付　属　資　料

１．M/M 及び合同評価報告書

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１．M/M 及び合同評価報告書

MINUTES OF MEETING
ON
The Joint Terminal Evaluation Survey for
THE TECHNICAL COOPERATION PROJECT (SATREPS) ENTITLED:
THE PROJECT FOR ENHANCING RESILIENCE TO CLIMATE AND ECOSYSTEM CHANGES IN SEMI-ARID AFRICA: AN INTEGRATED APPROACH

Japan International Cooperation Agency (JICA) organized the Terminal Evaluation Team (hereinafter referred to as "the Team") headed by Mr. Hajime Nabeta, and the Team visited Ghana from August 8 to August 23, 2016, for the purpose of conducting joint terminal evaluation on the Project for Enhancing Resilience to Climate and Ecosystem Changes in Semi-Arid Africa: Integrated Approach (hereinafter referred to as "the Project").

The Japanese and Ghanaian Joint Terminal Evaluation Team (hereinafter referred to as "the JTE Team"), consisting of four members from the Japanese side and four members from the Ghanaian side, was formed. The JTE Team carried out intensive studies and analysis of activities and achievements of the Project and prepared the Joint Terminal Evaluation Report.

The JTE Team presented the JTE Report to the Project's Joint Coordinating Committee (hereinafter referred to as "JCC") meeting held on August 22, 2016 in Accra. Based on the presentation, the participants of the JCC exchanged their views.

The main points discussed are shown on the Attached Sheet as understanding between the Ghanaian and Japanese sides.

Accra, August 22, 2016

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Team Leader
Japanese Terminal Evaluation Team
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Ms. Yvonne Quansah
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Chief Director
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Attached Sheet

1. **Joint Terminal Evaluation:**
   Both sides agreed the result of the Joint Terminal Evaluation as Annex1.

2. **Recommendations:**
   JTE Team made recommendations based on the findings of the evaluation. Major recommendations are as follows:

   i. **Importance of the Ghana Model:**
   Although the scientific and evidence-based information and data are fundamental and essential resources for development activities as well as Climate Change Adaptation and Disaster Risk Reduction, these have not been utilized effectively because their importance might not yet be fully recognized or appreciated in general.
   Scientists could play pivotal role in showing the correct mechanism of climate change and natural disaster for the public and it would contribute to enhancing the people's understanding of the risk and enabling them to prepare for the future risk. Thus, the Ghana Model as scientific findings and research outputs of the Project should be applied and materialized as the risk awareness tools in user-friendly way for the public interest and benefit by the relevant stakeholders in the future.

   ii. **Strengthening of Ties for Further Utilization of the Ghana Model:**
   Since enhancing resilience of the society to Climate Change and natural disaster requires inter-disciplinary and cross-sectoral collaboration, collaboration among academia, researchers and practitioners such as Ministries and local government should be more strengthened in accordance with their roles based on the laws and regulations enforced in Ghana.
   For example, the National Disaster Management Organization (NADMO) and local government should utilize the Model and the outputs of the Project, which are scientific, and evidence-based information/data, for appropriate risk awareness education, hazard mapping and risk assessment.
   And Ministry of Education should support the interface between policy and science for decision-making.

   iii. **Clarification of the Ghana Model:**
   The Project, with supports from the relevant Ministries of Ghana, should accelerate final works to complete the Ghana Model, taking into consideration that, (i) the Model needs to clarify on the customized parts and common parts applicable to outside the Project; and, (ii) the Model needs to be clear about its advantage, and the different roles played by the different stakeholders in terms of social implementation.

   iv. **Identification of integration schemes:**
   The Ghana Model being a model that enables local people to overcome vulnerability to climate and ecosystem changes by integrating outputs of three research areas, the Project needs to identify schemes as to which data, information, and knowledge from Output 1 and Output 2 are utilized in Output 3, and how they are used.
   In order to apply the Ghana Model to other communities in Ghana as well as other African countries, continuous modification and upgrading should be required in the Post Project period by Ghanaian counterparts.

   v. **Establishment of the platform for dissemination and implementation of the Ghana Model**
   KTCSR (Kazuhiko Takeuchi Centre of Sustainability and Resilience) has been established in the University for Development Studies (UDS) as a core research center to lead the further research and capacity building of stakeholders. It is considered that the establishment of the

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KTCSR is one of the most important exit strategies for securing sustainability of the Project. However, the structure for implementation and dissemination of the Ghana Model are not clear at the time of terminal evaluation. Therefore, it is recommended that the Project identifies the role and collaboration scheme among related institutions so that a platform will be established for further upgrading of the Ghana Model and future utilization of the Model for social profit.

vi. **Support to Policy formulation and implementation:**

The objective of the Project is highly consistent with the current Ghana National Climate Change Policy (NCCP: 2014) and the Ghana National Climate Change Master Plan Action Programmes for Implementation (2015-2020) which serves as the implementation tool for the Policy. To complement the evidence-based implementation of the Master Plan and formulation or reviews of relevant policies/interventions in the future, efforts should be made by the collaborating stakeholders to make policy makers at various levels access the outputs of the project to help create a congenial policy environment for climate change mitigation and adaptation interventions. A case in point is the on-going development of the Long Term National Development Plan where it will be worth making accessible to the formulators of this plan, the evidence-based scientific results that this Project has produced.

vii. **Financial sustainability**:

It is observed that financial resources allocated for the C/Ps by the Ghanaian government have been limited. To continue the research activities using outcome of the Project, the Ghanaian side is required to secure necessary budgets for research and outreach activities as well as maintenance of the equipment.

