UNITED NATIONS
ESCAP
Economic and Social Commission for Asia and the Pacific

ESCAP Multi-donor Trust Fund for Tsunami, Disaster, and Climate Preparedness in Indian Ocean and Southeast Asian Countries

TERMINAL REPORT

PROJECT TITLE	Capacity Building on Generation and Application of Downscaled Climate Change Projections
ORGANIZATION	Regional Integrated Multi-Hazard Early Warning System for Africa and Asia (RIMES)

Total project budget	US$ 329,115	Funding received to date	US$ 329,100

Percentage of total project budget spent	100.0%	Percentage of funding received to date that has been spent	100.0%

Interest earned on funding received from ESCAP	US$ 0

| Date of signature of Letter of Agreement	20 Nov 2014	Date of project completion	30 Sep 2016

ANNEX

1. Guidelines on interpretation and application of downscaled projections
2. Audited financial report

I certify the accuracy of the substantive and financial information contained in this report.

A.R. Subbiah
Director
25 November 2016

The terminal report is accepted.
I hereby certify that I satisfied with the delivery of the project from the funds ESCAP provided to partner and the expense reporting from IP reflects the realistic progress of the project
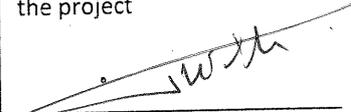
(Signature of Certifying Officer)   _Date_
Mr. Edward Turvill, Programme Officer
Trust Fund for Tsunami, Disaster and Climate Preparedness

OVERALL ASSESSMENT

Goal: Contribute to climate-resilient development planning and improved resource management in Cambodia, Lao PDR, Myanmar, Pakistan, and Sri Lanka

Expected Outcomes 1 and 2:

1. National planning agencies in Myanmar, Sri Lanka, and Pakistan adopt a climate risk management approach in development planning process
2. At least 3 sectoral climate change adaptation programs that are informed by climate risk assessments

Expected Outputs:

1. Availability of downscaled, customized climate projections for Myanmar, Sri Lanka, and Pakistan

   Indicators:
   o *Scenario products delivered to users through the Monsoon Forums, and are available from the websites of DMH (Myanmar), DOM (Sri Lanka), and PMD (Pakistan)*
   o *At least 10 staffs each from DMH, DOM, and PMD (total of at least 30) trained on climate downscaling and visualization of climate scenario products*

   Performance:

- Myanmar: Projections of rainfall and temperature for 2021-2040, 2041-2060, and 2061-2100 available for 17 states/ regions for RCP 4.5 and 8.5
- Pakistan: Projections of rainfall and temperature for 2010-2050 available for 5 provinces for RCP 4.5 and 8.5
- Sri Lanka: Projections of rainfall and temperature for 2020-2040, 2040-2060, and 2070-2090 under RCP 4.5 and 8.5 available for the country's 3 climatological zones

- Products delivered to users through user workshops in Myanmar and Sri Lanka. In Pakistan, key users were involved in the national training on downscaled projection generation

- Total of 39 officials from DMH, PMD, and DOM trained:
   o 3 officers (1 each) from DMH, PMD, and DOM at the 4th World Climate Research Program (WCRP) CORDEX Science and Training Workshop in East Asia, which focused on climate model output evaluation, downscaling techniques, integration of user requirements, and RCM modeling.
   o 4 officers (2 each) from DMH and PMD received comprehensive 3-month training at RIMES on science aspects of climate projections, characterization of climate and extremes, observation data quality control, model evaluation, statistical and dynamical downscaling, development of climate change scenarios using CDAAS, detailed analysis of baseline climate and future scenarios, generation of climate projections at sub-national scale, and results interpretation and visualization
   o 10 officers from DOM trained in-country over 6 days on data quality control, model evaluation, statistical and dynamical downscaling, analysis of past and future climate trends and extremes, generation of climate projections at sub-national scale, and results interpretation and visualization

- o National level training workshops trained 15 DMH officers in Myanmar over a 3-day program, and 7 PMD officers in Pakistan over a 5-day program

- Climate Data Access and Analysis System (CDAAS) developed for online access to and analysis of downscaled datasets, for generation of downscaled projections. Customized landing pages were created for linking to websites of DMH, PMD, and DOM, to facilitate access from the project countries.

