proposed project, we expect that number to at least triple in the next 3 years. For that reason, it is critical to update and maintain documentation and training resources available through the project website, and to provide users with the required support and training, allowing for equitable participation by women and men. Updated documentation and online training courses will include guidelines for integrated assessments using Trends.Earth, LandPKS, WOCAT, and Collect Earth maximizing the utility of remotely sensed and field data, and local expert knowledge. To support UNCCD signatory countries on their reporting needs for the cycle 2021-2022, we will host a capacity building technical workshop at a UNCCD parties meeting, on tools and methods monitoring strategic objectives progress.

B.2. Enabling Activities Stakeholders

Executing agency and partners: The Moore Center for Science at Conservation International will lead the execution of the proposed Enabling Activities project following recommendations of the UNCCD Secretariat and the Global Mechanism. The University of California-Santa Barbara, University of Colorado and the World Overview of Conservation Approaches and Technologies are partners of The Moore Center for Science at Conservation International within this project, each with specific roles as determined by the activities detailed in the work plan.

The Convention: The UNCCD, as the key stakeholder promoting LDN and as custodian agency of the Sustainable Development Goal Indicator 15.3.1, will play a key role in this project, providing guidance to the technical team, and making sure that the project outcomes align with the Convention and countries' needs in support of LDN.

Scientific and development organizations: The project will facilitate further collaboration with scientific and development organizations, in particular, those in the area of data extraction and

analysis to support LDN implementation. Some of those organizations will be: the German Development Agency (GIZ), International Soil Reference and Information Centre (ISRIC), The Commonwealth Scientific and Industrial Research Organisation from Australia (CSIRO), The Group on Earth Observation (GEO), and the GEO LDN Initiative in particular, and the International Union for the Conservation of Nature (IUCN).

Project governing and overseeing bodies

Project Executive Team: A four-member executive team will be comprised of one representative each from Conservation International, the LandPKS team, the WOCAT team, and the University of California Global Health Institute. The Executive Team will manage the project and will be responsible for implementing the project activities to achieve the proposed outcomes. The team will have monthly meetings to assess progress of the different project components, and to plan accordingly.

Project Steering Committee: An eight-member Steering committee will be comprised of the Project Executive Team (4 members) plus one representative from the UNCCD, one from the Group on Earth Observations LDN Initiative, a representative from the pilot country as appointed by the UNCCD focal point, and one member from UN Environment. The Steering Committee will provide high level guidance, will monitor overall project progress, and will be responsible for securing alignment of project activities with other global and national processes on LDN. The Steering Committee will meet in person once following the project inception workshop and will meet quarterly online for the duration of the project.

Project Scientific and Technical Advisory Panel: A group of four scientific experts on LDN, remote sensing, and sustainable land management will be invited to participate in advisory roles for this project. Organizations which will be invited to participate include, but are not limited to, FAO, JRC, NASA, UNCCD SPI and the GEF STAP. The Scientific and Technical advisory panel will meet online with the project Executive team every six months, and will have an advisory role, reviewing progress made by the project team and advising on future directions to secure alignment with other strategic partners and stakeholders working on LDN planning and monitoring.

B.3. Gender Equality and Women's Empowerment

Women's roles in developing countries are inherently tied to land change and management through fuel wood, water, fodder, and non-timber forest product collection where degradation greatly impacts food production. Commonly lacking ownership, land tenure or control over agricultural land, female farmers tend to have lower production than men due to limitations such as reduced access to technical information, farming on smaller plots or marginal land and

fewer opportunities to get access to credit[10]. Women engaging in agricultural activities receive only 5% of agricultural extension services and are half as likely to use fertilizers and other inputs as men[11]. Studies show that greater adoption of technologies occur when women can interact with female agricultural officers, yet only 15% of agricultural extension officers are female. In sub-Saharan Africa, women farmers receive 10% of smallholder loans and less than 1% of the total credit allocated to the agriculture sector while there is an equal number of men and women engaging in farming[12]. By reducing gender disparity, female farmers can increase yields by up to 20-30% and at times exceed male farmer's productivity[13] potentially increasing total agricultural output in developing countries by 2.5-4%. Estimates show that the number of hungry people would decrease by 12-17%, or nearly 100-150 million people, if gender gaps in agriculture are closed. Access to technology and infrastructure can also lead to time savings[14], essential for increasing the agency of women in rural areas.

Women continue to be underrepresented in technical fields, for example, in a study in North America, women in technical GIS roles still fall below men at every professional level ranging from 22.22% (female executives) to 44.89% (female analysts)[15]. There are, however, positive trends in use of smartphone technology that may further decrease the disparity in access of information between men and women. In sub-Saharan Africa, farmers are using smartphones to better understand climatic patterns and market access to plan their planting, harvesting and selling of crops[16]. Mobile devices are decreasing the gap among small- and large-holders of agricultural land[17]. Many argue that access to this technology still limits women, thus exacerbating gender equality within rural subsistence farmers[18]. In low and middle-income countries, 1.4 billion (or 48%) of 2.9 billion males and 1.1 billion (or 38%) of the 2.9 million

[10] Croppenstedt, A., Goldsetin, M., and Rosas, N., 2013. Gender and agriculture: inefficiencies, segregation and low productivity traps. The World Bank Research Observer

[11] FAO, 2011. The State of Food and Agriculture 2010–11. Women in Agriculture: Closing the Gender Gap for Development. FAO, Rome. The State of Food and Agriculture 2010–2011. www.fao.org/docrep/013/i2050e/i2050e04.pdf

[12] FAO, undated. Agricultural Support System. http://www.fao.org/docrep/005/y3969e/y3969e05.htm Accessed 14/12/2016

[13] Agarwal, B., 2015. Food security, productivity and gender inequality. In: Herring, R.J. (ed.) The Oxford Handbook of Food, Politics and Society. Oxford University Press, Oxford: 273-301.

[14] Sendzimir, J., C. P. Reij, and P. Magnuszewski., 2011. Rebuilding resilience in the Sahel: regreening in the Maradi and Zinder regions of Niger. Ecology and Society 16(3): 1. http://dx.doi.org/10.5751/ES-04198-160301

[15] Gender in the Workforce, 2014. Breakdown of GIS Job Titles. https://www.gislounge.com/gender-gis-workforce/

[16] Osadebamwen Anthony Ogbeide & Ideba Ele, 2015. Smallholder Farmers and Mobile PhoneTechnology in Sub-Sahara Agriculture, Mayfair Journal of Information and Technology Management in Agriculture1(1), 1-19.

[17] Vodafone, 2018. Smartphone and small farmers. https://www.vodafone.com/content/dam/vodafone-images/public-policy/inequality/Vodafone-equal-world-small%20farmers.pdf

[18] The Trust Project, 2015. Focus on Gender: Farming app is out of touch with reality. https://www.scidev.net/global/gender/columns/gender-farming-app-reality.html

women owned mobile phones by 2010[19]. By 2018, there was a reduction of the mobile gender gap from 30% to 10%, translating to 184 million fewer women owning mobile phones compared to men[20]. As the mobile phone gender gap continues to close, there is much higher likelihood that women will have greater access to a mobile application over a technical tool requiring access to a computer, software and technical training.

This project will use gender-responsive approaches and actions into developing technical tools and training materials. There will be three technical components: 1) expanding capabilities in the Trends.Earth plugin to QGIS, 2) collecting information or attributes related to land condition (including vegetation surveying), soil condition, land degradation, and sustainable land management using an abbreviated version of the World Overview of Conservation Approaches and Technologies (WOCAT) Global Database on Sustainable Land Management (SLM), and 3) data sharing and validation through the LandPKS application. There are opportunities to address gender inequality and support women's empowerment throughout this process by reviewing the potential to collect gender disaggregated datasets upon review by the Institutional Review Board (IRB) to ensure that data collecting methods are in line with the ethical standards of CI, the GEF and its partners, and that public datasets do not compromise the safety and security of persons submitting information. This project has the potential to bridge the technological gap that causes disparity between genders by making data derived from earth observation accessible to scientists, extension officers and decision makers, while bringing cutting edge agricultural tracking information to female farmers. These resources can identify potential areas for restoration, which can lead to an increase in gender and economic equity[21].