ANNEX:

ANNEX 1: Joint Terminal Evaluation Report

Joint Terminal Evaluation Report of the Project on Enhancing Resilience to Climate and Ecosystem Changes in Semi-Arid Africa: An Integrated Approach in the Republic of Ghana

August 22, 2016

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ANNEXES

ABBREVIATIONS

AMSR	Advanced Microwave Scanning Radio Meter
ARG	Automatic Rain Gauge
AWS	Automatic Weather Station
CBD	Convention on Biological Diversity
COP	Conference of the Parties
C/P	Counterparts
DAC	Development Assistance Committee
DSSAT	Decision support system for Agro technology Transfer
GHS	Ghana Cedi
GIS	Geographical Information System
G-Met	Ghana Meteorological Agency
GSF	Global Science Forum
GSGDA	Ghana Shared Growth and Development Agenda
GSMaP	Global Satellite Mapping of Precipitation
IPBES	Intergovernmental Platform on Biodiversity and Ecosystem Services
IPCC	Intergovernmental Panel on Climate Change
JCC	Joint Coordination Committee
JICA	Japan International Cooperation Agency
JPY	Japanese Yen
JST	Japan Science and Technology Agency
KTCSR	Kazuhiko Takeuchi Centre of Sustainability and Resilience
KU-STIV	Kobe University Space-Time Image Velocimetry
NADMO	National Disaster Management Organization
NCCC	National Climate Change Committee
NCCP	National Climate Change Policy
NDPC	National Development Planning Commission
MoFA	Ministry of Food and Agriculture
MODIS	Moderate Resolution Imaging Spectroradiometer
OECD	Organization for Economic Co-operation and Development
PDM	Project Design Matrix
PO	Plan of Operation
R/D	Record of Discussion
SARI	Savannah Agricultural Research Institute
SATREPS	Science and Technology Research Partnership for Sustainable Development
SYNOP	Surface Synoptic Observations
TICAD	Tokyo International Conference on African Development
TFP	Total Factor Productivity
UDS	University for Development Studies
UG	University of Ghana
UNCSD	United Nations Conference on Sustainable Development
UNDP	United Nations Development Plan

UNFCC	United Nations Framework Convention on Climate Change
UNU-IAS	United Nations University Institute for the Advanced Study of Sustainability
UNU-INRA	United Nations University Institute of Natural Resources in Africa
UPS	Uninterruptible power supply
WRC	Water Resources Committee
WRF	Weather Research and Forecasting
WRI	Water Research Institute

1. Outline of the terminal evaluation

1-1 Background of the Terminal Evaluation

The northern regions of Ghana are semi-arid and vulnerable to the climate change. The majority of its residents practice subsistence agriculture and inevitably remains poor; and accelerated north-to-south outmigration of youth is debilitating the regions' base of natural resource management. Therefore, the government of Ghana in 2011 requested the government of Japan for technical cooperation by joint research under the program of the Science and Technology Research Partnership for Sustainable Development (SATREPS), and Japan International Cooperation Agency (JICA) launched a five-year project entitled "Enhancing Resilience to Climate and Ecosystem Changes in Semi-arid Africa: An Integrated Approach" in May 2012. The Project aims to develop a Model, by integrating approaches to enhance resilience to climate and ecosystem changes, to enable local communities to overcome their vulnerability in natural resource management. The Project includes the Volta River Basin, the most vulnerable area in the semi-arid northern Ghana in terms of natural resource management.

The implementation structure of this technical cooperation consists of the University of Ghana (UG), Ghana Meteorological Agency (G-Met), University for Development Studies (UDS) and the United Nations University Institute for Natural Resources in Africa (UNU-INRA) for the Ghanaian side, and The University of Tokyo, Kyoto University, and the United Nations University Institute for the Advanced Study of Sustainability (UNU-IAS) for the Japanese side.

As the Project comes to a close in six months, JICA dispatched a Terminal Evaluation Team to jointly evaluate the Project's progress with the Ghanaian side, against the indicators set out in the Project Design Matrix (PDM) using the five criteria (relevance, effectiveness, efficiency, impact, sustainability) indicated in the Joint Mid-term Evaluation in September 2014. The Terminal Evaluation intends to provide recommendations to relevant parties so to achieve the Project's expected Outputs and Purpose will be attained in the remaining cooperation period.

1-2 Objectives of the Terminal Evaluation

The objectives of the Terminal Evaluation are as follows:

(1) To review the Project Performance with focus on (i) the results of Inputs and Outputs implemented and (ii) the degree of achievement of Outputs, Project Purpose and Overall Goal based on the indicators in the PDM;
(2) To analyze factors that promoted and/or inhibited the Project performance including matters related to both the Project design and project implementation process;
(3) To evaluate the Project based on the five evaluation criteria: "relevance", "effectiveness", "efficiency", "impact", and "sustainability";
(4) To make recommendations to stakeholders of the Project and derive lessons from the Project for improving planning and implementation of similar technical cooperation project in the future; and
(5) To make a terminal evaluation report by joint evaluation team and get endorsement from the Joint Coordinating Committee (JCC)

1-3 The Terminal Evaluation Team

The Joint Terminal Evaluation Team (hereinafter referred to as "the Team") was organized with the following members from both the Japanese and Ghanaian sides.

