Sustainable livelihoods and adaptation to climate change (SLACC) project

Terms of reference for project integrated monitoring and evaluation (M&E) with remote sensing and geographical information system (GIS)

1. Background

The Sustainable Livelihoods and Adaptation to Climate Change (SLACC) Project is being implemented in Madhya Pradesh and Bihar under National Rural Livelihoods Mission (NRLM) of Ministry of Rural Development (MoRD), Government of India. National Rural Livelihood Promotion Society (NRLPS) is the coordinating agency under MoRD, whereas State Rural Livelihoods Missions of Madhya Pradesh and Bihar are the implementing agencies. The SLACC project is funded by the GEF-administered Special Climate Change Fund managed by the World Bank. This is a three years project. The project will be implemented in villages) 8 blocks in four districts of Bihar and Madhya Pradesh. In Bihar the project is being implemented in Gurua and Barachatti block of Gaya district, Khajauli and Rajnagar block of Madhubani district. In Madhya Pradesh the project is implemented Mandla and Bichiya blocks of Mandla district, Karhal and Sheopur blocks in Sheopur District. . The states have selected one drought and one flood prone districts for climate change interventions. SLACC project will be implemented in convergence with the MKSP, MGNREGS and other programmes of the Government contributing to strengthen climate resilience.

2. Project Objectives

The Project Development Objective (PDO) is to improve adaptive capacity of rural poor engaged in farm-based livelihoods to cope with climate variability and change. The components of the project are:

a) ***Component 1*** - Planning, Service Provision and Implementation of Climate Change Adaptation. The objective of this component is to support risk assessment, planning, service provision and implementation of climate change adaptation interventions. A key input to improving adaptive capacity is knowledge of weather and its impact on farming through local weather information and crop advisories. Weather information will also form the basis for delivering weather-linked insurance products that help farmers transfer weather related risk.

b) ***Component 2*** **-** Scaling and Mainstreaming Community-based Climate Adaptation. This component seeks to build the capacity of the national and state level staff of NRLM and build a cadre of CRPs to mainstream and scale-up planning and implementation of climate change adaptation in the country.

c) ***Component 3*** -Project Management and Impact Evaluation. This component will support creation of climate change adaptation units in the NRLM and SRLMs to manage the SLACC project. Monitoring and evaluation (M&E) of the SLACC project is a key task under this component and the objective is to facilitate result-based management and provide the basis for evidence-based decision-making processes. The M&E system is also intended to enhance learning on climate change adaptive management during implementation because of the considerable uncertainties involved in community-based adaptive interventions that still require experimentation and learning. The M&E system will employ a variety of tools including monthly remote sensed data to provide continuous feedback to the project management and other stakeholders on the progress and quality of project implementation. The beneficiaries will use the monthly monitoring data to consistently make adaptive adjustments to depart from their business as usual practices to overcome climate change vulnerabilities.

This assignment is related to developing and implementing a Monitoring and Evaluation system for the SLACC project in Bihar and Madhya Pradesh that includes a hybrid approach of using remote sensing (RS) and geographical information system (GIS) technologies with more conventional qualitative and quantitative survey techniques. The RS & GIS technologies will also develop climate change and crop suitability plans that are based on historical climate data and projected climate data for the project villages.

3. Objective Of the Consultancy

The objective of the consultancy is twofold:

a) To ***prepare a climate change and farm-based livelihoods suitability plan*** that is based on historic, current climate analysis and future climate scenarios for each project village.

b) To ***develop and implement a GIS MIS system*** that measures, tracks and reports progress against indicators mentioned in the Results Framework and the GEF Tracking Tool.

The service provider is expected to use remote sensing, GIS, smart-phone technology and other appropriate technology in data collection, processing, analysis and presentation of results. The baseline, bi monthly crop monitoring reports, monthly progress reports and thematic reports should be provided in a timely manner so as to enable scientific evidence-based decision making by the project management and the communities. This assignment seeks to introduce a smart phone based ICT-based culture in the project that removes drudgery of data collection through paper-based systems and the associated non-utilization of data collected, due to limited access to all levels of users. In short, this assignment will create systems such that data is collected and stored and shared electronically so that it is always available to a user on demand without barriers of location, distance and access.

4. Scope of activities

Prepare Climate Change and Farm-based Livelihood Suitability Plan

The service provider will develop a climate change adaptation plan that takes into account historical medium resolution (30m) satellite imagery of at least 25 - 30 years and weather data of 60 - 100 years depending on data availability for each project district. Further the local natural resources such as soil, water, etc. would be mapped and analyzed for assessing suitability of current farm-based livelihoods up to 5 hectare plot level for each project village and suggest possible responses to climate change.

Similarly the service provider, using future climate scenarios and crop and livelihoods modeling will prepare climate adaptation plan covering the next 10, 20, 30 years horizon including crop and livelihood suitability for each project village at a resolution of 0.10 hectare.

In preparing the above historical, current and future sets of plans, the service provider will use appropriate remote sensing images, maps and analysis (Refer Annex-2). The tasks will be coupled with geotagging of all SLACC beneficiaries land assests and natural resources as appropriate for collecting data from the project villages and control villages (list will be provided by the project team). Data needs for carrying out this task are expected to overlap significantly with data needs of the M&E baseline survey; hence the service provider needs to closely coordinate with the M&E service provider (procured separately).