The use of the LandPKS application will bring datasets derived from remote sensing into the hands of farmers, extension agents, policy and decision makers through a familiar device, a smartphone. Currently, users of the products derived from Trends.Earth require a computer, open-source software and technical knowledge to run an analysis on an area of interest and interpret the outputs. The LandPKS application will serve as the medium between the user and technology, by informing users of relevant data within their area based on their GPS location, or by selecting information within the application. This facilitates access and allows the user to validate the data with their intimate knowledge of the context on the ground. As part of the

[19] Development Fund, 2010. Women & Mobile: A Global Opportunity. A study on the mobile phone gender gap in low and middle-income countries. http://www.cherieblairfoundation.org/wp-content/uploads/2012/07/women_and_mobile_a_global_opportunity.pdf

[20] GMSA, 2018. The mobile Gender Gap Report 2018. https://www.gsma.com/mobilefordevelopment/wp-content/uploads/2018/04/GSMA_The_Mobile_Gender_Gap_Report_2018_32pp_WEBv7.pdf

[21] Iiyama, M., Neufeldt, H., Dobie, P., Njenga, M., Ndegwa, G. & Jamnadass, R., 2014. The potential of agroforestry in the provision of sustainable woodfuel in sub-Saharan Africa. Current Opinion in Environmental Sustainability, 6: 138–147.

"Enabling Activities" programs of the GEF, the project is not designed to have direct interventions on the ground, however the project will develop tools and technical capabilities to support monitoring of such interventions. As such, it will follow guidance outlined within the priorities of the UNCCD's Gender Action Plan (GAP) and the GEF's Gender Implementation Strategy to have scalable contributions towards gender equality and women's empowerment. This includes women's participation during the design, planning, implementation and evaluation of project activities, and by:

- collecting gender disaggregated datasets to better understand women's land rights and access to resources
- designing gender appropriate training documentation that enhances women's access to improved knowledge and technologies
- deploying scalable training programs geared towards closing technical gaps commonly restricting women from accessing information, funding and resources
- minimizing the negative effects of educational differentials (including male vs. female) on usage of technology (tools and applications), particularly using pictures and diagrams
- translating training materials, and text within the tool and application into multiple languages commonly used by target audiences
- testing the visuals used in tools, applications and training materials to ensure they are easily understood and accepted through the lens of different cultures and genders

We envision that this project will contribute towards achieving targets in the Agenda 2030 for Sustainable Development. This project will encourage women to make informed decisions about sustainable land management through improved access to technical tools and data, develop a baseline on gender-related issues in land degradation and desertification by offering a platform for assessing and monitoring, as well as reporting, trends in land condition, and mobilize resources towards achieving land degradation neutrality by targeting areas identified through data collection. This will lay the foundation for future work by
the GEF and UNCCD that utilizes the tools and applications developed and deployed throughout this project to further reduce the gender gap.

C. DESCRIBE THE ENABLING ACTIVITY AND INSTITUTIONAL FRAMEWORK FOR PROJECT IMPLEMENTATION (Discuss the work intended to be undertaken and the output expected from each activity as outlined in Table B).

Component 1: 1. Improvement of land degradation biophysical indicators to support monitoring towards land degradation neutrality

Outcome 1.1. High spatial resolution (10-30m) datasets available through Trends.Earth

Land degradation is a multi-faceted process resulting from the interaction of socio-ecological factors operating at multiple scales. Given this complexity, monitoring land degradation is not a simple task. The UNCCD developed a Scientific Conceptual Framework for Land Degradation Neutrality[22] and a Good Practice Guidance document[23] for the calculation of SDG Indicator 15.3.1 (proportion of land degraded over total land area) which recommends the combination of three biophysical sub-indicators as the minimum information needed to identify degraded lands. Those indicators are changes in land cover, changes in total carbon, and changes in primary productivity. Trends.Earth, following these recommendations, provides the user with access to the best global datasets to date to perform such assessments. Even though Trends.Earth allows for the use of custom data when available, to improve the confidence of the final land degradation assessment, recent reports from the UNNCD CRIC report that most countries used default data for their reporting purposes[24], highlighting the need for providing better quality default data moving forward. For this reason, this project component will focus on the implementation of improved datasets and methods to support analysis at high spatial resolution, relevant to national and subnational land degradation assessments and monitoring.

Land productivity is the biological productive capacity of the land, the source of food, fiber, and fuel that communities rely on[25]. Land productivity can be measured as net primary productivity (NPP) which is the net amount of carbon assimilated after photosynthesis and autotrophic respiration over a given period[26] and is typically represented in units such as kg/ha/year. Remote sensing is the most effective way to estimate productivity at varying scales through known correlations between the fraction of absorbed photosynthetically active radiation and plant

[22] Scientific Conceptual Framework for Land Degradation Neutrality. A report of the Science-Policy Interface https://www.unccd.int/sites/default/files/documents/2017-08/LDN_CF_report_web-english.pdf
[23] Good Practice Guidance, SDG Indicator 15.3.1, Proportion of land that is degraded over total land area. https://www.unccd.int/sites/default/files/relevant-links/2017-10/Good%20Practice%20Guidance_SDG%20Indicator%2015.3.1_Version%201.0.pdf
[24] ICCD/CRIC(17)/2 - Preliminary analysis – strategic objective 1: To improve the condition of affected ecosystems, combat desertification/land degradation, promote sustainable land management and contribute to land degradation neutrality. https://www.unccd.int/sites/default/files/sessions/documents/2019-02/newCRIC2%20-%20advance.pdf
[25] Good Practice Guidance, SDG Indicator 15.3.1, Proportion of land that is degraded over total land area. https://www.unccd.int/sites/default/files/relevant-links/2017-10/Good%20Practice%20Guidance_SDG%20Indicator%2015.3.1_Version%201.0.pdf
[26] Clark, D.A., Brown, S., Kicklighter, D.W., Chambers, J.Q., Thomlinson, J.R., Ni, J., & Holland, E.A. (2001). Net primary production in tropical forests: an evaluation and synthesis of existing field data. Ecological Applications, 11, 371-384

growth vigor and biomass. Following the UNCCD Good Practice Guidance (GPG) for SDG Indicator 15.3.1, Trends.Earth currently computes the productivity indicator using an algorithm used to measure land productivity levels from image data called Normalized Difference Vegetation Index (NDVI).

Improved methods that incorporate finer spatial resolution data and a higher sensitivity to recent changes in primary productivity are needed in order to support the monitoring of implementable on-the-ground activities to halt degradation processes and favor restoration activities. Integrals of the normalized difference vegetation index (NDVI) are valid surrogates for net primary productivity (NPP)[27] [28]. To date, Trends.Earth has implemented the land degradation primary productivity change sub-indicator using annual integrals of NDVI, allowing users to perform baseline assessments of land condition starting in 1981 until present at relatively coarse spatial resolutions (250 m for MODIS and 8 km for AVHRR) in a standardized and systematic way. This allows for comparisons of trends of change in primary productivity among different geographies, or within the same geography over time. However, the spatio-temporal sensitivity of the current method and datasets present significant limitations as we move from the baseline assessment phase of land degradation neutrality to the implementations and monitoring phase.

With the increasing availability of high-resolution satellite sources (defined in this proposal as 10 to 30m pixel size), the development of a higher-resolution indicators, based on NDVI or other variables such as fractional cover (i.e. the relative proportional representation of different land cover within a given pixel), is now feasible. For example, the harmonization of Landsat and Sentinel products opens the door to high spatio-temporal analyses which were only possible at 250 m resolution until now. Initial studies have highlighted the utility of Sentinel-2 data (using NDVI as one component) for improved degradation mapping, especially forest degradation due to its high spatial resolution, frequent revisit time, and spectral characteristics.