(1) Japanese Evaluation Team

Designation	Name	Title / Organization
Team Leader	Mr. Hajime Nabeta	Senior Assistant Director, Team-4, Rural Development Department, Japan International Cooperation Agency (JICA)
Science and Technology Evaluation (academic)	Dr. Yoshifumi Yasuoka	Senior Research Supervisor, Japan Science and Technology Agency (JST) Prof. Emeritus, The University of Tokyo
Science and Technology Evaluation (administrative)	Ms. Mari Takagi	Program Officer, Dept. of International Affairs, Research Partnership for Sustainable Development Group, JST
Evaluation Analysis	Mr. Okano Teppei	Consultant, Icons Inc.

(2) Ghanaian Evaluation Team

Designation	Name	Title / Organization
Team Leader	Mr. Ernest Wesley-Otoo	Development Partners Coordinator, Ministry of Education
Member	Mr. Ali Mohammed	Head of Cooperation, Japan, Korea and China Desk, Ministry of Finance
Member	Mr. Austin Hesse	Deputy Director, Policy Planning and M&E Directorate, Ministry of Communication
Member	Mr. Ahmed Gibrilla	Assistant Agriculture Officer, Environment, Land And Water Management Unit, Ministry of Food and Agriculture

1-4 Schedule of the Terminal Evaluation

See Annex 1.

1-5 Methodology of the Terminal Evaluation

1-5-1 Design of the Terminal Evaluation

The Terminal Evaluation was conducted based on the PDM and Plan of Operation (PO) in accordance with the JICA Project Evaluation Guideline of June 2011. The Team first formulated The Evaluation Grid which identified the specific review points and the data collection methods as shown in Annex 5

1-5-2 Data collection Methods

For data collection, the Team applied various methods such as analysis on reports, interviews with counterparts (C/P), JICA experts (researchers), administrative officers, community leaders and members in the Project's targeted communities, group discussions and visitation to project sites and analysis of project equipment made available. The details of the interviewees are attached as Annex 2

1-5-3 Points for the Evaluation and Analysis

(1) Project Implementation and Achievement

Achievement of the Project was reviewed in terms of Inputs, Activities, Outputs, and Project

Purpose based on the materials showing the framework of the Project such as the Record of Discussion (R/D), PDM, and Plan of Operations (PO). Implementation of the Project was examined to see if the planned activities had been implemented according to the schedule described in the PO, if the Project had been managed appropriately, and to identify promoting and inhibiting factors that affected the implementation process.

(2) Collection and analysis of supplementary information

Since no numerical goal is set for the indicators of Outputs, Project purpose and Overall goal in PDM, supplementary information is necessary to assess the achievement level of each indicator. The Team reviewed and confirmed the intended targets of Outputs, Project purpose and Overall goal through document survey, interview survey and group discussions with stakeholders, and described the achievement status with narrative explanation to complement the achievement of the indicators.

(3) The Five Evaluation Criteria

Table 1-1 shows the five evaluation criteria established by the Development Assistance Committee (DAC), Organization for Economic Co-operation and Development (OECD), which are applied in this Terminal Evaluation.

Table1-1: Definitions of Five Evaluation Criteria

Criterion	Criteria
Relevance	Degree of compatibility between the development assistance and priority of policy of the target group, the recipient, and the donor.
Effectiveness	A measure of the extent to which an aid activity attains its objectives (Project Purpose). Effectiveness refers to the extent to which the expected benefit(s) was (were) brought about as a result of the Project.
Efficiency	Efficiency measures the outputs in relation to the inputs. It is an economic term which is used to assess the extent to which aid uses the least costly resources possible in order to achieve the desired results. This generally requires comparing alternative approaches to achieving the same outputs, to see whether the most efficient process has been adopted.
Impact	The positive and negative changes produced by a development intervention, directly or indirectly, intended or unintended. This involves the main impacts and effects resulting from the activity on the local social, economic, environmental and other development indicators.
Sustainability	Sustainability is concerned with measuring whether the benefits of an activity are likely to continue after donor funding has been withdrawn Projects need to be environmentally as well as financially sustainable.

(Source: JICA Guideline for Project Evaluation)

2. Outline of the Project

2-1. Project framework

The Project was implemented with the aim to developing an integrated approach to enhance resilience to climate and ecosystem changes in Semi-Arid Africa. Toward the achievement of the Project purpose and overall goal, the Project was designed in such a way that it develops forecasting methods for climate

and ecosystem changes and assess the impacts on agro-ecosystem use (Output 1), applies the prototype of water resources management through prediction and risk analysis (Output 2), develops and implements the institutional and engineering capacity development programs (Output 3). The outline of the Project is as shown in Table 2-1.