Task 1: Baseline, GIS and MIS System development

a) Identify and measure indicators that form part of Climate change resilience index (CCRI) especially ecological, further where feasible economic, social and human indicators.
b) Develop a Baseline land use land use change and forestry (LULUCF) for 25 - 30 years from 1989 using freely available Landsat (30 m), or Aster imageries LISS 3 and LISS 4 imageries and other additional imageries provided by the project.
c) Provide geo locations and maps for collection soil and water samples in all project villages and control villages
d) Produce a LULUCF baseline report that amalgamates the baseline developed by the M&E service provider. Produce a climate change and farm-based livelihoods suitability report based on historic climate data, current analysis and projected climate scenarios that uses UNFCCC/ IPCC protocols for downscaling and up scaling data sets.
e) Develop a simple community friendly geotagged photo based android app to facilitate household level data collection of agriculture plots data and interventions of SLACC farmers by community resource persons (CRP). This data will be used in household / group / village level climate change adaptation planning.
f) Pilot test and validate the use of small drones with the permission of district authorities for video based inventory assessment Natural resources and crop productivity estimates for possible scaling up for concurrent monitoring.

Task 2: GIS integrated MIS System development

a. Develop and establish a robust Web GIS MIS system that would consist widgets for legend, layers list, print, advanced search, 30m DEM SRTM & 5m Cartostat DEM based watersheds, contour generator upto 0.25 mt intervals, elevation profile, auto report generator up household level with select geotagged photos, KML data import, weightage analysis etc. The data collection module should encompass data collation, maps integration, data display for Android smart phones and develop a data analysis, data query and data archives in Windows or Linux systems in consultation with the project. The GIS MIS should have import and export interfaces to collate geotagged data from AWS, Crop advisory and M& E systems etc. The Web GIS platform should be Android system compatible for display and if possible for the widgets as well.
b. Data collection module: Develop an Android smart app for geotagged photo based data collection with auto GPS switch on function that would be independent of mobile network for collection and input of data at the field level. . Pictures will be geotagged to enable to be viewed and analyzed using appropriate GIS software. Data will be collected inter alia, during baseline, concurrent, mid-term and end of project surveys. The service provider will develop data collection methods that are based on use of remote sensing, GIS and other ICT tools. As far as feasible, input of data collected at the field level will be through use of smartphones only. Paper-based data collection will be minimized to the extent possible.
c. Data upload/input module: The service provider will develop a module for uploading/inputting data collected from various sources[1] and from various levels of the project. This module will provide interface to upload data in an electronic form from smartphones, GIS platforms, remote sensed data, and also manual entry from paper-based

[1] Sources of data other than M&E surveys could be from crop advisory services, weather data, weather indexed insurance performance, etc.

data source etc. The focus will be on developing input methods that are based on smartphone apps that remotely upload data into a central database.

d. Data storage, processing and generation of standard reports module: Data uploaded will be stored in a central and state servers at NMMU and state level in the form of appropriate GIS-MIS databases. The module will auto generate regular GIS MIS reports at monthly, quarterly, half-yearly, yearly and for any other periods as required from time to time and display results through a web-based portal that also has GIS interfaces.
e. Install the GIS MIS systems in project devices at National, State, District, block and village level. Manage data collation, analysis, query, and display in Android and Windows / linux systems. The service provider will develop a web based MIS system that also provides a GIS interface to the user. Specifically, the GIS MIS system will comprise the following modules.
f. Customize an open source GIS Software with widgets for simple analysis, query, file conversion from common GIS to Google earth.

Task 3: Concurrent monitoring to track project results

a) Develop a standard report format to provide satellite data analysis (freely available LANDSAT and project procured AIWFIS) inputs every 15 days using remote sensed data on soil nutrient status, moisture level, crop cover, crop cover variations, crop phenology, crop health, projected crop yield estimates, at a resolution of 5 Ha for each project village for the entire duration of the project (approximately 18 months). These data sets and may be used as inputs to the crop advisory system (the project has procured an ICT-based crop advisory system separately).
b) The Service provider will validate the RS projected estimates provided for every 5 ha plot for various crops in representational sample villages across 4 district at end of every crop season by participating in the crop cutting experiments (CCE) together with communities and other stakeholders in project and control villages and use the data to further improve its projects. The project will video (fhd /4k) document them for transparent record keeping.
c) Data and maps generated will be made available in most commonly used file formats in GIS – MIS that can be imported and used by an ICT-based crop advisory service that the SLACC project has procured.
d) Produce a report that documents and compares the performance of selected crops (farm based livelihoods) in treatment and control villages at the end of every crop season (Kharif, rabi and zaid) as well as at the end of a year.
e) Integrate and display the self-monitoring format by the communities via smartphone interface.
f) Produce periodic reports (monthly, quarterly, half-yearly and yearly) on project activities and outputs that among others address and collates to the intermediate results indicators detailed in the results framework.