Under outcome 1.1, we will assess the range of freely available high spatial resolution satellite data and derived products (including Landsat and Sentinel, among others) for supporting enhanced degradation sub-indicators. We will determine which dataset, or combination of datasets, best support monitoring of changes in primary productivity, land cover, and soil organic carbon at fine scales, and will provide them through Trends.Earth. Among the factors to be considered will be: time series availability, frequency of image capture (or product generation), pre-processing required, and the sustainability of each data source for future monitoring. The

[27] Ma, X., Huete, A., Moran, S., Ponce-Campos, G., & Eamus, D. (2015). Abrupt shifts in phenology and vegetation productivity under climate extremes. Journal of Geophysical Research: Biogeosciences, 120, 2036-2052
[28] Fensholt, R., Rasmussen, K., Kaspersen, P., Huber, S., Horion, S., & Swinnen, E. (2013). Assessing Land Degradation/Recovery in the African Sahel from Long-Term Earth Observation Based Primary Productivity and Precipitation Relationships. Remote Sensing, 5, 664

suite of recommended datasets and methods needed for computing high spatial resolution degradation indicators at fine spatial resolution will be implemented into Trends.Earth making them available to the global community through this free and open source platform.

Targets:

- At least one global high spatial resolution (10-30m) remote sensing data for assessing changes in primary productivity incorporated into Trends.Earth
- At least one global high spatial resolution (10-30m) land cover dataset for assessing changes in land cover incorporated into Trends.Earth.
- One module for integrating high spatial resolution land productivity, land cover, and soil organic indicators implemented into Trends.Earth.
- Four step by step guidelines developed and available online (one for each sub-indicator, and one for the integration of the final high spatial resolution SDG).

Outputs

1.1.1. Remotely sensed data and algorithms for assessing changes in primary productivity at high spatial resolution (10-30 m) available through Trends.Earth.

1.1.2. Global land cover products at high spatial resolution (10-30 m) available through Trends.Earth.

1.1.3. Soil Organic Carbon (SOC) degradation indicator at high spatial resolution (10-30m) available through Trends.Earth.

1.1.4. Updated documentation and step by step guidelines for using high spatial resolution indicators (10-30 m) available through project website.

Component 2. Understanding the socio-environmental interactions between drought, land degradation, and poverty to support development of monitoring frameworks for UNCCD strategic objectives 2 and 3.

Outcome 2.1. Improved understanding of the interactions between land degradation, drought, and socioeconomic factors as they contribute to the development of vulnerable communities.

Land degradation costs countries billions of dollars annually associated with soil fertility loss, pollution mitigation, vegetation die offs, or health expenditures related to higher threats of malnutrition from reduced food and water supplies or increased infectious diseases[29]. Recognizing the importance of land degradation on the livelihoods of affected communities, the UNCCD established as strategic objectives to improve the living conditions of affected

[29] Global Environment Facility. 2017. Land degradation focal area study. Accessed on Jan 21 2019: https://www.thegef.org/sites/default/files/council-meeting-documents/EN_GEF.ME_C.52_Inf.02_Land_Degradation_May_2017.pdf

populations (Strategic objective 2), and to mitigate, adapt to, and manage the effect of drought in order to enhance resilience of vulnerable populations and ecosystems (Strategic objective 3). However, the link between land degradation, drought, and livelihoods outcomes, especially food insecurity, remains an understudied area of research. Compared to Strategic objective 1, for which there are recommended methods and datasets countries can use to report on progress, SO2 and 3 are still in early stages, highlighting the need for supporting ongoing processes at the UNCCD and partner organizations to develop robust indicators and guidance. Under this component, we will contribute to this process by laying the scientific foundation for identifying datasets and approaches which could be used to report on SO2 and 3, and later implemented into Trends.Earth.

Climate variability strains the complex linkages between physical landscapes and human well-being[30]. To understand the relationship between vulnerability, climate change, land degradation and human livelihoods, our proposed research adapts Turner et al.'s[31] vulnerability framework with three main components: exposure, sensitivity, and adaptive capacity and incorporates context, livelihoods and institutions. These linkages remain susceptible to interacting feedbacks between population growth, poverty, political variability, and environmental degradation, potentially creating a downward spiral of reduced capacity to cope with shocks or stress within a coupled human-environment system. The forecasted changes in temperature, precipitation variability, and extreme weather conditions pose major challenges, especially for smallholder, rain-fed agricultural systems with reduced adaptive capacity[32]. The IPCC (2013) emphasizes that adaptability to climate variability and change, especially in rural, subsistence-based communities, will be determined by ecosystem health, which interacts with policies, institutions, markets, and cultural practices governing resource-use decision-making. By examining interactions of climate variability, land degradation and household vulnerability, we will determine if, and at what spatial resolution, land degradation can be best detected on the landscape as measured by changes in vegetation productivity and structure.

Over recent decades, the field of land systems science (LSS) has generated a large body of literature that examines how climate, land cover, and people interact across spatiotemporal

[30] Hartter J, Stampone MD, Ryan SJ, Kirner K, Chapman CA, et al. (2012) Patterns and Perceptions of Climate Change in a Biodiversity Conservation Hotspot. PLoS ONE 7(2): e32408. doi:10.1371/journal.pone.0032408.
[31] Turner, B. L., R. E. Kasperson, P. A. Matson, J. J. McCarthy, R. W. Corell, L. Christensen, N. Eckley, J. X. Kasperson, A. Luers, M. L. Martello, C. Polsky, A. Pulsipher & A. Schiller (2003a) A framework for vulnerability analysis in sustainability science. Proceedings of the National Academy of Sciences of the United States of America, 100, 8074-8079.
[32] Muller C., Cramer W., Hare W. L., Lotze-Campen H. (2011) Climate change risks for African agriculture. Proceedings of the National Academy of Sciences of the United States of America, 108, 4313-4315.Murphy, J., Casley, D.J., Curry, J.J. (1991). "Farmers' estimations as a source of production data". World Bank Technical Paper 32. Washington DC.

scales to operationalize vulnerability[33][34]. While multiple definitions exist for vulnerability within the LSS context, we define it here as a function of the sensitivity and adaptive capacity of socio-ecological systems when exposed to environmental and climate changes[35]. We posit that households and villages with established practices for risk mitigation, strong social safety nets, and robust governance structures, will have greater adaptive capacity and therefore be less vulnerable to climate shocks, land degradation, and increasing variability. The pathways linking LULCC, landscape degradation, climate variability and household and community-level livelihood outcomes are many, but ultimately, they can be distilled to mechanisms influencing vulnerability conceptualized here as exposure, sensitivity, and adaptive capacity. Sensitivity (S) is the extent to which a system is susceptible to exposure (E) components, while adaptive capacity (AC) denotes a system's ability to adjust, modify, or change its characteristics in response to shocks or stress. We conceptualize AC as the mitigating property of vulnerability, influenced by the proportion of livelihood derived from the agro-ecosystem (sensitivity) interacting with climate variability and vegetation degradation (exposure).

Spatially-explicit models that account for multiple stressors are vital to understanding potential adaptation responses at different scales[36]. For example, Smit and Wandel[37] argue for creating vulnerability scores based on stakeholder participatory assessments. They show that most community participation-based adaptation schemes focus on immediate problems, while longer-term issues such as climate change and variability are bundled into vague, future concerns, or are ignored. Therefore we see a pressing need to merge these two approaches more explicitly in order to fully address a system's vulnerability and propose a mixed methods research design: (1) analyzing spatiotemporal precipitation patterns, teleconnections and vegetation change to create landscape degradation trajectories and hotspots; (2) identifying the interactions of biophysical and social conditions associated with population and livelihoods vulnerability; and (3) combining a vulnerability modeling framework with multi-temporal climate and vegetation analyses to assess how community decision-making interacts with environmental change.

[33] Rindfuss, R. R., S. J. Walsh, V. Mishra, J. Fox, and G. P. Dolcemascolo. (2004b) "Linking Household and Remotely Sensed Data." People and the Environment: 1–29.
[34] Turner, B. L., E. F. Lambin & A. Reenberg (2007) The emergence of land change science for global environmental change and sustainability. Proceedings of the National Academy of Sciences of the United States of America, 104, 20666-20671.
[35] Kuriakose, A., Livia, B. and Bachofen, C. (2009) Assessing vulnerability and adaptive capacity to climate risks: Methods for investigation at local and national levels. Washington DC: World Bank.
[36] Quinn, C. H., G. Ziervogel, A. Taylor, T. Takama, and F. Thomalla. (2011) Coping with multiple stresses in rural South Africa. Ecology and Society 16(3): 2. http://dx.doi.org/10.5751/ES-04216-160302
[37] Smit., B. and Wandel, J. (2006) Adaptation, adaptive capacity and vulnerability. Global Environmental Change 16: 282-292.