Table 2-1: Outline of the Project

Project Title		Enhancing Resilience to Climate and Ecosystem Changes in Semi-Arid Africa: An Integrated Approach in the Republic of Ghana
Cooperation Period		5 years (2012 - 2017)
Target Group		Counterpart researchers, local engineers, local residents in Northern Ghana, Ghanaian administrative officers and policy makers
Target Area		Northern Ghana (Northern Region, Upper East Region, Upper West Region)
Overall Goal		The Integrated Approach to Enhancing Resilience to Climate and Ecosystem Changes will be incorporated in international environmental policies.
Project Purposes		An Integrated Approach to Enhancing Resilience to Climate and Ecosystem Changes in Northern Ghana will be developed as the 'Ghana Model', enabling target groups to overcome the vulnerability of natural resource management.
Outputs	**Output 1**	Forecasting methods for climate and ecosystem change are developed and the impacts on agro-ecosystem use are assessed
	Output 2	Prototype of water resources management is applied through prediction and risk analysis of extreme weather events using satellite remote sensing and ground-based observation network
	Output 3	Institutional and engineering capacity development programs for local communities and engineers are developed and implemented

(Source: PDM of the Project)

3. Achievements and Implementation Processes of the Project

3-1 Inputs

The Team confirmed that the Project provided the following inputs in accordance with the plan stated in the PDM and PO (see Annex 3 and 4).

3-1-1. Inputs from the Japanese side

(1) Assignment of Japanese Experts

Twenty one Short-term Experts has been dispatched to the Project since May 2012 in fields such as Chief Adviser, GIS Analysis, Meteorology, Flood Management, Disaster Risk Management, Resilience Evaluation, Resilience Strategy, and Agronomy. The total duration of their assignments by the end of August 2016 is 47.77 man/months (see Annex 6 for details). In addition, 2 Project Coordinators have been dispatched; the total duration of their assignments by the end of July 2016 is approximately 52 man/months.

(2) Training of C/P in Japan

A cumulative total of 22 C/Ps participated in the training in Japan. In addition, one (1) C/P from UDS pursued a PhD course at UNU-IAS as a long-term trainee in Japan since September 2013. The

details of training are shown in Annex 7.

(3) Provision of Equipment

Machinery and equipment including Data Servers, Elemental Analyzer, Automatic Weather Station, Electronic Meeting system have been provided for the Project activities. Total amount of the procurement is 94,907,561 JPY (3,098,460 GHS). The list of these machinery and equipment are shown in Annex 8.

(4) Local Operation Cost

A total amount of 1,706,650.42 GHS (approximately 68 million JPY) was provided for necessary expenses to carry out project activities as of the end of March 2016. The details are as shown in Table 3-1. The cost includes computers, UPS and refurbishment of office space for the Project office. Other cost include; travel costs and fuel costs for field survey, field allowances, GIS training, workshops and various activities such as JCC, international conference.

Table 3-1: Local Expenses borne by the Japanese Side (GHS)

Fiscal Year (*1)	2012 – 2013	2013 -2014	2014 -2015	2015-2016	Total
Local Expenses (GHS)	252,797.82	314,996.21	507,594.30	884,059.91	1,706,650.42
Local Expenses (JPY)	12,186,371.00	12,743,801.00	17,434,849.00	25,975,448.00	68,340,471.00
Exchange rate (*2)	48.206	40.457	34.348	29.382	

Note *1: Japanese Fiscal Year (April – March). *2: JICA rate on the end of each fiscal year.
(Source: Documents prepared by the Project)

3-1-2. Inputs from the Ghanaian side

(1) Assignment of Counterparts

A cumulative total of 53 counterpart personnel was assigned to the Project: 20 from UG, 8 from G-Met, 16 from UDS, 5 from UNU-INRA, 3 from Water Research Institute (WRI) and 1 from Water Resources Committee (WRC). The details are shown in Annex 9.

(2) Provision of Land and Facilities

The five project offices including utility costs for the Project personnel was provided by UG, G-Met, UNU-INRA, and UDS (Nyankpala and Wa campuses). Installation sites for the equipment provided as well as lands for Automatic Weather Station (AWS) and Automatic Rain Gauge (ARG) were also made available. A GIS Resource Center has been established by UNU-INRA.

3-2 Achievement of Outputs

The activities have been conducted according to the PO and most of activities related to Output 1 and Output 3 have been implemented without significant delay. As to Output 2, although some activities were slightly delayed due to limited number of human resources and unstable utility infrastructure (power supply and communication network), all the activities are now expected to be completed by the end of the Project because of the Project's adequate remedial measures. There were some difficulties reported in the first half of the Project with 1) coordination and communication among the Project personnel, 2) mutual understanding on budgetary system of the Project and 3) timely collection of necessary data; however these difficulties have been mostly overcome by the continuous effort of both Japanese and Ghanaian Project members.

3-2-1 Activities and Achievements of Output 1

Output 1:
Forecasting methods for climate and ecosystem change are developed and the impacts on agro-ecosystem use are assessed

The activities of Output 1 has been conducted to 1) develop the forecasting method for climate change and ecosystem, and 2) assess the impact on agro-ecosystem. The thematic group-1 developed regional climate change prediction model and estimated Total Factor Productivity (TFP)[1] of target community. Capacities have been built for downscaling, statistical modeling, crop modeling and Geographic Information System (GIS) . Demonstration plots have been established for the research activities as well.