Task 4: Inputs to Mid-term and End-of-Project Evaluation

a) The service provider will map out all possible project results based framework indicators that can be monitored directly or indirectly using the remote sensing, GIS & MIS data base and track their progress on monthly basis and include them in the monthly reports.
b) the service provider will carry out atleast three thematic studies[2] that would cover issues such as agricultural productivity and its stability water-use efficiency due to climate change, area of farmland having adopted climate adaptive practices, and soil and water

[2] The scope of these studies will cover technical, economic, social and environmental assessment of the theme and will be against the backdrop of climate change and variability

status of project villages before and after project interventions, land use land use change and forestry on household income and income variability, livelihoods diversification due to climate change, , etc.

c) The reports prepared under (a) and (b) should provide adequate data and information for carrying out a detailed impact evaluation study that covers technological, economic, social and environmental dimensions.

d) The service provider in consultation with the NMMU, the World Bank and the respective SRLMS in Bihar and Madhya Pradesh will provide inputs to the ToRs for carrying out an impact evaluation study at the end of the project.

Task – 5: Trainings and training manual

a) Prepare step by step bilingual (Hindi and English) video tutorials with subtitles and conduct five day hands of field training on smart phone based android app for community resource persons and all project staff in each project blocks.

b) Prepare step by step bilingual video tutorials with subtitles and conduct two day training on use of GIS MIS database on data collection, collation, upload, download, store, secure, retrieve, query, display, report generation etc. in each project blocks.

Key Outputs of the Assignment

a) Climate change and farm-based livelihoods suitability plan that is based on historic climate data and current climate project climate scenarios using remote sensed data for each project village (upto 0.10 Ha. resolution)

b) Report on crop performance (farm-based livelihoods) at the end of crop season and at the end of the year for each project (upto 5 Ha. plot level) village and selected control villages. (on going, but beginning with the end of the first crop season that starts after the inception of the assignment).

c) A web based District climate change atlas with all data sets downscaled, downloadable and interlayable data at panchayat, block and taluk level in shape, kml or kmz formats.

d) Android app to collect geotagged photo based data collection, data entry, report view, and search functions through Web GIS.

e) Customize an open source GIS Software with widgets for simple analysis, query, file conversion from common GIS to Google earth.

f) Analytical inputs for mid-term and end-of-project reports based on remote sensing analysis and internal M&E.

g) Report on thematic studies for themes selected in consultation with NMMU, World Bank, LTSA, and the respective SRLMS (12 months from start of assignment)

h) A web and GIS based MIS system that can receive inputs remotely from smart phones as well as display reports on various ICT platforms including android based smart phones.

i) Remote sensing and GIS maps and databases (refer annex -2)

j) Video tutorials and documentation on trainings conducted

5. Location, Duration, and Institutions

The project is operational in the states of Madhya Pradesh and Bihar for 2 years (2016-2018). The project will cover more than 200 villages identified for project interventions spread across 08 blocks in 4 districts of Bihar and Madhya Pradesh. The project institutional arrangement

- *National Level*: MoRD is the key implementation agency and National Rural Livelihoods Promotion Society (NRLPS) under the MoRD would be responsible for management, supervision, guidance and technical support. The NRLPS will coordinate with the SRLMs for implementation of the SLACC project.

- *State Level*: The Madhya Pradesh Rajya Ajeevika Forum (MPRAF) will be the nodal agency for SLACC implementation in Madhya Pradesh, while the Bihar Rural Livelihoods Society (BRLPS) will be the nodal agency for SLACC implementation in Bihar. These SRLMs, established by the rural development departments in the states, will be responsible for the outputs and outcomes of the project at the state level, and for mobilizing co-financing for coordinating and implementing the project at the state level.

- *Community Institutions*: The SLACC will work with community institutions supported by the NRLM. These include the primary federations of women's self-help groups as well as common interest/producer groups and producer companies. A trained CRP will be placed in each village or producer company to provide ongoing support to these institutions on climate adaptation planning, implementation and monitoring. A committee will be created within the community institution to anchor climate adaptation interventions.

6. Consultant Firm Staff qualification requirements

The Consulting firm staff should be long standing have expertise in Advanced Remote sensing, downscaled historical land use land use change and forest (LULUCF) at 0.1/0.5 ha level, soil and forest inventory, water analysis, farm scale crop planning (1 -5 ha), agriculture, natural resources, vulnerability analysis, rural development, livelihoods, watershed, crop to site suitability, climate change adaptation options etc. The consulting firm should also have experience in developing using software for smartphones for digitized base line data collection with geo tags. The firm should have in house expertise or could form joint venture or hire consultants. The senior staff of the Service provide and its JV partners should be directly involved in the day to day project technical analysis and management and will be responsible for the delivery of the outputs. The Senior staff of the team should have been at least fifteen years of standing and high reputation for professional excellence and should have been with the service provider and /or JV partner atleast for a year. Additional experience of key technical personnel in development projects, participatory approaches is essential. While evaluating the proposal qualifications and experience of the below personnel will be considered. Inputs in terms of person months of each of these staff should be included in the technical and financial proposals.