2. Enhanced capacity within climate-sensitive sectors in Myanmar, Sri Lanka, and Pakistan on climate risk analysis and adaptation planning

   Indicators:
   - o *At least 10 institutions in each of the countries trained on the use of climate projections in risk analysis and adaptation planning*
   - o *Technical guide on climate projections-informed risk analysis and adaptation planning*

   Performance:

- Total of 81 institutions were reached and introduced to the downscaled climate projection outputs from the project:
   - o 39 user institutions from government, and national and international NGOs in Myanmar
   - o 28 user institutions in Sri Lanka who were also guided in the application of downscaled projections in the analysis of potential impacts, which formed the basis for policy recommendations and actions
   - o 14 key user, academic, and research institutions in Pakistan, who joined the training of PMD technical staff

- Technical guide on using downscaled climate projections in risk analysis and adaptation planning prepared, and may be accessed by users in the countries through respective NMHSs

Expected Outcome 3: Potential losses minimized in the target countries from application of climate risk information in resource management

Expected Output: Robust climate information provider-user forums in Cambodia, Lao PDR, and Pakistan

   Indicators:
   - o *Monsoon forums convened before the start of the southwest and northeast monsoons each year in each of the countries, with wider user participation*
   - o *Articulation of user needs and demands, and NMHS actions in response to these demands*
   - o *Written commitment from each country to financially sustain the Forums*

   Performance:

- Total of 9 forums held: 3 in Cambodia, 4 in Lao PDR, and 2 in Pakistan
   - o User institutions participating in the Forums in Cambodia increased in number, from 18 in 2014, to 26 in 2015, and 35 in 2016
   - o In Lao PDR, number of user institutions increased from 9 in 2014, to 12 in 2015 and 2016
   - o In Pakistan, the number of institutions participating in the Forums increased from 12 in 2015 to 40 in 2016

- All forums articulated user needs and demands, which were noted by respective NMHSs for action, a number of which were implemented within the

project's duration

- Requests for RIMES support for the Forums were received:
    - o Technical support for Pakistan
    - o Technical and funding support for Cambodia and Lao PDR

ACTIVITY WORK PLAN

	Activity	Time Frame	Description of results
1	Project initiation National level: ○ Project start-up workshop ○ Constitution of Project Implementation Committee ○ Preliminary data collection, including stakeholder inputs on emission scenario to be considered and user need requirements for climate projections application	Nov 2014 – Jan 2015	Project initiation meetings, held in project countries, brought together partner NMHSs and key sectoral agencies involved in planning and seasonal preparedness, such as national planning and economic development, environmental conservation, water resources, agriculture, transport, etc. These meetings brought these partners on board for project implementation, and updated capacity baselines – climate projections that are currently available in the countries and status of their utilization, and capabilities of the NMHS in generating downscaled projections and of user agencies in applying these in long-term planning. The meetings also provided useful inputs, such as user-specific needs in terms of relevant climate parameters and time slices for generating climate projections, user preference for accessing climate projections, and geographical areas that could be considered for pilot.
2	Capacity building on usable climate projections ○ Regional climate modeling (Myanmar); access to CORDEX-SEA outputs ○ Validation ○ Downscaling ○ Visualization ○ Analysis and interpretation ○ Delivery ○ Transfer of methodologies and tools	Jan 2015 – Mar 2016	***Web-based interface for climate data and scenario products*** RIMES developed a web-based interface for access to and analysis of climate data and scenario products, for generation of downscaled projections for any area of interest within the RIMES domain. Named Climate Data Access and Analysis System (CDAAS), this user interface contains datasets from: 8 Global Climate Models (CMIP5 GCMs), 6 models from the NASA Earth Exchange (NEX), and 6 Regional Climate Models (RCMs) of the Coordinated Downscaling Experiment (CORDEX) South Asia. CDAAS also includes 2 future emission scenarios – RCP 4.5 (moderate) and RCP 8.5 (high). Each model data spans the period 1980-2005, representing baseline period, and future projections for the period until 2100. These datasets enable telescopic downscaling of climate baseline and projections, from coarse resolution GCMs (~180km) to downscaled information of up to ~25km, from multiple climate models, enabling development of robust climate change projections, with uncertainty levels. CDAAS has capability to extract smaller subsets of data from large climate model datasets, archived in the backend server through easy graphical interface. The climate data analysis engine is capable of a variety of climatological analysis, including analysis of extremes. The system is being hosted at RIMES on a dedicated server, procured through this project. Access to CDAAS is restricted by user name and password. ***Downscaled projections*** Generation of downscaled projections for the project countries used CDAAS, with participation of technical officers from Myanmar's Department of Meteorology (DMH), Pakistan Meteorological Department (PMD), and Sri Lanka's Department of Meteorology (DOM), who brought with them historical observation data for analysis of baseline climate. *Myanmar.* Projections of rainfall and temperature were generated for three time slices: 2021-2040, 2041-2060, and 2061-2100, with base period of 1981-2010, using NEX-NASA ensemble models, which better simulated Myanmar climatology and climate trends, compared to CORDEX ensemble models and CMIP5 GCMs. Projections were generated for each of the country's 17 administrative regions/ states for RCP 4.5 and 8.5.