Regarding the forecasting method, the dynamic downscaling of selected past wet/dry years in Ghana was conducted in order to develop the forecasting model for climate and ecosystem changes. The results clarified the actual conditions of rainfall in Ghana. Upon analyzing the impact of climate and ecosystem changes on agricultural production, statistical downscaling was making them mutually complementary. At the same time, the thematic group-1 have collaborated with the Savannah Agricultural Research Institute (SARI) to conduct field experiment of crop production. The results of downscaling and field experiments have been input to Decision Support System for Agro Technology Transfer (DSSAT)[2] and were utilized for the simulation of the impact of climate and ecosystem changes on agricultural production.

As to the impact assessment on agro ecosystem, macro level (National and Regional levels) and grass-roots level (Community level) analysis on agricultural production were conducted. On the macro level, TFP was estimated and the time-series change of TFP in 10 regions of Ghana, 2000 to 2009 was grasped. Currently the Project conducts the estimation of TFP at the regional level using the result of dynamic downscaling. On the grass-roots level, detailed field surveys were conducted in 5 communities of Tolon district to grasp the crop and treatment in the area. Also household survey were conducted on a total 150 households of 6 target communities in Tolon District, and 81 households of 4 target communities in Wa District in order to understand the real agro economic situation and adaptation measures for climate change. The Project also assessed the vulnerability of target communities using 4 indicators (Physical/Engineering, Natural/Ecological, Social/Economic and Political/Governance). Based on these results, the thematic group-1 found that it is important to clarify the impact of climate change on agricultural productivity and formulate strategies such as improvement of crop production methods and selection of appropriate varieties of crops. Since 2015, additional field experiment of crop production and land use survey have been carried out to assess the impact on the agro-ecosystem in target communities.

These results, including updated data of GIS and the satellite data, will be compiled with other findings of the Project. The resilience map and ecosystem map corresponding to climate change will be developed in collaboration with thematic group 2 and 3. Thus, all the activity of Output 1 are expected to be completed by the end of the Project.

[1] TFP is an attempt to measure productivity taking into account all factors of production and linking them to an aggregate production function.

[2] DSSAT is a decision-making support system which consists of database (weather, soil, gene, pest etc.), support software and simulation application.

Indicator
1.1. Journal articles on climate and ecosystem change will be published
1.2. Assessment of climate change impact to agro ecosystem will be utilized
1.3. Report on options of adaptive agricultural production management to climate change (land utilization and cropping system etc.) will be issued.

Even though several research activities are still on-going, Indicator 1.1 and 1.3 have been achieved, and Indicator 1.2 is expected to be achieved by the end of the Project.

Based on the above research activities, 10 research papers have been published including the journal articles on climate and ecosystem change as shown in Annex 10 (Indicator 1.1). Currently, the thematic group-1 is proceeding with the assessment of climate change impact to agro-ecosystem utilizing climate change forecasting information, field data from demonstration plots and crop models established through the research activities, which are all products of Output 1. In addition, the maps using GIS for land utilization and cropping system are in the process of development, and these maps will be utilized by the Ghanaian side even after the completion of the Project (Indicator 1.2). In order to propose an appropriate farming system at target communities, the thematic group simulated the impacts of fertilizer application for major crops with field experiments and identified the key strategies to improve on the yield gaps between different maize varieties under four treatments. Intensive household surveys have been conducted and the land use change in the communities was understood. On the basis of the results, options of adaptive agricultural production management to climate change were reported in various workshops, project documents and presentations. (Indicator 1.3).

In the aspect of the capacity building in utilizing the technology and system introduced by the Project, GIS resources center was established in UNU-INRA and 4 Ghanaian researchers (UG:1 person, UDS:1 person, UNU-INRA: 2 persons) participated in the GIS training program in Japan. Also 4 times of training for GIS, Statistical downscaling and Crop modeling were held in Ghana and totally 54 students learned the subjects. It should be noted that the lecturer of the GIS training in Ghana were the participants of the training in Japan.

3-2-2 Activities and Achievements of Output 2

Output 2
Prototype of water resources management is applied through prediction and risk analysis of extreme weather events using satellite remote sensing and ground-based observation network

The major activity under Output 2 are 1) development of prediction method for extreme weather event, 2) implantation of flood risk assessment, and 3) application of the prototype of water resource management. The thematic group-2 established satellite data application system using the Global Satellite Mapping of Precipitation (GSMaP), and soil moisture contents have being estimated for comparative analysis. Eleven AWSs (Automatic Weather Stations) and 20 ARGs (Automatic Rain Gauge) have been installed in the Volta basin area and weather prediction techniques using Weather Research and Forecasting (WRF) have been introduced. Data accumulation from bore-holes and field experiments of crop production were also carried out under the research activity of Output 2.

At initial stage of the activity, the Project conduct analysis of changes in rainfall using the past data of

22 observation points of the Surface Synoptic Observations (SYNOP) in Ghana. In parallel with the analysis of existing data, the Project installed 2 data servers in G-Met and UDS, and established satellite monitoring system using GSMaP. Capacity building of 3 researchers from G-Met, UDS and UG were carried out through the training in Japan to learn how to use of satellite derived precipitation data. Soil moisture contents also have been estimated using data from satellite born Advanced Microwave Scanning Radio Meter (AMSR). Since there was difficulty to collect hydrological data in timely manner, the Project developed a tool to detect flooding areas using the Moderate Resolution Imaging Spectroradiometer (MODIS) as an alternative solution. To date, a total of 11 AWSs and 20 ARGs have been installed in Northern Ghana and these installations enable the Project a comparative study of the satellite data and ground-based rain gauge observation data to clarify the correlation between these data.