Nos.	Key Position	Professional Experience required	Estimated person-month
1	Team Leader Remote	PhD/ ME / MSC/ MCA in Remote Sensing, GIS, Geo technology, Geo informatics or related discipline. More than 20 years Hands on work experience in	12 months

	Sensing & GIS (part time) Home based with periodic travels to field	leading integrated analysis of Soil, Water, Agriculture and NRM areas. Hands on experience in working with large sets of very high, high, medium and low resolution global and Indian satellite image processing project experience. Worked as team leader for World Bank, Asian Development, African Development Bank, , UN, international, bilateral and national clients projects. Having international project experience in developing countries; Expertise with ArcGIS and QGIS software; Knowledge of ESRI and open-source web mapping GIS applications; Familiarity with relational databases, SQL and SQL lite; Professional experience in GIS compilation and database development; Excellent knowledge of GPS technology and its application to GIS compilation. Should have atleast worked 1 year experience with firm or with the JV partner leading RS-GIS projects.	
2	Senior GIS expert (part time) With Regular travels to field	PhD/ ME / MSC/ MCA in Remote Sensing, Agriculture, Irrigation engineering, GIS, Geo technology, Geo informatics or related discipline. More than 10 years of project experience in handling in Integrated GIS data base management and analysis in Watershed, Irrigation, Agriculture, Livestock, NRM etc with international and national clients. Expertise with ArcGIS and QGIS software; Knowledge of ESRI and open-source web mapping GIS applications; Familiarity with relational databases, SQL and SQL lite; Professional experience in GIS – MIS compilation and database development; Excellent knowledge of GPS technology and its application to GIS compilation, experience in coordinating and coordinating various baseline data collection studies, integrating PRA data into GIS, RS data base. Good understanding of Participatory monitoring and evaluation. Should be atleast having 1 year experience with organisaiton or with the JV partner.	18 months
2	RS – GIS - MIS experts (Full time) 1 for Bihar (field) 1 for MP SRLM (field)	Masters in Remote sensing with bachelor's degree in Agriculture, Biology, Geography, Rural Development or geo informatics, or Geography or statistics. Detailed knowledge with work experience in GIS/geospatial technology and data base management with National / international agencies; 3 to 5 years in various GIS database projects for national and international agencies in Geography, agriculture, etc. Expertise with ArcGIS and QGIS software; Knowledge of ESRI and open-source GIS web mapping applications; familiarity with relational databases SQL and SQL lite; Professional experience in GIS compilation and database development; Excellent	18 months

		knowledge of smartphone based GPS technology and its application to GIS data compilation.	
8	8 one based at each block	Masters or PG Diploma in Remote sensing, Agriculture with remote sensing as ancillary, with bachelor's degree in preferably Biology, botany, Zoology, geology, forestry and soil sciences. Detailed knowledge with work experience in GIS/geospatial technology; for non-agriculture students should have 1 - 3 years in various GIS database projects for national and international agencies in agriculture, NRM, environmental management etc. Expertise with ArcGIS and QGIS software; Knowledge of ESRI and open-source GIS web mapping applications; familiarity with relational databases SQL and SQL lite; Professional experience in GIS compilation and database development; Excellent knowledge of GPS technology and its application to GIS compilation to be based in the respective blocks.	18 months
2	Web and Android software development experts Home based	BE/ ME/MSC/MCA in Information technology. 1- 5 yrs experience in national or international projects in Android app development and web based data base program; Have successfully released Android apps on Google Play for versions above 4.2. Some experience in training technicians in using the data base MS office, MS excel; Working knowledge on Google Maps, Software Testing; Have good experience with Android, HTML5, CSS, Java, JavaScript, J2EE/Core Java, Asp.net, .net, C#, C++ Programming, SQL Programming, Studio SQLite, Additionally knowledge in some of the Web Services (DOM,SAX & XML Pull Parser), Dom Json, Json Parsing, Android Studio, Android SDK, and Android Components Knowledge, Multithreading, strong background in Android and , Database SDK Integration; Adt Knowledge other software development, Have experience designing and developing RESTful web services;	18 months

7. Deliverables and Payment schedule

Item	Outputs/ Reports / Deliverables	Payment	Submission dates
1	- Inception report, work plan and DEM layers for the districts, blocks and villages - MIS- GIS reporting formats for all stakeholder - list of Indian satellite images to be procured by the project. - Web GIS - MIS and widgets data base architecture with drill down data base up to household level agriculture plots. Android smartphone interface.	10%	1st month

	- Design outline for Android app for Geotagged data collection, view and query by CRPs and project team. - Develop a draft monthly progress tracking report format consisting project indicators using remote sensing and GIS data for all key implementing and support agencies. - Google earth clipped current and historical images for each selected villages in four districts.		
2	- Field training for project staff and CRPs to use smartphones and computers for viewing google maps, google earth, google earth pro, for satellite image viewing android app, data collection using GPS data on smart phone house hold, photographing, editing, uploading geo tagged photos, short video capture by CRPs, for MIS- GIS and house location etc. - Android app for Geotagged data collection, view and query by CRPs and project team. A brief summary report after each phase 1 geotagged photo field survey 10% of the villages household land parcels covered with CRPS - Downscaled LULUCF maps for last 25 years using landsat, LISS 3 and LISS 4 for the 4 selected districts - Monthly monitoring reports for first and second month.	15%	2nd month
3	- 3D Remote Sensed maps and District Climate change Atlas with Crop suitability and livelihoods options draft report, GIS data, second field visit and training completed. - Validated Android smartphone app. - A brief summary report after phase 2 geotagged photo field survey 40% of the villages household land parcels covered with CRPS - Customized open source GIS Software with widgets for simple analysis, query, file conversion from common GIS to Google earth. - Monthly monitoring reports for third and fourth month.	10%	4th month
4	- Baseline report for treatment villages and control villages - Climate change and farm-based livelihoods suitability plan that is based on historic climate data and project climate scenarios using remote sensed data for each project village (upto 5 Ha. resolution) and detailed Climate change district atlas and finalised,	5%	6th month