Activity	Time Frame	Description of results
		By the end of the 21st century, projections indicate increase in maximum and minimum temperatures by at most 4°C, consistent with the observed trend of general warming. Increase in mean temperatures is lesser in deltaic areas than in other regions of the country. Rainfall is projected to increase by at most 30% in most regions, except for northern and coastal regions where up to 50% increase may be expected. This projected increase is also consistent with the observed trend of increasing rainfall and rainfall extremes. *Pakistan.* Simulations were undertaken for RCP 4.5 and 8.5 for 2010-2050, with base period of 1970-2000, using NEX-NASA ensemble models, which showed better correlation with mean climatology and extreme climatic indices of the country, compared with CORDEX and CMIP5 GCMs. Projections were generated season-wise for 4 provinces (Baluchistan, Punjab, Sindh, and Khyber Pakhtunkhwa), including the disputed territories of Gilgit-Baltisan and Azad Kashmir (GB&AJK). By end of 2050, mean maximum and minimum temperatures are projected to increase to as much as 1.5°C and 3°C respectively during the dry season. Heat-related extremes are projected to increase in all provinces. Mean rainfall is projected to increase in all seasons, more prominently during June-Jul-Aug. *Sri Lanka.* Projections of rainfall and temperature were generated using NEX-NASA ensemble models, which were able to capture the climatology of the country. Three time slices were considered (2020-2040, 2040-2060, and 2070-2090) under RCP 4.5 and 8.5, using base period of 1975-2005. Analysis was undertaken for 4 seasons (southwest, northeast, and 2 inter- monsoon seasons), for each of the 3 climatological zones. By end of the century, mean maximum and minimum temperatures are projected to increase up to 3.5°C; total annual rainfall is projected to increase, particularly in the wet zone. Season-wise, northeast monsoon rainfall is projected to decrease, more prominently toward the end of the century. ***Delivery of downscaled projections to users*** Products generated through the project were first presented to users in user workshops on 13 June 2016 in Myanmar and on 16 August 2016 in Colombo (refer to Section 3 below). User workshop was not convened in Pakistan due to scheduling problems. Key users were, however, included in the national training for technical staff of the Pakistan Meteorological Department (PMD). ***Capacity building of project countries' NMHSs*** A three-tiered capacity building approach was undertaken: a) Participation of 1 technical officer each from DMH, PMD, and DOM to the 4th World Climate Research Program (WCRP) CORDEX Science and Training Workshop in East Asia. The workshop trained participants on climate model output evaluation, downscaling techniques, integration of user requirements, and RCM modeling. b) Secondment of 2 technical officers each from DMH and PMD to RIMES for 3 months for training and participatory generation of climate projections. This included science aspects of climate projections, characterization of climate and extremes, observation data quality control, model evaluation, statistical and dynamical downscaling, development of