In response to the demand from G-Met, the thematic group-2 has conducted a study to establish extreme weather prediction techniques using WRF since 2013. Since the system requires higher knowledge and skills, the Project focused on capacity building for C/Ps for system development of numerical weather prediction in Ghana. Five C/Ps, including 4 young meteorologists, participated in a training in Japan and learned the method of weather forecast calculation using WRF. As for the flood risk assessment, WRI and WRC have been joined to the Project in 2015, and the verification of the prototype model for flood prediction has progressed. A new method of flow measurement using video camera, KU-STIV (Kobe University Space-Time Image Velocimetry) has been introduced and the technology related to the method was transferred to the C/Ps. Necessary equipment was also provided to WRI to conduct the flow measurement.

In relation to the study on the water resources management in the target communities, field experiments for drought monitoring and development of cropping methods resilient to droughts have been conducted by initiative of UDS. The observation data from bore-holes installed by the Project had been accumulated. The Project has compiled all the findings of the surveys for vulnerability assessment on floods and droughts, current water resources management, and appropriate water resources management methods.

Indicator
2.1. Report on flood risk assessment and extreme weather risk assessment will be issued.
2.2. Report on prototypes of water resource management methods will be issued.
2.3. Journal articles on extreme weather risk or water resource management will be published

Indicator 2.1 and Indicator 2.2 have not yet been achieved. Although the research activities related to risk assessment and water resource management have not yet completed at this point, there is no notable delay on these activities, and these indicators are expected to be achieved by the end of the Project. Indicator 2.3 have been achieved already.

Since numerical weather prediction is important in forecasting extreme weather events, totally 5 forecasters from G-Met have studied in Japan and the computer servers have been installed in G-Met headquarters. The system for automatic forecasting is now under construction. Due to the delay in the collection of hydrological data, flood risk assessment is not in a practical level so far, though the thematic group-2 is developing a methodology for monitoring flood areas and a hydrology model to predict river discharge and inundation. These are to be used for emergency warning, early warning or production of hazard maps for extreme weather events (Indicator 2.1). The thematic group also has compiled the

findings as a result of surveys assessing vulnerability to floods and droughts, current water resources management, and locally appropriate water resources management methods. The results of on-going field experiments will be added to the above findings and the prototypes of water resource management methods will be reported by the end of the Project (Indicator 2.2). On the basis of the above research activities, 14 research papers have been published including the journal articles on extreme weather risk or water resource management as shown in Annex 10 (Indicator 2.3).

3-2-3 Activities and Achievements of Output 3

Output 3
Institutional and engineering capacity development programs for local communities and engineers are developed and implemented

The activities of Output 3 focus on 1) engineering and natural resources management capacity development, 2) institutional capacity development, and 3) establishment of an integrated approach to enhancing resilience. The thematic group-3 selected 10 pilot sites through series of discussions and field surveys with other thematic groups. All project members jointly developed community-based resilience assessment framework and matrix, and assessed resilience of the target communities to generate effective interventions. Various ssocial / economic surveys, recognition / capacity assessment of local community and capacity building of local stakeholders for disaster risk reduction was conducted. Crop value chain assessment and demonstration of various methods of crop production / income diversification also have been conducted. In addition, various outreach activities at the community level have been carried out by thematic group-3.

The thematic group-3 prepared a background conceptual paper to define the resilience in the context of the Project as a part of efforts to select the target sites. Through series of discussions and field surveys by all thematic groups, the Project selected 10 target communities as the pilot sites (6 communities in Tolon district, Northern Region and 4 communities in Wa West District, Upper West Region) considering ecological, engineering, and socio-economic aspects of resilience. After the selection, the Project established the information platform for the researchers and conducted the detailed farm field surveys to understand farming activities of the sites.

At the earlier stage of the Project, all project members jointly developed community-based resilience assessment framework and matrix by dividing the concept of resilience into three dimensions: ecological resilience, engineering resilience and socio-economic resilience, based on extensive literature review, field surveys, focus group discussions, unstructured interviews with various stakeholders, and participatory observations. The outcome of this resilience matrix was published in a peer-reviewed paper to be an integrated assessment model for the entire project. This integrated model provides a workable assessment criteria and key indicators for community level resilience assessments, which is expected to be an important component of the Ghana Model. The Project has assessed resilience of the target communities in Tolon and Wa West to generate effective interventions to enhance their resilience.

Field surveys on the governance system on climate change resilience and socioeconomic household conditions were also implemented to find out the promoting drivers to develop the capacity of farm households, local administrative officers and engineers, in both the target districts. Regarding the local governance, the survey revealed the several issues on limited capacity of the local actors in climate change resilience and adaptation. The socioeconomic survey was also conducted from the point of view of the

mobility and gender, and the cropping situation of the main crops such as groundnuts and okra was clarified. A detailed study on value chain of shea butter, okra and pepper production was also conducted. The study on material flow of shea clarified environmental effects of using water and fuelwood. Introduction of fuel efficient stoves and demonstration of honey production also were carried out aiming at income generation and diversification. The Project has established demonstration plots for crop production in all target sites and continues various tests, data collection, and onsite trainings in close collaboration among all thematic groups. Outreach activities at the community level have been conducted through active involvement of the demonstration activities, workshops and community environmental theater.