	- A brief summary report after phase 2 geotagged photo field survey 100% of the villages household land parcels covered with CRPS - SLACC household database with drill down options in GIS MIS A web and GIS based MIS system that can receive inputs remotely from smart phones as well as display reports on various ICT platforms including android based smart phones. - conclusion of the complete baseline survey a draft final report - monthly monitoring reports for fifth and sixth month		
5	- Monthly monitoring progress reports with major crop phenology reports first week of each month Monthly Report on crop performance (farm-based livelihoods) at the end of crop season and at the end of the year for each project (upto 5 Ha. plot level) village and selected control villages. (on going, but beginning with the end of the first crop season that starts after the inception of the assignment) - SLACC household plans down options in GIS MIS - Mid Term report project inputs.	15%	9th month
6	- Monthly monitoring progress reports by first week of each month (5% for 6 months) - Report on 1 thematic studies for themes selected in consultation with LTSA, NMMU and the respective SRLMS.	15%	12th month
7	- Monthly progress reports by first week of each month (5% for 6 months) - Report on 2 thematic studies for themes selected in consultation with LTSA, NMMU and the respective SRLMS.	15%	15th month
8	- Approval of the final reports - Climate change online atlas for four districts, block, village atlas and GIS- MIS data on fully functional online web GIS and smart phone app, detailed report to be provided in A3 Word format using World Bank report standards. - GIS data base layers to be provided in most widely used shape and KML/KZM format, and any project WBADMIP specific format if required. - All word reports would be provided in 4 copies with soft copies in data secure hard disks & DVD's.	15%	18th month

	- Final evaluation report, final published, technical papers and atlas, presentations and video tutorials for training - -End of project report		

8. Composition of review committee and review procedure to monitor consultants work and reports

The review committee will comprise of following seven officers:

i. CEO and State Mission Directors (MP and Bihar) [also chair and co-chair]
ii. M&E Specialists (MP and Bihar)
iii. NMMU Lead Agriculture Coordinator
iv. NMMU M&E Specialist

The consultant will interact with the committee:

i. At the time of Inception of study.
ii. Before finalization of mid-term reports.
iii. Before finalization of draft reports.
iv. During the preparation of Final reports.
v. If needed, after review of the monthly progress report.

The Chairman and Co-Chair can co-opt any other member if he finds it necessary.

The procedure of review will be as follows -

1. The consultant will submit the printed Reports in 24 Copies in both English and Hindi and will also provide an electronic copy of the same. Final datasets should be submitted in both ASCII and STATA/SPSS.
3. The consultant will always submit the draft of each report on the stipulated dates and the Review Committee will give its comments in period not exceeding 45 days from the date of receipt of the draft report. The consultant will incorporate the comments and suggestions of the Review Committee and submit the Final version of the Report in period not exceeding 30 days from the date of receiving the comments of the Review Committee.
4. The Review Committee will accept the report and then the agreed amount for the Report will be paid to the consultant.

9. Support to be provided to the consultants by GoMP and GoB

The RS –GIS Consultant team leader will be reporting to the CEO and State Mission Directors and will work closely with the NMMU officials at the headquarter of NRLM and obtain technical guidance from World Bank project team at New Delhi and also the implementing Staff to design and undertake the review.

a. The project will provide key back-ground documentation to the team (project appraisal document, supervision mission reports, any progress reports, special studies conducted by the Project, and background information on the project area and the reports from the participatory M&E by the Village communities).
b. Procurement of required cloud free (5%) Indian satellite images (AWFIS, LISS3, LISS 4, Cartosat 1 or 2) for past 20 years, present data up to the project end.
c. Adequate office space for Dual screen workstation computer table, revolving chair one RS- GIS staff at NMMU, SRLM, District and blocks offices work during entire project period.
d. Adequate electricity, water, basic amenities, meeting hall space at SMMU, DMMU, BMMU and VO's during data collection, training and data validation missions.

e. Required level of access to NRLM / SRLM MIS data base of respective districts to import, analyse and post data.
f. Three advanced dual screen Xeon processor workstations one at NMMU and two at SMMU of satellite data with required RS, GIS and common windows software.
g. One All in one computer with table, chairs, internet and basic amenities to be provided to each of the GIS consultant at the block / district office.

The consultants will make their own arrangements for equipping the office space with needed map printing supplies materials, conveyance for staff for field, telephone and communication facilities and the client will not be responsible for these.

Annex 1: Results Framework and Monitoring

INDIA: Sustainable Livelihoods and Adaptation to Climate Change Project

Results Framework

Project Development Objective

The Project Development Objective (PDO) is to improve adaptive capacity of the rural poor engaged in farm based livelihoods to cope with climate variability and change.