We propose to improve our understanding of the interactions between land degradation, drought, and socioeconomic factors as they contribute to the development of vulnerable communities through identifying the cutting edge biophysical and human data sets relating to climate exposure, impacts on crop productivity, and potential livelihood and health outcomes. We will combine remotely-sensed data analyses at multiple spatial and temporal scales with socio-economic and livelihoods datasets to characterize how indicators of vulnerability relate to land use and reliance on natural resources with interlinking factors shaping smallholders' land-use decisions, including climate variability, market factors, government policy and subsidies, culture and ethnicity, and the presence and intervention of NGOs. These data will be integrated with remotely sensed data into a modeling framework to compare trajectories of Land Use and Land Cover Change (LULCC) with underlying socioecological drivers. An integrated modeling framework is proposed to evaluate the strength of hypothesized associations between aspects of exposure, sensitivity, and adaptive capacity and the relationship between climate change, land degradation and population vulnerability. The main outcome of this work will be a quantitative assessment of how climatic, institutional and land degradation conditions affect vulnerability and potential leverage points where changes in adaptive capacity might reduce vulnerability across transnational, climatic, and institutional gradients, which will lay the scientific foundation for identifying datasets and approaches which could be used to report on SO2 and 3, and later implemented into Trends.Earth.

Targets:

- One synthesis report on global climate and weather datasets which could be used to better understand how drought impacts LDN (and vice versa), including indicators on droughts occurrence, severity and impacts using global climate datasets to understand rainfall, soil moisture and temperature changes (e.g. WorldClim, CHIRPS) completed.
- One synthesis report on global socioeconomic data sets to assess progress on SO2 and SO3 such as those from Integrated Public Use Microdata Series (IPUMS) International, EMDAT International database, the Demographic and Health Surveys (DHS) while allowing, to the extent possible, for the use of other national-level census or other data.
- One synthesis report evaluating approaches for assessing socio economic vulnerability to drought and interplay with land degradation, completed and presented to major stakeholders, including GEF, UNCCD and their scientific and technical bodies.
- Three climate related datasets in support of monitoring progress towards SO2 and SO3 added to Trends.Earth
- Three socioeconomic datasets in support of monitoring progress towards SO2 and SO3 added to Trends.Earth.
- One case study testing the usefulness of the datasets and approaches suggested to monitor progress towards SO2 and SO2 completed for the pilot country.

Outputs:

2.1.1. Evaluation of approaches for assessing socio economic vulnerability to drought and interplay with land degradation.

2.1.2. Global drought and early warning datasets added to Trends.Earth for supporting analysis and visualization of analytical results.

2.1.3. Global socioeconomic datasets to support UNCCD Strategic Objective (SO) 2 added to Trends.Earth for supporting analysis and visualization of analytical results

2.1.4. Case study performed in a pilot country.

2.1.5. Documentation and step by step guidelines for using climate, and socioeconomic variables available through project website.

Component 3. Support planning and monitoring of land degradation neutrality (LDN) priorities from field to national scales

Outcome 3.1. Approaches to support monitoring of LDN target progress integrating field data collection and remote sensing data at multiple scales developed

Remote sensing data is extremely useful for identifying spatial and temporal patterns of change in the most cost effective and systematic way. Its value for decision making, however, only materializes when it is combined with contextual information and expert knowledge. Currently, local knowledge is not systematically included in most national land degradation assessments performed using the three globally accepted LDN indicators: changes in land cover, productivity and soil organic carbon. For achieving a more accurate assessment of LD and to support evidence-based decision making we need tools which combine the best cutting-edge technology with the vast traditional land management knowledge which comes from land managers. Local knowledge is needed to inform on land management practices, and land condition characteristics which can much more precisely be assessed on the ground than from space. Mobile phones have become much more accessible in recent years, and network coverage is rapidly expanding globally, providing coverage to most populated areas. This progress in technology allows us now to use mobile phones to provide information to decision makers on the ground and also to collect data which can be later analyzed to generate better informed management decisions.

We propose here to combine already established and proven global tools, each addressing different aspects of land management and degradation to produce a mobile application which will greatly improve the quality of land degradation assessments, facilitate the collection and sharing of sustainable land management practices, and provide useful information to the land manager for improving decision making. The platforms are:

1) WOCAT Global SLM Database: the primary recommended database of UNCCD on SLM Best Practices, which collects information on the three accepted LDN indicators as well as assessing on- and off-site impacts of SLM;
2) Land PKS – a mobile application that allows stakeholders to document land use practices and assess the health state of the land; and
3) Trends.Earth – a monitoring platform for analyzing remote sensing data to assess the three LDN sub-indicators.

The integration of these three tools will allow us to leverage on each of the individual strengths to provide a product which will greatly enhance the quality of land degradation assessments performed and facilitate the deployment of sustainable land management activities at scale in support of land degradation neutrality.

The user-friendly mobile application LandPKS will serve as a focal hub for simplified versions of Trends.Earth and the WOCAT database. A land management module integrating the mentioned tools and databases will be made accessible through a mobile application platform which will allow the user to:

- Collect information: The user will be able to record point locations containing coordinates, including capabilities for taking photographs, and to collect attributes related to land condition (including vegetation surveying), soil condition, land degradation, and sustainable land management. This information will be later stored in a server which will make the information available through the different specific applications of LandPKS, Trends.Earth, and WOCAT.
- Distribute information: When in the field, the user will be able to retrieve site-specific information and data from Trends.Earth, Land PKS, and the WOCAT SLM Database to support local decision-making on land management through retrieving context-specific information. For example, different SLM options suitable for the specific site conditions could be displayed based on the user's location and data from WOCAT on field-tested SLM practices.

In consultation with technical experts, the team will design the simplified functionalities of Trends.Earth, Land PKS, and the WOCAT Global SLM Database which will be integrated and linked in a land management module. Based on the conceptual and content development, the IT specifications will be elaborated, and the mobile application platform will be developed.
The use of the mobile application platform at the local level will contribute to an improved monitoring of LD and an increased documentation and monitoring of the spread of SLM practices. The promotion of documenting SLM practices at the local level will also increase the

number of field-based reference points available, which will incrementally improve the validation and calibration of the remote sensing data and their analyses in Trend.Earth. This will allow a more accurate interpretation of the remote sensing data and continuous improvement of the analysis of such data which will contribute to the better assessment and monitoring of LD and LDN.

As part of this Outcome, we will also assess synergies and complementarities with other tools being used to support monitoring and assess impact of land-based interventions. A few examples of those applications include:

- Collect Earth: Collect Earth is a tool that enables data collection through Google Earth. In conjunction with Google Earth, Bing Maps and Google Earth Engine, users can analyze high and very high resolution satellite imagery for a wide variety of purposes, including : Support multi-phase National Forest Inventories, Land Use, Land Use Change and Forestry (LULUCF) assessments, Monitoring agricultural land and urban areas, Validation of existing maps, Collection of spatially explicit socio-economic data, and Quantifying deforestation, reforestation and desertification[38].
- The Carbon Benefits Project (CBP): provides tools for agriculture, forestry and land management projects to estimate the impact of their activities on climate change mitigation (carbon stock changes and greenhouse gas (GHG) emissions). The tools can be used at all stages of a project, are free to use and user friendly. The CBP modeling tools were developed by Colorado State University and partners under a Global Environment Facility co-financed project which was led by the United Nations Environment Program.[39]

We will finally develop integrated workflows for assessing changes in land condition combining data from Trends.Earth, WOCAT, LandPKS, and other relevant monitoring tools, providing guidance on recommended approaches to be applied at different scales of analysis. The mobile application and workflows will be tested with local stakeholders from different geographies within the pilot country (Outcome 3.3).