	Activity	Time Frame	Description of results
			climate change scenarios using CDAAS, detailed analysis of baseline climate and future scenarios, generation of climate projections at sub-national scale, and results interpretation and visualization. DOM was not able to send secondments, but opted for a national training and remotely guided generation of climate projections. This training was participated by 10 officers. c) Echo training workshops in Myanmar and Pakistan, which trained 15 DMH officers for 3 days, and 7 PMD officers for 5 days. The workshop in Pakistan included 24 other participants from key user agencies and research institutions. The table below summarizes the number of participants from each training. Country-specific landing pages for CDAAS were created to enable linking to DMH, PMD, and DOM websites, through which these NMHSs, researchers, and other key stakeholders could have access to CDAAS. http://cdaas.rimes.int/myanmar http://cdaas.rimes.int/pakistan http://cdaas.rimes.int/srilanka
3	Interpretation and application of customized projections ○ Policy and institutional analysis ○ Consolidation of sectoral inputs ○ Workshop for planners and decision-makers	Oct 2015 – Aug 2016	Total of 81 institutions were reached and introduced to the downscaled climate projection outputs from the project: ○ In Myanmar, through a Policymakers' Dialogue in June 2016, participated by 39 user institutions from government, and national and international NGOs. DMH presented the downscaled projections and received user feedback. The Dialogue also discussed the integration of these products in the National Climate Change Strategy and Action Plans. ○ In Sri Lanka, through a Policy Level Dialogue on Potential Integration of New Climate Change Projections into Development Planning in Sri Lanka, in August 2016, with 28 user institutions from government and non-government organizations. The Dialogue discussed potential impacts from future climate, considered policy/ regulatory actions for dealing with potential impacts, and articulated user-specific demands for climate projections in terms of spatial and temporal resolutions. ○ In Pakistan, workshop for planners was not held due to scheduling problems. Fourteen (14) user institutions, however, participated in the national training that targeted PMD for technology transfer. These institutions appreciated the process of generating downscaled projections, as well as provided feedback. The draft technical guide for users on the use of downscaled climate projections in risk analysis and adaptation planning was refined as attached, and shall be made available to users in the project countries through respective NMHSs. This guide shall be made available to all other NMHSs of RIMES Member and Collaborating States.

The participants table:

Training	Myanmar		Pakistan		Sri Lanka	
	Men	Women	Men	Women	Men	Women
1. CORDEX training	1		1		1	
2. Secondment to RIMES	1	1	2			
3. National level training	3	12	7+17	7	8	2
Total	5	13	27	7	9	2

	Activity	Time Frame	Description of results

4	Strengthening of Monsoon Forums:
	  o Conduct of Monsoon Forums
	  o Advocacy with concerned ministry
		Nov 2014 – Jun 2016	**Cambodia.** Total of 3 forums were conducted under the project: the 4th National Forum for the northeast monsoon 2014, the 5th for the southwest monsoon 2015, and the 6th for the southwest monsoon 2016. The tables below present the institutions participating in the Forum, from the 4th until the 6th Forum, including recommendations received.
			
			Lao PDR. Total of 4 forums were conducted under the project: the 3rd National Forum for the northeast monsoon 2014, the 4th for the southwest monsoon 2015, the 5th for the northeast monsoon 2015, and the 6th for the southwest monsoon 2016. Institutions participating in the Forum, including recommendations received, are presented in the following tables.
			
			One forum recommendation was implemented by DMH within the project period – training of media personnel on understanding and communicating forecasts, which was attended by 25 participants from various media outlets. The training also fostered media-forecasters dialogue toward better communication of forecasts and warnings.
			
			Pakistan. Only 2 forums were held in Pakistan under the project: the 3rd National Forum for southwest monsoon 2015, and the 4th for southwest monsoon 2016. The tables below present the institutions participating in the Forum, including recommendations received.
			
			As in Lao PDR, one forum recommendation was implemented by PMD within the project period – the Heat Wave Awareness Program, which was held back-to-back with the 4th Monsoon Forum, aimed at raising public awareness on forecasted heat wave during the season, and to promote multi-agency, multi-level preparedness.
			