PDO Level Results Indicators	***Core***	***Relevant Indicator in Tracking Tool***	***Unit of Measure***	***Baseline***	***Cumulative Target Values***				***Frequency***	***Data Source / Methodology***	***Responsibility for Data Collection***
					YR 1	YR2	YR3	YR4-end target			
Indicator One: At least 50% of the targeted households adopt livelihoods with enhanced climate resilience	☐	Indicator 1.3.1.1 – % of targeted households that have adopted resilient livelihoods under existing and projected climate change	Percentage of households	0	-	10%	25%	50%	Yearly; mid-term and end-of-term evaluation	Score on a climate resilience index that will be developed. MIS, monitoring reports, evaluation	NMMU, SMMU; external evaluation
Indicator Two: At least 50% of the targeted households demonstrate strengthened awareness and ownership of adaptation and climate change risk reduction processes/measures	☐	Indicator 2.2.2 – Capacity perception index Indicator 2.3.1 – % of targeted population awareness of predicted adverse impacts of climate change and appropriate responses	Percentage of households	0	-	20%	40%	50%	Yearly; mid-term and end-of-term evaluation	MIS, monitoring reports, evaluation	NMMU, SMMU; external evaluation

INTERMEDIATE RESULTS

Intermediate Result (Component 1): Support community-based planning and implementation of climate adaptation interventions.

Intermediate Results Indicators	***Core***	***Tracking Tool Reference***	***Unit of Measure***	***Baseline***	***Cumulative Target Values***				***Frequency***	***Data Source / Methodology***	***Responsibility for Data Collection***
					YR1	YR2	YR3	YR4-end target			
Indicator One: At least 8000 farmers demonstrate climate resilient agricultural practices	☐	Indicator 1.2.1.3– Climate resilient agricultural practices introduced to promote food security	Number of farmers	0	2000	6000	8000	8000	Yearly	MIS, monitoring reports	NMMU and SMMU

		Indicator 2.3.1.1 – Risk reduction and awareness activities introduced at local level.									
Indicator Two: At least 30% of the community institutions access technical and/or financial support for climate adaptation plans through convergence with government programs.	☐		Percentage of community institutions	0	-	10%	20%	30%	Yearly; mid-term and end-of-term evaluation	MIS, monitoring reports, evaluation	NMMU, SMMU; external evaluation
	Intermediate Result (Component 2): Build core operational capacity and relevant knowledge base/networks for broader scaling and mainstreaming of climate adaptation interventions.										
Intermediate Results Indicators	***Core***	***Tracking Tool Reference***	***Unit of Measure***	***Baseline***	***Cumulative Target Values*** YR1	YR2	YR3	YR4-end target	***Frequency***	***Data Source / Methodology***	***Responsibility for Data Collection***
Indicator One: At least 800 VO/self-help groups and community resource persons are trained in adaptation-related technologies.	☐	Indicator 2.2.1 – Number and type of targeted institutions with increased adaptive capacity to reduce risks and response to climate variability Indicator 2.3.1.2 – Number and type of community groups trained in climate change risk reduction	Number of community-based individuals	0	200	400	600	800	Yearly	MIS, monitoring reports	NMMU and SMMU
Indicator Two: At least 300 staff of state and district offices as well as extension and rural service providers trained on technical adaptation themes.	☐	Indicator 2.2.1.1 – Number of staff trained on technical adaptation themes	Number of staff	0	0	0	150	300	Years 3 and 4	MIS, monitoring reports	NMMU and SMMU
Indicator Three: Climate change adaptation guidelines developed for NRLM Implementation Framework and	☐	Indicator 1.1.1 – Adaptation actions implemented in national/sub-regional development frameworks.	Number of guideline documents developed and disseminated	0	0	0	0	1	End-of-term evaluation	Evaluation	NMMU; External evaluation

disseminated to all SRLMs										
	Intermediate Result (Component 3): Establish management units within the NRLM and SRLM institutional structure to enable coordinated functioning and efficient implementation of SLACC.									
Intermediate Results Indicators	***Core***	***Tracking Tool Reference***	***Unit of Measure***	***Baseline***	***Cumulative Target Values***				***Frequency***	***Data Source / Methodology***	***Responsibility for Data Collection***
					YR1	YR2	YR3	End Target			
Indicator One: Established Climate Adaptation Units staffed with full-time professionals within the NMMU and the SRLMs of the participating states			Number of climate adaptation units	0	3 (NMMU plus 2 SRLMs)	3	3	3	Yearly; mid-term and end-of-term evaluation	MIS, monitoring reports	NMMU and SMMU
Indicator two: State level resource agencies and/or technical service providers for providing field level technical support appointed and operational			Number of resource agencies	0	1	2	2	2	Yearly; mid-term and end-of-term evaluation	MIS, monitoring reports	NMMU and SMMU

Annex -2

Detailed remote sensing and GIS – MIS data base for M&E)