Targets:

- One mobile platform with capabilities for collecting and retrieving field-based and locally specific information on land/land management deployed
- One mobile platform with capabilities for distributing remotely sensed assessments of land condition deployed.

[38] http://www.openforis.org/tools/collect-earth.html
[39] http://www.carbonbenefitsproject.org/

- One user manual for the mobile platform completed and published in the project's website.

Output:

3.1.1. LandPKS mobile platform with functionalities to retrieve degradation assessment from Trends.Earth and collect field data on land condition to contextualize remote sensing analysis.

3.1.2. LandPKS mobile platform with functionalities to collect and distribute data on sustainable land management practices harmonized with simplified version of WOCAT SLM database.

3.1.3. Integrated workflows for assessing changes in land condition combining Trends.Earth indicators with other monitoring tools, such as Collect Earth developed.

3.1.4. Documentation and guidelines for performing integrated assessments of land condition at national and subnational scales using WOCAT, LandPKS, Trends.Earth, Collect Earth and other tools available through project website.

Outcome 3.2. Decision support tool for identifying LDN priorities implemented into Trends.Earth

Knowledge on land condition, including areas which have experienced degradation, improvement or remained stable, is a key input for decision making around LDN, but other contextual socioeconomic data and local knowledge are needed to reach technically solid decisions with broad social support and high likelihood of success. The WOCAT-LADA approach is an example of a broadly used methodology for performing national-level assessment of degradation based on participatory mapping. Similarly, the Restoration Opportunity Assessment Methodology (ROAM) from IUCN provides guidelines on how to use outputs from geospatial analysis guided by expert groups opinions to identify the best locations for restoration interventions. Through this component, we will incorporate into Trends.Earth a simple decision support tool, incorporating the data collected and distributed by the mobile platform, to facilitate the integration of different spatially explicit data-sources, both from Trends.Earth and externally generated, to facilitate participatory planning of activities at national level in support of LDN planning.

A multi-criteria evaluation tool, integrating remote sensing products with contextual socio-economic data and field data collected through the mobile application and informed by a participatory planning process will be added to Trends.Earth. Priority setting is a field which has benefited greatly from the increase in computing power currently available at low cost and the emergence of a plethora of modeling approaches in recent years. Sophisticated scenario planning tools are actively being developed and will provide very valuable inputs into decision making processes, but they are not at the point in which they can be made available to inform

decision making in straight forward and simple to understand way yet. For that reason, the decision-making tool will be built in such a way that users can easily understand the underlying assumptions being made and will provide flexibility to the user to assess the impact of different decisions on the outcome of the analysis.

A decision support framework, such as the one produced by WOCAT for scaling SLM, will be used to guide and support evidence-based decision making. Through applying the participatory assessment and decision support framework to the data and evidence from the different tools and databases (including from the mobile platform), stakeholders will be able to access and analyse a wide range of information from their specific area of interest. This will allow them to identify priority areas of intervention for implementing measures for achieving LDN. Following the overall philosophy of Trends.Earth, the decision support tool will come pre-populated with global datasets relevant for decision making. Specific variables will be determined in dedicated project workshops, but they will include a variety of socioeconomic and biophysical variables, on top of the degradation assessments produced by Trends.Earth. Trends.Earth will also integrate other functionalities from LandPKS and WOCAT, such as the possibility of identifying appropriate SLM practices based on information contained in the WOCAT database and visualizing the field data collected via LandPKS. The decision-support tool will facilitate and enhance the evidence base for decision-making on land management, thereby facilitating implementation and scaling of sustainable land management practices in support of achievement of LDN.

When Trends.Earth was released, the most current version of QGIS (the software Trends.Earth is based on) was 2.18.15. However, in the last year QGIS has been updated to version 3 making the plugin not compatible with users running the most up to date version. QGIS v3[40] is an improved version of the software, which brings new, updated and enhanced functionalities allowing users to run more comprehensive analysis in this free and open source platform. As such, to maximize usability of the Decision Support tool to be integrated as part of this component, and of Trends.Earth overall, we consider a priority to provide the Trends.Earth users access to the plugin through the latest version of QGIS. To support this improved version, we will update Trends.Earth to be fully supported on the most recent stable version of QGIS, transferring all current functionalities, and the ones to be developed as part of this project.

Targets:

- A decision-support module integrating WOCAT and Land-PKS collected data to facilitate and enhance evidence-based decision making on land management implemented into Trends.Earth.

[40] https://qgis.org/en/site/index.html

- One updated version of Trends.Earth supported by QGIS v3.
- One user manual for the decision support module completed and published in the project's website.

Output:

3.2.1. New version of Trends.Earth optimized for Quantum GIS software version 3

3.2.2. LDN priority setting decision support functionalities based on multi-criteria evaluation of geospatial data, field data and participatory assessments at national level available through Trends.Earth

3.2.3. Documentation and step by step guidelines for performing prioritization of LDN activities available through project website.

Outcome 3.3. Pilot testing and capacity building completed

Pilot testing is a key element of the development and deployment process for new tools and approaches. It provides an opportunity to assess the validity of the conceptual framework which underpinned the development and the robustness of the technological implementation. By piloting under different environmental and social conditions, and with the participation of a sample group of the target intended audience, it allows for adjustments and corrections to be made before final deployment of a tool. In this project, we intend to perform tests of the main tools and approaches to be developed: the improved biophysical indicators, the mobile application, and the decision support tool to be added to Trends.Earth, all guided through an integrated approach to use WOCAT, LandPKS, and other relevant tools to inform decision making in different geographies within a pilot country

Local level activities will be undertaken in different geographies within the project's pilot country. The country will be selected upon implementation. A country with a diversity of environmental and socioeconomic conditions to test the tools and approaches developed under this project will be selected. It would ideally cover a range of ecoregions, ranging from extreme arid to tropical rainforest, including different combinations of land use practices. The country would have to be an active participant in the UNCCD Target Setting Program, indicating political and technical will and capabilities to address land degradation within their territory. Previous engagements and field experience from WOCAT, LandPKS, and Conservation International, the availability of already established well-functioning partnerships, and minimal language barriers, are all factors to be taken into account when selecting the best suited candidate for these activities, in order to obtain useful insights for application in other regions of the globe.

Within the pilot country, engagement with key stakeholders involved in LDN planning will occur in the early stages of the project, since their input will be fundamental for the design and final

implementation of the different project elements. Actual on-the-ground activities will happen in the second half of the project, once tools are functional and documentation and training materials have been completed. Piloting activities will include: 1) Land degradation assessments to be completed using improved methods (high spatial resolution indicators and indicators for high biomass forest ecosystems, where applicable); 2) Use of the mobile application to verify remotely sensed indicators of degradation and to collect sustainable land management field data; 3) Development of a participatory LDN priority setting exercise at national or subnational level using the decision support tool; and 4) Capacity building to local land users and stakeholders on tools for planning and monitoring for LDN, and the role sustainable land management practices play for achieving it. It will also provide the knowledge on evidence-based decision making at local and national level on implementing and scaling SLM and thus achieving LDN. Findings and experiences from pilot activities will be summarized in the form of reports highlighting lessons learned for refining the tools, their dissemination and further application in different countries.

Targets:

- One country level assessment of land condition completed for the pilot country.
- 30 country stakeholders, with equitable participation by women and men, trained on the usage of Trends.Earth, LandPKS and WOCAT to support national and subnational planning and monitoring towards LDN.

Output:

3.3.1. Degradation assessment for different geographies within the pilot country using improved biophysical indicators.

3.3.2. Pilot testing of mobile platform and WOCAT integration for verifying biophysical degradation indicators and collection of land management information.