			Participating institutions in the Monsoon Forum

Country	NE monsoon 2014	SW monsoon 2015 Additional institutions	NE monsoon 2015 Additional institutions	SW monsoon 2016 Additional institutions
Cambodia	MOWRAM MAFF GDA CARD MRD Fisheries Administration MOE MOH CDRI MOP NCDM Caritas IRRI WFP MOI Media outlets RUPP MOWA	CARDI DHRW DOI Farmer Water Use Community FAO MPWT MRD UNDP	Not convened	CDC DALRM DCC DIA IFReDI National Committee-ESCAP CGIAR GISTDA RADI

	Activity	Time Frame	Description of results				
			Country	NE monsoon 2014	SW monsoon 2015 Additional institutions	NE monsoon 2015 Additional institutions	SW monsoon 2016 Additional institutions
			Lao PDR	MAF MWRE MOH MOE MPI Media outlets NDMC World Bank WFP	No new institution participating	MOM MONRE MOT	No new institution participating
			Pakistan	Not convened	CIIT FFC IIU MFSR NDMA PDMA- KP and Punjab PAF Rescue 1122 SDPI WFP WPDA IRSA	Not convened	MNHSRC MWP GCISC MOCC NUST UAF KIU UAP UET MNSUA NARC IC-Peshawar MUET UB

Summary of key recommendations

Country	NE monsoon 2014	SW monsoon 2015 Additional institutions	NE monsoon 2015 Additional institutions	SW monsoon 2016 Additional institutions
Cambodia	o Enhance forecast quality and communicate forecast reliability o Build DOM human resource through professional courses/ training o Explore use of mobile phones for forecast/ warning dissemination o Convene technical multi-sectoral working group for forecast application	*Forecast products:* o Improved typhoon forecasting o Forecast validation to improve forecast systems o Analyzed historical data o Collaborations for data sharing – among institutions and with other countries particularly on trans-boundary hazards *Dissemination:*	Not convened	o Forecast of rainfall onset and quantity, for the fisheries sector o Mechanism for receiving information relevant to the fisheries sector o Capacity building on forecast interpretation and application, for the agriculture and fisheries sectors o Forecast-based agro-advisories for farmers

	Activity	Time Frame		Description of results			
				o Involve more stakeholders, including farmers, in the Monsoon Forum	o Use of various dissemination mechanisms to ensure redundancy in warning delivery o Use of simple terms, along with explanations to better understand forecasts o A "question and answer" mechanism through mass media, which the public could use to clarify forecast/ information o Enhanced forecasters-media relations *Application:* o Capacity building on forecast application o Coordination between government ministries, departments, and line agencies for forecast application		
			Lao PDR	o Enhance forecast temporal and spatial resolutions o Build DMH capacity in forecast generation and validation o Improve timeliness of forecast delivery, particularly at the provincial level o Increase awareness on forecast and warning terminologies o Provide interpreted/ translated forecasts to communities o Increase the number of participating institutions in the	*Forecast products:* o Discharge information, and analysis of rainfall-water level correlation for guiding the Water Resource Department in undertaking water management/ flood control activities o Forecast validation to ascertain forecast reliability o Climate change scenarios for education sector o Earthquake information for magnitudes below 5.5 o DMH capacity building	o Densification of observing and monitoring stations to aid forecasting o Climate information products that are customized to user needs o Collaboration with the Army on dissemination o Use of various dissemination mechanisms	No new institution participating

	Activity	Time Frame			Description of results			
				Monsoon Forum	*Dissemination:* o Simple, easy to understand information, with use of visuals o Media demand for twice a day forecast updates o Media training on forecast communication o Press release and conferences for severe weather forecast/ warning dissemination o Frequent airing of weekly forecast and 3-monthly outlook *Monsoon Forums:* o Use of visuals in DMH presentations in Monsoon Forum *Application:* o Awareness building on DMH products and services o Capacity building on product utilization for preparedness		
			Pakistan	Not convened	*Observation, monitoring:* o Densification of earthquake and tsunami monitoring systems o Collaboration between India, Pakistan, and Oman on earthquake monitoring is a must o Enhancement of rainfall observation system o Regional cooperation on data sharing, noting non-availability of rainfall data in upper catchment areas *Forecasts and warnings* o Timely seasonal	Not convened	o Simple PMD information products customized to various users o At least 6 days lead time for marine/ ocean hazards o Capacity building of user sectors to enable them to use the range of products available from PMD o Public education on utilization of forecast at different timescales for managing hazard impacts	