- Develop a Web GIS portal compatible with Android, Windows based computers and smartphone systems. It would consist widgets for legend, layers list, print, advanced search, 30m DEM SRTM & 5m Cartostat DEM based watersheds, contour generator upto 0.25 mt intervals, elevation profile, auto report generator up household level with select geotagged photos, KML data import, weightage analysis etc. The data collection module should encompass data collation, maps integration, data display for Android smart phones and develop a data analysis, data query and data archives in Windows or Linux systems in consultation with the project. The GIS MIS should have import and export interfaces to collate geotagged data from AWS, Crop advisory and M& E systems etc. The Web GIS platform should be Android system compatible for display and if possible for the widgets as well.
- Develop an Android app compatible with 4.0 and above for Geotagged data collection, view and query by CRPs and project team bilingual (Hindi and English) with voice assistant. The Android app must auto switch on the GPS when app starts for fail safe geotagged photo based data collection using on GPS/GLONASS independent of mobile network. The camera function should have the full functionality of the smartphone camera to ensure quality. The app should have auto review to verify the photos and videos taken are of acceptable quality and an inbuilt option for autoback up of the data with microsd. The app should have a data view, report generator and query. The App should also have simple community friendly self-monitoring and evaluation format to feed into auto report generation.
- Download all cloud free (less than 5% cloud cover) Satellite images available (Landsat 5, 6, 7, 8, SRTM, MODIS, ASTER, ALOS, LISS3, LISS 4, AWIFIS, Carotsat 1 &2, RISAT etc) continuously from 1989 and catalogue them for future analysis by the contractor personal located at the state and district unit for developing historical crop phenology.
- Download all google earth pro (available) historical high resolution images and clip them by blocks, meso, macro and micro watersheds attach selected geo tag photos of various village assets provided from the project.
- Obtain existing maps from Soil, water, geology etc. for project teams to use during the PRA's and Climate change action plan development. The GIS team of the contractor may participate to assist the project staff during various trainings. Add the soil test results to each of the tested plot.
- Extract free digital elevation model (DEM) from SRTM, ASTER and ALOS images 90m and 30m, 10m, 5m (from cartosat) contour intervals and clip DEM, drainage and other data at state, district, taluk / block, village and micro watershed levels in four districts. The 30m and 10m and 5m DEM should be loaded to the data base for extrapolated contor generation widget at 0.5 m intervals.
- Provide clipped data from state to micro-watershed levels in shape and KML file format of stream, contour, administrative boundaries, road, location names, etc. to view them as map layers in Bhuvan, WRIS, Arc GIS, Google earth and other web based GIS programs.
- Obtain demographics, census, gender, literacy, health, age distribution and other socio economic data create thematic data at SHG level, village, cluster, block and district level.
- Integrate household field data generated form project sites such as community PRA/RRA/ consultation results with science-based historical satellite imagery analysis and provide suggestions for communities, technicians and other stakeholders on possible CCA development activities and potentials. Add non spatial and spatial data comprising of available economic and demographic data and integrate the PRA asset photos, target villages with household data, and farm plot data (with GPS points) for future monitoring.
- Compile and provide cloud free image (less than 5% cloud cover) list of Indian satellite data to be procured by project for analysis - AWFIS (2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014 and 2015) LISS 3 (2005, 2010, 2015 three crop seasons), LISS 4 (2014 – 3 crop seasons),

Cartosat 1m for 2014 or 2015 or 2016 for the four districts and process them for all analysis listed below. Further these images shall be compiled and analysed during the project period and continuously updated on intranet, GIS MIS for project staff to view.

- Obtain IMD weather data for the last 100 years, 60 years depending on data availability and 30 years daily data and create rainfall maps for analysis at hourly/ daily, weekly, monthly, yearly, decadal scales for analysis. This data will be further augmented by the data from local automatic weather station data from the project areas.
- Create continuous time series maps (daily/ weekly, monthly and yearly) drought model and flood model using free images from SRTM, MODIS, ASTER, and other similar free satellite data for the four target districts for the last 10-15 years (from date of availability). Highlight any variability in monsoon onset, rainfall patterns, and integrate with IMD data analysis, other weather, LULUCF parameters crop phenology etc. Using this past and present models simulate climate change projections for next 10, 20, 30, 40, 50 year based on downscaled data and global/ regional / national climate models. Also provide simulated climate change scenario outputs for +/-1,2 & 3 degree temperatures, +/- 5%, 10%, 20%, 25%, 30%, rainfall and impacts of early / late onset of Kharif and Rabi village wise changes mapped.
- Carry out "semi supervised and automated pixel and sub pixel analysis digital analysis" of historical satellite images from freely available and relevant LANDSAT satellite imageries for time intervals (1990, 1995, 2000, 2005, 2010, 2011, 2012, 2013, 2014, 2015 and 2016) for the entire for entire year for detailed three season crop phenology (Kharif, Rabi and Zaid optional), leaf season, off leaf season, carbon sequestration and emission estimates using Indian Forest and other relevant UNFCCC definitions.
- Create multispectral stereoscopic 3D maps by merging Cartosat 1mand LISS 4 data further to selected districts, Taluks, Blocks, panchayats, watershed, village and project areas 1: 5,000 scale with detailed land use-land cover analysis and provide clipped data for each order of streams (1st to Highest order) demarcating micro, meso, macro watersheds grouped under basin and sub-basins, villages, villager buffer zone, villages, block, taluk, district and align the boundaries with WRIS WSD data.
- Detect historical land use, land use change and forest (LULUCF) change using Land sat, from 1990 – 2015 (1990, 1995, 2000, 2005, 2010 and 2011, 2012, 2013, 2014, 2015,2016) and compare them with LISS 3 and LISS 4 data procured from the project. This will act as baseline for the project and further analysed during the project period for periodic monitoring and impact evaluation.
- Geotag all water ways and calculate water stored in 0.5 ha and above harvesting structure, provide water budget within the project area. Provide a detailed water budget for each village using rainfall data, NDVI, NDWI, soil types, temperature etc. Based on inputs from Rain gauges and AWS develop a model to provide monthly by year 1 and progressively to twice / thrice weekly water balance by end of the project to facilitate irrigation scheduling by farmers. Provide a water potential map and monthly estimated water balance based on project provided rainfall data. Also integrate AWS and rain gauge data regularly to improve data accuracy for future climate change analysis.
- Develop an inventory potential location map for soil, water, forest, agriculture and to carry out a rapid inventory. Collect samples for detailed soil NPK, all macro, micro nutrients and detailed water analysis for all heavy metals and supply the samples on behalf of the project at accredited laboratories. Undertake a few representative inventory in each district of 1 ha plots of forest and trees outside forests, inventory and map major potential NTFP inventory for species (timber, tendu, Mahua, bamboo, etc.) mapping involving local forest department, and agriculture crop and livestock census data in each village in representative plots.
- Identify all agriculture, fallow and other land parcels that have potential for micro irrigation works, assisted natural regeneration in the upstream areas, minor irrigation development, design optimal common irrigation lines laying for drip, sprinkler and rain guns matching soil and crops (in GIS / Autocad/ relevant software).