In addition, capacity assessment in 6 communities in Wa West was conducted through the focal group discussion. The capacity of target communities was evaluated by 1) Asset and funds management capability, 2) Vulnerability management capability, 3) Mutual accountability, 4) Engagement capability, and 5) Leadership and ownership. The capacity assessment tool was developed through the survey and expected to be utilized by C/Ps after completion of the Project. Regarding the education for disaster risk reduction addressing climate and ecosystem changes, the Project have suggested a capacity development program for primary and secondary education on the basis of syllabus analysis, questionnaire survey, interview and workshops.

In order to discuss about the specific adaptation strategy and capacity development plan utilizing several critical findings by the Project, Matching Workshop was held in August 2015. Totally 136 people from universities, research institutes, private business sector, local NGO and local administration participated in the workshop. The outcomes of the Project have been shared with the participants and empirical verification of the integrated approach to enhancing resilience as Ghana Model was promoted. The design and principal of Ghana Model were also discussed at the workshop held in UNU on 14th to 15th March 2016 in Tokyo. The result will be presented in the book "Building Integrated Resilience Strategy Against Climate and Ecosystem Change for Sub-Saharan Africa" to be published by Springer. The Project also plans to present the Ghana Model at the side event of the 6th Tokyo International Conference on African Development (TICAD VI) to be held in Nairobi University, Kenya on 25th August 2016, and at the workshop to be held in Ghana in January to February 2017.

One point which should be noted at this moment is that integration scheme of three Outputs is not clearly identified. For example, it is not clear which data, information and knowledge from Output 1 and Output 2 are utilized in Output 3, and how they are used.

Indicator
3.1. Journal articles on regional disaster governance in Northern Ghana will be published
3.2. Repost on business models against for climate and ecosystem changes will be issued
3.3. The capacity development program on resilience for climate and ecosystem changes will be developed
3.4. Training course for local engineering, governors and community will be implemented at the project site and the monitoring report will be issued.
3.5. Guidelines for establishing an Integrated Approach to Enhancing Resilience to Climate and Ecosystem Changes will be presented.

Indicator 3.1, 3.2 and 3.3 have been achieved at the time of terminal evaluation. Activities related to indicator 3.4 and 3.5 are scheduled to be completed in March 2017 according to PO and, since there is no delay on the activities, both indicators will be achieved by the end of the Project

Based on the research activities under Output 3, 15 research papers have been published including the journal articles on regional disaster governance in Northern Ghana as shown in Annex 10 (Indicator 3.1). Thematic group-3 studied the material flow of shea production and introduced simple improved cook stove to reduce fuel wood consumption in shea production. Also value chain surveys for crops, such as okra, pepper and maize were conducted. Bee keeping with crop production was demonstrated as livelihood diversification and ecosystem enhancement strategy. These studies were conducted for development of business models against climate and ecosystem changes and reported already (Indicator 3.2). Regarding capacity development on resilience against climate and ecosystem changes, new disaster risk reduction education program was suggested to teachers and staffs of Ghana Education Service; also environmental community theater were held in 5 places to raise awareness of the community members (Indicator 3.3). Institutional and technological capacity development for local leaders and practitioners will be implemented in the co-design manner by the end of the Project, based on findings of the stakeholder analysis, socio-economic survey, local business models and capacity assessment as well as findings from theme 1 and 2 (Indicator 3.4). Guidelines for establishing an integrated approach to enhancing resilience to climate and ecosystem changes are planned to be developed and presented by the end of the Project (Indicator 3.5).

3-3 Achievements of the Project Purpose

Project Purpose:
An Integrated Approach to Enhancing Resilience to Climate and Ecosystem Changes in Northern Ghana will be developed as the 'Ghana Model', enabling target groups to overcome the vulnerability of natural resource management.

The development of an integrated approach to enhancing resilience to climate and ecosystem changes in Northern Ghana, as indicated in the Project purpose, is expected to be achieved, with room for further continuous improvement, with strong ownership and active involvement of Ghanaian stakeholders.

Currently the Project is in the final stage to compile the various findings of Output 1 to Output 3. The results of impact assessment on agro-ecosystem (Output 1) and risk analysis of extreme weather events (Output 2) have been utilized for the analysis of impacts on the local economy, livelihood and environment, and several adaptation options have been suggested to the target communities (Output 3). All these process and results of the research activities have been inputs to the formulation of the integrated approach to enhancing resilience to climate change and ecosystem as Ghana Model. The conceptual design and operational principles of Ghana Model have been developed through the discussion at workshop held in UNU, Tokyo and shared with C/P members and stakeholders. Another workshop for implementation of Ghana Model is also planned to be held in 2017 as well.