3.3.3. LDN prioritization analysis using decision support tool and participatory process with local stakeholders.

3.3.4. A capacity building workshop targeting 30 participants from key user groups (15 male and 15 female).

Component 4. Support UNCCD and its signatory countries by building capacity on planning, monitoring, and reporting of LDN

Outcome 4.1. Online and in-person capacity building on planning, monitoring, and reporting of LDN in support UNCCD 2021-2022 reporting cycle

The need for capacity building efforts to support UNCCD reporting on land-based progress indicators through the standardized automation of agreed algorithms in open-source

tools/plugins has been identified as one of the major needs by UNCCD country members [41]. To address that need, the project will generate a modular training program to support capacity building both in person and online. The training program will include a series of training modules on integrated assessments for land degradation mapping, planning and monitoring, facilitating the building of capacities customized to the needs of different user groups at national and sub-national level. In-person trainings are an important element of the overall capacity building strategy for this project. As such, 10 in person workshops have been completed in the last year on Trends.Earth, and similar workshops have been completed by the WOCAT and LandPKS teams. In this next phase, in person workshops will take one of two forms: 1) Conference trainings, and 2) In-country trainings. International conferences on land degradation, conservation, land management, forest landscape restoration, and UNCCD parties' meetings bring together stakeholders from different geographies, sectors, and levels of government. As such, they offer a unique opportunity to target a broad range of potential users. We plan to develop in person capacity building workshops in three of such meetings during the next 2 years, targeting a total of 60 participants. In-country field activities offer another opportunity for in person workshops, much more targeted in geographic scope, but broader in the range of users we can include. As such, we plan to have one in-person capacity building workshop in the pilot country, targeting representative from local governments, non-governmental organizations, local universities and civil society involved in land management (for details about the in-country capacity building activities please read section 3.3. on pilot testing).

In-person workshops are key elements of capacity building plans. As such, two in-person capacity building efforts will be implemented during this project: 1) The pilot country capacity building workshop (see project outcome 3.3.4); and 2) A workshop to be held during a UNCCD country members meeting (CRIC or COP) on data analysis and tools in support of the reporting needs on Strategic Objective's progress. To complement the in-person activities, during this project we will produce a series of online resources, composed of three main elements: 1) Training videos, 2) Online documentation, and 3) User support group.

An online modular training approach with videos and written materials available in three languages will be developed and deployed in the project website. The training course will include elements such as: land degradation assessment, LDN target setting, and evaluation of progress towards LDN. The online training videos will be supported by online training documentation, included step by step guides, which will be freely available on the project's website. The final element of the Trends.Earth training and support plan is the implementation of enhanced user

[41] Preliminary analysis – strategic objective 1: To improve the condition of affected ecosystems, combat desertification/land degradation, promote sustainable land management and contribute to land degradation neutrality https://www.unccd.int/sites/default/files/sessions/documents/2019-02/newCRIC2%20-%20advance.pdf

groups. User groups are essential tools of modern learning platforms in which users are able to ask questions, share experiences, and learn from the development team, but most importantly from each other. The aim is to develop an active platform to allow users such exchange, while actively monitoring it to make sure users' needs are being addressed. Through this combined capacity building effort and working in close collaboration with the UN Global Support program, we will support the UNCCD and its party members to facilitate reporting to the Convention for the 2020-2021 reporting cycle, making sure that not only appropriate tools are developed, and datasets are provided, but also that countries have the human resources capacities to produce country level assessments and reports to support achievement of LDN by 2030.

Targets:

- One modular training program completed in written and video form in three languages.
- One community of users with at least 50 active members implemented, with equitable participation by women and men.
- 50 country representatives trained on the usage of tools for data handling, analysis, and summary generation in support of the UNCCD country reporting needs for cycle 2021-2022 (25 female and 25 male).

Output:

4.1.1. Online modular training approach with videos and written materials available in three languages.

4.1.2. Implementation of a community of users' platform to mainstream and facilitate trouble shooting and sharing of experiences and continued learning.

4.1.3. An in-person capacity building workshop with at least 50 participants (25 female and 25 male) trained on the usage of tools for data handling, analysis and summary generation in support of the UNCCD reporting needs completed.

D. Describe, if possible, the expected Cost-Effectiveness of the project:

Supporting the UNCCD in facilitating the reporting process of country members in a cost effective, systematic and technically robust way are the main objectives of this Enabling Activities GEF proposal. Through coordination with the UNCCD, LandPKS, WOCAT, University of California and Conservation International, we'll minimize the need for duplicating efforts and costs for the development of monitoring and decision support tools needed to assess and inform land degradation. WOCAT maintains the UNCCD recommended platform for documenting sustainable land management practices and has a vast global network of partners on which we can build on. LandPKS is a mobile application tested and being used in many regions of the world, and with explicit linkages to other GEF funded project, such as the Carbon Benefit Project. Trends.Earth, also the result of a GEF funded project, was built on the premise of free and open

access for the global good. Through coordination with the project partners and the UNCCD, we will not only reduce the cost of providing monitoring and planning tools, as compared to the development of new tools, but we will also be making sure that the costs are zero for the final user, reducing their reporting costs while maximizing the effectiveness of the reporting process.

E. Describe the budgeted M&E plan:

Project monitoring and evaluation will be conducted in accordance with established Conservation International and GEF procedures by the project team and the CI-GEF Project Agency. The project's M&E plan will be presented and finalized at the project inception workshop, including a review of indicators, means of verification, and the full definition of project staff M&E responsibilities.

A. Monitoring and Evaluation Roles and Responsibilities

The PMU will be responsible for initiating and organizing key monitoring and evaluation tasks. This includes the project inception workshop and report, quarterly progress reporting, annual progress and implementation reporting, documentation of lessons learned, and support for and cooperation with the independent external evaluation exercises.

The Moore Center of Science (MCS), at Conservation International, is the project Executing Agency and is responsible for ensuring project activities are completed in accordance to the project proposal and following GEF procedures. The MCS will assess its own progress and partner's process as planned in the project work plan and will make necessary adjustment to assure completion of all Outcomes by the end of the project.

WOCAT, University of Colorado, and University of California Santa Barbara, the key project executing partners are responsible for providing any and all required information and data necessary for timely and comprehensive project reporting, including results and financial data, as necessary and appropriate.

The Project Steering Committee will play a key oversight role for the project, with semi-annual meetings to receive updates on project implementation progress and approve annual workplans. The Project Steering Committee also provides continuous ad-hoc oversight and feedback on project activities, responding to inquiries or requests for approval from the PMU or Executing Agency.

The CI-GEF Project Agency plays an overall assurance, backstopping, and oversight role and will assure monitoring and evaluation.

The CI Internal Audit function is responsible for contracting and oversight of the planned independent external evaluation exercises at the end of the project.

B. Monitoring and Evaluation Components and Activities

The Project M&E Plan should include the following components (see M&E table 8 for details):

a. Inception workshop

Project inception workshop will be held within the first three months of project start with the project stakeholders. An overarching objective of the inception workshop is to assist the project team in understanding and taking ownership of the project's objectives and outcomes. The inception workshop will be used to detail the roles, support services and complementary responsibilities of the CI-GEF Project Agency and the Executing Agency.

b. Inception workshop Report

The Executing Agency should produce an inception report documenting all changes and decisions made during the inception workshop to the project planned activities, budget, results framework, and any other key aspects of the project. The inception report should be produced within one month of the inception workshop, as it will serve as a key input to the timely planning and execution of project start-up and activities.

c. Project Results Monitoring Plan (Objective, Outcomes, and Outputs)

A Project Results Monitoring Plan will be developed by the Project Agency, which will include objective, outcome and output indicators, metrics to be collected for each indicator, methodology for data collection and analysis, baseline information, location of data gathering, frequency of data collection, responsible parties, and indicative resources needed to complete the plan. Appendix IV provides the Project Results Monitoring Plan table that will help complete this M&E component.

In addition to the objective, outcome, and output indicators, the Project Results Monitoring Plan table will also include all indicators identified in the Safeguard Plans prepared for the project, thus they will be consistently and timely monitored.

The monitoring of these indicators throughout the life of the project will be necessary to assess if the project has successfully achieved its expected results.