	Activity	Time Frame			Description of results			
					forecasts, with monthly updates o Validation of forecasts at different timescales o Improved accuracy of flood forecasting models *Dissemination:* o Use of local language, including for technical terms o Use of TV, radio, local observatories, PMD regional and provincial offices for dissemination o Targeted dissemination to low-lying areas o PMD collaboration with FM radio channels o Media training o Community awareness program *Application:* o Tsunami risk assessments o Improved water reservoir/ storage systems o Use of drought-tolerant crops in Tharparkar District in response to deficient rainfall forecast *Others:* o Better PMD interaction with stakeholders o Better PMD understanding of user needs o Expansion of Monsoon Forum to include other user sectors o Establishment of water		o Use of technology, including radio and television programs, to address last mile communication issues o Monsoon outlook briefings for district authorities, communities, and NGOs o Conduct of Monsoon Forum before and after the monsoon	

	Activity	Time Frame	Description of results			
			reservoirs in strategic areas o Collaboration with other countries on transboundary issues o Sub-national forum *Research:* o Collaborative research on southwest monsoon drivers o Relationship of ENSO and sun-tropical/ Tibetan high o Support from and involvement of private sector and academia			

Sustaining the Forums

Cambodia. DOM has requested for continued financial and technical support for the Monsoon Forum.

Lao PDR. In several discussions with RIMES, DMH has also requested for continued financial and technical support for the Monsoon Forum. Its effort to bring the Forum at provincial level is being funded by the World Bank.

Pakistan. PMD requested RIMES to support the Monsoon Forum in Pakistan in terms of RIMES presence in the Forum and technical inputs on NMHS-user engagement. PMD and other stakeholders have started supporting the Forum, such as the organizing of the 4th Forum and in responding to Forum recommendations (e.g. the Heat Wave Awareness Program).

	Activity	Time Frame	Description of results
5	Project management o Progress monitoring and reporting o Documentation o External evaluation O Audit	Nov 2014 – Sep 2016	Auditor's report attached, confirming full use of resources provided to RIMES for the project.

LESSONS LEARNED

- The Monsoon Forum is a user interface platform for climate services provider-user interaction to ensure that user needs and feedback are articulated and integrated in the development and provision of climate services. This Forum is a process of trust building between users and provider of climate services, hence requires time and resources for enabling the NMHS to meet user needs – a challenge particularly in low capacity countries. The greater challenge is how to approach capacity building and Monsoon Forum institutionalization while breaking away from the culture of dependence on external funding.

- Ensuring availability and quality of climate data are important for timely execution of the project. Partial/ non-availability of long-term observation data from Sri Lanka/ Pakistan, unavailability of the Earth System Grid Federation (ESGF) server (the source of all CMIP5 GCMs) from June-September for downloading regionally downscaled datasets, and partial availability of regionally downscaled CORDEX datasets contributed to the delay in project delivery.

- Capacity building by secondment at RIMES was highly appreciated by participants and their seconding agencies, noting the mentoring approach and consideration of user needs in product development that RIMES advocates. However, DOM, having limited human resource, found that staff having the right background for the training are senior officers that could not be spared for 3-months, away from their key tasks. Flexibility in capacity building approach is, hence, essential.

SUSTAINABILITY

Please elaborate on any progress towards ensuring that this project results in a long-term benefit to the project stakeholders.

- The project is taking participatory approaches to ensure that NMHSs and user institutions are fully engaged in project initiatives, hence should lead to improved outcomes and better ownership of processes. These include: stakeholder consultations before the technical work to guide downscaling activities and after the technical work to get feedback on initial products; mentoring and learning by doing through secondment of NMHS scientists to RIMES; and engagement with users through training and coaching for utilization of downscaled climate projections.

- The web-based climate data and projections portal that is being developed can be used for data and projections for other countries as and when this initiative is replicated, with minimal additional investment. It can also be scaled up with other model data for different time scales of climate information.

- Having partner NMHSs take the lead in in-country project activities has led to NMHS ownership of processes that involve users, such as the Monsoon Forum and stakeholder engagement for climate projections application.