- Develop climate-based Disaster Risk analysis maps clearly indicating the degraded areas, erosion prone areas, flood prone areas, drought prone areas, shifting cultivation areas, fire prone areas, and wastelands for all the villages in 1: 5,000/10,000 scale using Cartosat 1 m data and LISS 4 data..
- Carry out site suitability analysis for agriculture, livestock, aquaculture, and forestry development and enterprise with clear site suitability at district level using the latest high resolution multispectral imagery with possible climate change scenarios (flood, drought, land degradation, deforestation, erosion, etc.) identify and provide list of suggest adaptation and mitigation actions for communities to develop their resilience plans atleast at 5 ha scales.
- Identify land parcels for agriculture, livestock, NTFP, forestry, agro enterprise clusters and other non-farm development in the four districts integrating multi criteria weightage analysis.
- Using multiple criteria weighted analysis carry out crop to site suitability analysis for present crop varieties and suggest 10 to 20 best suited crops and alternate crop varieties for overcoming climate vulnerability for each cropping season (Kharif, Rabi and Zaid) amongst cereals, cash crops, horticulture, plantation (premium rice varieties, high value horticulture fruits and vegetables and plantation crop varieties) for mostly rain fed areas as well as partially irrigated areas.
- Carry out three field accuracy assessments and provide comparative analysis between medium, high, and very high resolution imagery data and stereoscopic imageries data.
- Organise a four day hands on training every six months for state level RS and GIS staff from government departments, universities etc on the detailed GIS methodologies. Develop a detailed training manual.
- Identify and demarcate locally viable, seasonal sources of biomass from agro residues (e.g. rice husk, cassava stems, invasive species, forests, livestock sources, etc.), and possible locations for setting up agro-residue- biogas plants of 50 - 100 kWh capacity based bio electrification enterprises and design mini grids map in villages for household supply.
- Identify best suited locations for installing 10 kw Solar photovoltaic for minor irrigation and above 2 MW solar thermal plant locations preferably in waste lands that are suited for off grid and on grid energy solutions to power agro industries and other sectors.
- Identify best suited and efficient value chain clusters for agro industrial promotion and marketing.
- Develop three scientific papers with 8000 words for World Bank seminar presentation and for publishing internationally in relevant peer reviewed journals.

GIS - MIS and M&E integration with remote sensing

- Conduct two trainings for field staff and community members to carry out Rapid Resource Inventories in all districts project areas to map out the catchments, command areas identify major plant species distribution, their distribution, and digitize land parcels in command areas with attributes.
- Develop Android Application and collect Geo-tagged photos and videos of SLACC project and convergence scheme assets, participating household and their farm lands in 200 villages in four districts of Bihar and Madhya Pradesh.
- Train the local community resource persons in Geo-tagging all participating households and control households their land assets, cropping practices and integrate them in the data base for monitoring and for impact evaluation.
- During the course of the project Provide monthly detailed crop phenology NPK nutrient data at 5 ha level for Kharif and Rabi season for major crops (Cereals, Millets, pulses and some vegetables) using free Landsat data and cloud free AWFIS data procured by the project.
- Procure LISS 4, AWFIS/ Land sat 8 or LISS3 images in early 2016 (mid-term evaluation), early 2018 (final evaluation) and carry out change detection.
- Integrate the NRLM SHG MIS data base with remote sensing and GIS data base to scale up climate change adaptation in non-participating villages in the district.

- Display the results in Web GIS software for computers and smart phones for data viewing and data entry.
- Establish way to extract the NMMU SHG data and develop an interface to use the data for various climate change and development analysis.