Baseline Establishment: in the case that all necessary baseline data has not been collected during the PPG phase, it will be collected and documented by the relevant project partners ***within the first year*** of project implementation.

d. GEF Core Indicators

The relevant GEF Core Indicators will be completed i) prior to project start-up, ii) prior to mid-term review, and iii) at the time of the terminal evaluation.

e. Project Steering Committee Meetings

Project Steering Committee (PSC) meetings will be held annually, semi-annually, or quarterly, as appropriate. Meetings shall be held to review and approve project annual budget and work plans, discuss implementation issues and identify solutions, and to increase coordination and communication between key project partners. The meetings held by the PSC will be monitored and results adequately reported.

f. CI-GEF Project Agency Field Supervision Missions

The CI-GEF PA will conduct annual visits to the project country and potentially to project field sites based on the agreed schedule in the project's Inception Report/Annual Work Plan to assess first hand project progress. Oversight visits will most likely be conducted to coincide with the timing of PSC meetings. Other members of the PSC may also join field visits. A Field Visit Report will be prepared by the CI-GEF PA staff participating in the oversight mission, and will be circulated to the project team and PSC members within one month of the visit.

g. Quarterly Progress Reporting

The Executing Agency will submit quarterly progress reports to the CI-GEF Project Agency, including a budget follow-up and requests for disbursement to cover expected quarterly expenditures.

h. Annual Project Implementation Report (PIR)

The Executing Agency will prepare an annual PIR to monitor progress made since project start and in particular for the reporting period (July 1st to June 30th). The PIR will summarize the annual project result and progress. A summary of the report will be shared with the Project Steering Committee.

i. Final Project Report

The Executing Agency will draft a final report at the end of the project.

j. Independent Terminal Evaluation

An independent Terminal Evaluation will take place within six months after project completion and will be undertaken in accordance with CI and GEF guidance. The terminal evaluation will focus on the delivery of the project's results as initially planned (and as corrected after the mid-term evaluation, if any such correction took place). The Executing Agency in collaboration with the PSC will provide a formal management answer to the findings and recommendations of the terminal evaluation.

k. Lessons Learned and Knowledge Generation

Results from the project will be disseminated within and beyond the project intervention area through existing information sharing networks and forums. The project will identify and participate, as relevant and appropriate, in scientific, policy-based and/or any other networks, which may be of benefit to project implementation though lessons learned. The project will

identify, analyze, and share lessons learned that might be beneficial in the design and implementation of similar future projects. There will be a two-way flow of information between this project and other projects of a similar focus.

l. Financial Statements Audit

Annual Financial reports submitted by the executing Agency will be audited annually by external auditors appointed by the Executing Agency.

The Terms of References for the evaluations will be drafted by the CI-GEF PA in accordance with GEF requirements. The procurement and contracting for the independent evaluations will handled by CI's General Counsel's Office. The funding for the evaluations will come from the project budget, as indicated at project approval.

ANNEX A: PROJECT RESULTS FRAMEWORK (either copy and paste here the framework from the Agency document, or provide reference to the page in the project document where the framework could be found)

Objective:	To provide improved methods and tools for assessing land degradation and understanding the socio-economic conditions of vulnerable communities in affected areas through the integration of free and open platforms to support country level implementation and reporting to the UNCCD
Indicators:	a. Number of datasets to estimate national and subnational-level trends of land degradation added to the Trends.Earth toolbox and made freely available b. Number of datasets in support of UNCCD Strategic objectives 2 and 3 reporting added to the Trends.Earth toolbox and made freely available c. Number of mobile applications and databases to support assessment of land degradation at varying scales integrated into user ready workflows d. Number of guidance documentation and capacity-building materials completed and available e. Number of users, disaggregated by gender, trained on integrated approaches for assessing land condition through online and in person capacity building efforts.

Expected Outcomes and Indicators	Project Baseline	End of Project Target	Expected Outputs and Indicators
Component 1: Improvement of land degradation biophysical indicators to support monitoring towards land degradation neutrality			
Outcome 1.1.: High spatial resolution (10-30m) datasets available through Trends.Earth ***Indicator 1.1.:*** *# of high spatial resolution datasets added to*	Current data available through Trends.Earth allow for analysis at 250 m spatial resolution	Users able to run land degradation assessments with globally provided high spatial resolution datasets through Trends.Earth	**Output 1.1.1**.: Remotely sensed data and algorithms for assessing changes in primary productivity at high spatial resolution (10-30 m) available through Trends.Earth

Expected Outcomes and Indicators	Project Baseline	End of Project Target	Expected Outputs and Indicators
Trends.Earth and readily available for users			***Indicator 1.1.1.:*** *# of global satellite data sources at high spatial resolution for assessing changes in primary productivity available through Trends.Earth* **Output 1.1.2.:** Global land cover products at high spatial resolution (10-30 m) available through Trends.Earth ***Indicator 1.1.2.:*** *# of global land cover products at high spatial resolution available through Trends.Earth* **Output 1.1.3.:** Soil Organic Carbon (SOC) degradation indicator at high spatial resolution (10-30m) available through Trends.Earth ***Indicator 1.1.3.:*** *# of soil organic Carbon degradation indicators at high spatial resolution available through Trends.Earth* **Output 1.1.4.:** Updated documentation and step by step guidelines for using high spatial resolution indicators (10-30 m) available through project website

Expected Outcomes and Indicators	Project Baseline	End of Project Target	Expected Outputs and Indicators
			Indicator 1.1.4.: *# of documents and step by step guidelines for using high spatial resolution for assessing land degradation produced and available through the project website*
Component 2: Understanding the socio-environmental interactions between drought, land degradation, and poverty to support development of monitoring frameworks for UNCCD strategic objectives 2 and 3			
Outcome 2.1.: Improved understanding of the interactions between land degradation, drought, and socioeconomic factors as they contribute to the development of vulnerable communities ***Indicator 2.1****.: # of reports on the interactions between land degradation, drought and socioeconomic factors completed readily available for key stakeholders*	Lack of understanding on key datasets needed to assess progress on land degradation neutrality in relation to drought vulnerability and poverty	Progress made on understanding the interplay of land degradation, drought and socio-economic vulnerability and identification of key datasets which can be used to track progress as part of UNCCD SO 2 and 3	**Output 2.1.1**.: Evaluation of approaches for assessing socio economic vulnerability to drought and interplay with land degradation ***Indicator 2.1.1****.: # of reports evaluating approaches for assessing socio economic vulnerability to drought and land degradation* **Output 2.1.2**.: Global drought and early warning datasets added to Trends.Earth for supporting analysis and visualization of analytical results ***Indicator 2.1.2****.: # of datasets on drought and early warning added and available through Trends.Earth* **Output 2.1.3**.: Global socioeconomic datasets to support UNCCD Strategic Objective (SO) 2 added to

Expected Outcomes and Indicators	Project Baseline	End of Project Target	Expected Outputs and Indicators
			Trends.Earth for supporting analysis and visualization of analytical results ***Indicator 2.1.3****.: # of datasets on socioeconomic information added and available through Trends.Earth* **Output 2.1.4**.: Case study performed in a pilot country ***Indicator 2.1.4****.: # of case studies performed and made available publicly* **Output 2.1.5**.: Documentation and step by step guidelines for using climate, and socioeconomic variables available through project website ***Indicator 2.1.5****.: # of documents and step by step guidelines for using* climate and socioeconomic variables *in support of SO 2 and 4 produced and available through the project website*
Component 3: Support planning and monitoring of land degradation neutrality (LDN) priorities from field to national scales			
Outcome 3.1.: Approaches to support monitoring of LDN target progress integrating field data	Lack of user-friendly tools and approaches to integrate field and remote sensing data for assessing	Tools for assessing land condition and sustainable land management at the field level and tools for assessing land degradation from	**Output 3.1.1**. LandPKS mobile platform with functionalities to retrieve degradation assessment from Trends.Earth and collect field

Expected Outcomes and Indicators	Project Baseline	End of Project Target	Expected Outputs and Indicators
collection and remote sensing data at multiple scales developed *Indicator 3.1.: # of approaches to support monitoring of LDN target progress integrating field and remote sensing data completed and available through project website*	land degradation and progress towards LDN	remote sensing data will be integrated into user-friendly workflows to improve land degradation assessments at multiple scales.	data on land condition to contextualize remote sensing analysis *Indicator 3.1.1.: # of mobile applications with capabilities for working in an integrated manner with Trends.Earth* Output 3.1.2. LandPKS mobile platform with functionalities to collect and distribute data on sustainable land management practices harmonized with simplified version of WOCAT SLM database *Indicator 3.1.2.: # of mobile applications with capabilities for collecting and distributing data on sustainable land management* Output 3.1.3. Integrated workflows for assessing changes in land condition combining Trends.Earth indicators with other monitoring tools, such as Collect Earth developed *Indicator 3.1.3.: # of integrated workflows for assessing change in land condition combining remotely*