Moreover, various equipment, tools and materials have been provided by the Project, and capacity building of C/Ps, especially young researchers has been successfully conducted. Through the research activities under the Project, 40 journal articles were published and 44 times of conference presentation have been conducted. An international conference on enhancing resilience was held in August 2014 and more than 200 people, including over 20 international participants, participated. Community workshops were held in the target communities to verify and discuss the findings with local communities. Social implementation work shop also is planned to be held in January to February 2017 for finalization of all results of the Project. Furthermore, Kazuhiko Takeuchi Centre of Sustainability and Resilience (KTCSR)

has been established in UDS in August 2016, aiming at improvement of sustainability and resilience to climate and ecosystem change in Africa. It is expected that the centre promotes further improvement and implementation of Ghana Model.

Indicator
1. Educational policy and curriculum development at university level, which focus on climate and ecosystem changes
2. Educational policy for engineers and observation capacity development for the Ghana Meteorological Agency
3. Contribution to the ongoing policy formulation for climate adaptive capacity development by the Ghana Government

Indicators 1 and 2 are expected to be achieved by the end of the Project. Indicator 3 have been achieved already and further contribution to the on-going policy formulation is expected.

The structure to continue further studies for downscaling will be set up at UG by the end of the Project and new programs for enhancing resilience will be developed at UG and UDS. Although it is not the education policy at university level stated in the Indicator 1, the study on syllabus analysis of primary and secondary education has been conducted to integrate climate change and disaster management into their educational curriculum. (Indicator 1). The structure of the operation of forecasting method utilizing skills and equipment provided by the Project was established and will be utilized by G-Met as well. Since the importance and the usefulness of prediction and risk analysis using satellite data and ground-based observation data are highly recognized by G-Met, the Project has contributed to reinforcing the capacity building policy of G-Met (Indicator 2). Even though some parts of the policy formulation are out of control of the Project, some Project members are in the position to directly contribute to policy formulation of several national strategies. A member of thematic group-1, Dr. Kawadu Owusu is a principle author of the National Climate Change Adaptation Strategy. A member of thematic group-3, Dr. Godfred Seidu Jasaw is a former National Development Planning Commission (NDPC) member and is expected to transfer the knowledge and make the Project's outcomes accessible to policy makers (Indicator 3).

3-4 Prospect of achievement of Overall Goal

Overall goal
The Integrated Approach to Enhancing Resilience to Climate and Ecosystem Changes will be incorporated in international environmental policies

Necessary and important steps are being taken by the Project with a positive prospect for Indicator to be achieved several years after the completion of the Project if the Ghanaian C/Ps continues efforts for research, implementation and monitoring of the various components of the Ghana Model. The capacity building by the Project, especially for Ghanaian C/Ps, have been adequately conducted and it is expected that these C/Ps leads the further improvement of Ghana Model in the Post Project period. The collaboration structure among universities both in Ghana and Japan also expected to be continued through the operation of KTCSR.

Indicator
Policy recommendations shared in the science and technology community (e.g. OECD/GSF) and

presented to international panels and conventions such as UNFCC, CBD, UNCSD, as well as platforms like IPCC, IPBES, and CBD Secretariat.

The Project has worked toward the achievement of the Indicator and the prospect of attainment of the Indicator is positive. In order to apply the Ghana Model to other African countries, the Project is in the process of analysis of socioeconomic situations, legal systems, political systems, religious situations of the countries interested in the model. In the short term, information sharing related to Ghana Model is being promoted through University network established by other UNU's research activities in Africa.

Moreover, several Project members are contributing to the formulation of several international strategies. Table 3-2 shows the Project's direct contribution to international platforms.

Table 3-2 Direct contribution to the International platform by the Project

CBD	Prof. Kazuhiko Takeuchi will provide relevant statement with input from the Project at high level segment presentation at CBD-COP-13 (4-17 Dec 2016).
IPBES	Prof. Alfred Oteng-Yeboah is a IPBES bureau member. Dr. Yaw A. Boafo and Dr. Osamu Saito have contributed to IPBES global and regional assessments as lead authors.
TICAD VI	The Project will hold side event at TICAD VI in University of Nairobi on 25 August 2016, to share recent research and best practice of the Project, to strengthen international network, and to discuss future action for collaborative research, capacity development and social implementation.

(Source: Project presentation document at launching ceremony of KTCSR on 17 August 2016)

3-5 Implementation Processes of the Project

(1) Communication and monitoring mechanism

No problem has been noted in daily communication between the JICA experts and their Ghanaian C/P personnel. Sufficient communication has been secured through positive efforts by both sides. The Project member communicates in face to face during the experts' stay in Ghana and communicate by e-mail, telephone or other means when the experts are out of the country. Also whenever the Ghanaian researchers face the challenge on the Project activity, the Japanese experts and the Project members discus about the issue and tries to lead the solution. On top of the communication among thematic groups, JCC was held once a year during the Project implementation period to share the progress and plans of activities, and to discuss issues related to the Project implementation.

(2) Establishment of mutual understanding through good coordination

In addition to the communication among the researches in the each thematic group, the Project assigned a project coordinator as a long term expert. Since a large number of experts, researches have been involved in the Project, the coordination and arrangement by the coordinator hugely contribute to the smooth implementation of the Project activities. On the other hands, at the initial stage of the Project, there was difficulty to build a mutual understanding among the Project members related to internal rules and procedure of the Project. This is because JICA's cooperation project was new to the Ghanaian C/Ps, which is different from the practices of other research funds. Due to the difficulty, some activities had not been conducted as planned. However, as the mutual understanding improved through smooth coordination and communication, the issue have been solved to a large extent.