Expected Outcomes and Indicators	Project Baseline	End of Project Target	Expected Outputs and Indicators
			sensed indicators with field data completed Output 3.1.4. Documentation and guidelines for performing integrated assessments of land condition at national and subnational scales using WOCAT, LandPKS, Trends.Earth, Collect Earth and other tools available through project website. *Indicator 3.1.4.: # of step by step guidelines for performing integrated assessment of land condition using remotely sensed data, mobile applications and databases on sustainable land management completed and available through the project website*
Outcome 3.2.: Decision support tool for identifying LDN priorities implemented into Trends.Earth *Indicator 3.2.: # of modules added to Trends.Earth to support decision making for LDN planning*	Lack of user-friendly platforms for supporting decision making processes on planning for Land degradation neutrality (LDN)	Improved functionalities added into Trends.Earth to support stakeholders on identifying priority sites for intervention while planning for LDN	Output 3.2.1.: New version of Trends.Earth optimized for Quantum GIS software version 3 Indicator 3.2.1.: Version # of QGIS currently supported by Trends.Earth Output 3.2.2.: LDN priority setting decision support functionalities based on multi-criteria evaluation of geospatial data, field data and

Expected Outcomes and Indicators	Project Baseline	End of Project Target	Expected Outputs and Indicators
			participatory assessments at national level available through Trends.Earth Indicator 3.2.2.: # of datasets supported by the multi criteria evaluation tool developed for Trends.Earth in support of LDN planning Output 3.2.3.: Documentation and step by step guidelines for performing prioritization of LDN activities available through project website Indicator 3.2.3.: # of step by step guidelines for performing multi criteria analysis in support of LDN completed and available through project website.
Outcome 3.3.: Pilot testing and capacity building completed *Indicator 3.3.: # of tests completed in pilot country*	Integrated approaches combining field data collection though mobile phones, remote sensing analysis, and local expert knowledge on sustainable land management are not common in the context of LDN planning	Experience on the integrated usage of tools and approaches for assessing and monitoring progress towards LDN which will serve as case studies for users from other geographies	Output 3.3.1.: Degradation assessment for different geographies within the pilot country using improved biophysical indicators *Indicator 3.3.1.: # degradation assessment within the pilot country using improved biophysical indicators*

Expected Outcomes and Indicators	Project Baseline	End of Project Target	Expected Outputs and Indicators
			completed and shared with local stakeholders Output 3.3.2.: Pilot testing of mobile platform and WOCAT integration for verifying biophysical degradation indicators and collection of land management information *Indicator 3.3.2.: # of tests of mobile application, WOCAT database and Trends.Earth indicators completed within the pilot country* Output 3.3.3.: LDN prioritization analysis using decision support tool and participatory process with local stakeholders *Indicator 3.3.3.: # of LDN prioritization analysis using decision support tool and participatory process with local stakeholders completed in the pilot country* Output 3.3.4.: A capacity building workshop targeting 30 participants from key user groups (15 male and 15 female)

Expected Outcomes and Indicators	Project Baseline	End of Project Target	Expected Outputs and Indicators
			Indicator 3.3.4.: # of stakeholders, disaggregated by gender, trained
Component 4: Support UNCCD and its signatory countries by building capacity to support planning, monitoring, and resource mobilization for LDN			
Outcome 4.1.: Online and in-person capacity building on planning, monitoring, and reporting of LDN in support UNCCD 2021-2022 reporting cycle completed *Indicator 4.1.: # of online training modules produced and made available through project website*	Limited national capacity to access and process data to estimate land degradation using integrated approaches	National capacity to access and process data to estimate degradation improved	Output 4.1.1. Online modular training approach with videos and written materials available in three languages *Indicator 4.1.1.: # of gender appropriate online modules completed and available through project website* Output 4.1.2. Implementation of a community of users' platform to mainstream and facilitate trouble shooting and sharing of experiences and continued learning *Indicator 4.1.2.: # of users, disaggregated by gender, as members of the community of users' platform* Output 4.1.3. Capacity building workshop on tools for supporting UNCCD 2021-2022 reporting cycle

Expected Outcomes and Indicators	Project Baseline	End of Project Target	Expected Outputs and Indicators
			Indicator 4.1.3.: # of users, disaggregated by gender, as trained

ANNEX B: CALENDAR OF EXPECTED REFLOWS (if non-grant instrument is used)

Provide a calendar of expected reflows to the GEF/LDCF/SCCF Trust Funds or to your Agency (and/or revolving fund that will be set up)

N/A

ANNEX C: PROJECT TIMELINE

OUTCOMES/OUTPUTS	Timeline									
	Year 1				Year 2				Year 3	
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2
Outcome 1.1.										
Output 1.1.1: Remotely sensed data and algorithms for assessing changes in primary productivity at high spatial resolution (10-30 m) available through Trends.Earth										
Output 1.1.2.: Global land cover products at high spatial resolution (10-30 m) available through Trends.Earth										
Output 1.1.3.: Soil Organic Carbon (SOC) degradation indicator at high spatial resolution (10-30m) available through Trends.Earth										
Output 1.1.4.: Updated documentation and step by step guidelines for using high spatial resolution indicators (10-30 m) available through project website										
Outcome 2.1.										
Output 2.1.1.: Evaluation of approaches for assessing socio economic vulnerability to drought and interplay with land degradation										
Output 2.1.2.: Global drought and early warning datasets added to Trends.Earth for supporting analysis and visualization of analytical results										
Output 2.1.3.: Global socioeconomic datasets to support UNCCD Strategic Objective (SO) 2 added to Trends.Earth for supporting analysis and visualization of analytical results										
Output 2.1.4.: Case study performed in a pilot country										
Output 2.1.5.: Documentation and step by step guidelines for using climate, and socioeconomic variables available through project website										

Outcome 3.1.										
Output 3.1.1.: LandPKS mobile platform with functionalities to retrieve degradation assessment from Trends.Earth and collect field data on land condition to contextualize remote sensing analysis										
Output 3.1.2.: LandPKS mobile platform with functionalities to collect and distribute data on sustainable land management practices harmonized with simplified version of WOCAT SLM database										
Output 3.1.3.: Integrated workflows for assessing changes in land condition combining Trends.Earth indicators with other monitoring tools, such as Collect Earth developed										
Output 3.1.4.: Documentation and guidelines for performing integrated assessments of land condition at national and subnational scales using WOCAT, LandPKS, Trends.Earth, Collect Earth and other tools available through project website										
Output 3.2.										
Output 3.2.1.: New version of Trends.Earth optimized for Quantum GIS software version 3										
Output 3.2.2.: LDN priority setting decision support functionalities based on multi-criteria evaluation of geospatial data, field data and participatory assessments at national level available through Trends.Earth										
Output 3.2.3.: Documentation and step by step guidelines for performing prioritization of LDN activities available through project website										
Output 3.3.										
Output 3.3.1.: Degradation assessment for different geographies within the pilot country using improved biophysical indicators										
Output 3.3.2.: Pilot testing of mobile platform and WOCAT integration for verifying biophysical degradation indicators and collection of land management information										

Output 3.3.3.: LDN prioritization analysis using decision support tool and participatory process with local stakeholders										
Output 3.3.4.: A capacity building workshop targeting 30 participants from key user groups (15 male and 15 female)										
Output 4.1.										
Output 4.1.1.: Online modular training approach with videos and written materials available in three languages										
Output 4.1.2.: Implementation of a community of users' platform to mainstream and facilitate trouble shooting and sharing of experiences and continued learning										
Output 4.1.3. Capacity building workshop on tools for supporting UNCCD 2021-2022 reporting cycle										