Climate Change Downscaling for Local Governments

Report 1

2022

Kerala State Disaster Management Authority (KSDMA)

Kerala Institute of Local Administration (KILA)

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A project funded by

Rebuild Kerala

Contents

1. Introduction

The Resilient Kerala Program for Results – PforR (the Program, RKP) is a Statewide Program to be implemented during the period 2021 – 2026. The objective of the Program is to enhance Kerala's resilience against the impacts of climate change and natural disasters, including disease outbreaks and pandemics. The Program aims for the development of institutions and systems (mainly with Result Area 1 (RA) – strengthening transversal systems for resilience in the areas of Fiscal, DRFI, Social Protection, Urban, and DRM) and focusing on districts along the Pamba Basin for demonstrating integrated resilience at local level (mainly within Result Area - RA 2 – embedding resilience in key economic sectors such as Health, Agriculture, WRM, and Roads).

The World Bank, through the National Cyclone Mitigation Project 2 and the DPO, has been supporting the Kerala State Disaster Management Authority (KSDMA) to establish norms, systems, and capacities for strengthening local level disaster risk planning and management across the State. The RKP will build on this and support the formulation/updating of DRM plans with local-level climate risk information, for all the 263 Local Self-Government Institutions (LSGIs) in the Pamba River Basin districts. The Program will include (a) the development of technical tools and training in DRM, (b) multi-year investment planning integrating climate risk information at the local level, and (c) support for the development of a scoring matrix called the Disaster and Climate Action Tracker (DCAT) to evaluate local investments which are climate and disaster risk informed. DCAT will be used by the Local Self-government Department (LSGD) to establish a performance- and reward-based system for incentivizing LSGIs that mainstream climate and disaster risk in their development and investment planning.

The PforR Program consists of the following activity under DLI 5

Indicator & Name	DLI 5: Climate risk Information is integrated into local body DRM plans	
Baseline	There lacks integration and use of local level climate risks to strengthen local level preparedness	
Period	Targets to be Achieved	Independent Verification Agency (IVA) Verification Procedure
Year 1	KSDMA has downscaled climate models and provided this information to all Local Governments (LGs) in the State.	Year 1: IVA to confirm that KSDMA has KSDMA has downscaled climate models and provided access to all LGs in the State.

Year 2	200 LGs in Pamba Basin districts have integrated climate information into the local body disaster risk management plans.	Year 2: IVA to confirm that at least 200 LGs in Pamba Basin districts have integrated the downscaled climate information into the updated local body disaster risk management plans.
Year 3	100 LGs in Pamba Basin districts have been assessed through DCAT and achieved the target of 30% co-benefits score.	Year 3: IVA to confirm that at least 100 LGs in Pamba Basin districts have been assessed through DCAT and achieved the target of 30% co-benefits score. Disbursement can be requested for every 50 LGs meeting the target.
Year 4	150 LGs in Pamba Basin districts have satisfactorily completed local level emergency management exercises coordinated by KSDMA as per the updated local body disaster risk management plans.	Year 4: IVA to confirm that at least 150 LGs in Pamba Basin districts have satisfactorily completed local level emergency management exercises coordinated by KSDMA as per the updated local body disaster risk management plans. Disbursement can be requested for every 50 LGs meeting the target.
Year 5	150 LGs have been assessed through DCAT and achieved enhanced target of 50% co-benefits score.	Year 5: IVA to confirm that at least 150 LGs have been assessed through DCAT and achieved enhanced target of 50% co-benefits score. Disbursement can be requested for every 50 LGs meeting the target.

So as to attain the first-year target of DLI5, the downscaled model data of general circulation model (GCM) runs conducted under the CMIP5 were taken.

KSDMA and KILA is jointly working to make climate change information available to local governments for adaption planning and resilience building. The project aims at facilitating precipitation and temperature change information from CMIP5 CORDEX data for the near term (2021-40), medium term (2041-2060) and long term (2061-2099) to local governments. The project eventually will also create a hyper resolution climate change model and translation of the various RCP scenario-based rainfall and temperature information into flood, landslide, heat and drought hazard probabilities.

The data, methodology and results are described in the following section.

2. Data

The data from the atmosphere-ocean coupled general circulation model runs conducted under the CMIP5 (Taylor et al., 2012) for the representative concentration pathway (RCP) scenarios is dynamically downscaled to 0.5°×0.5° resolution using RegCM4 and RCA4 regional climate models (RCM) under the Coordinated Regional Climate Downscaling Experiment (CORDEX) South Asia programme. The monthly precipitation, maximum temperature and minimum temperature for the historical run and climate scenarios RCP 4.5 and RCP 8.5 were taken from the ESGF portal (https://esgf-node.ipsl.upmc.fr/search/cordex-ipsl/). A brief description of the RCMs used in this work is provided below.

CORDEX simulation	RCM	Variable
CNRM-CERFACS-CNRM-CM5	SMHI-RCA4	Precipitation
NOAA-GFDL-GFDL-ESM2M	SMHI-RCA4	Precipitation Max Temperature Min Temperature
IPSL-CM5A-MR	SMHI-RCA4	Precipitation Max Temperature Min Temperature
NCC-NorESM1-M	SMHI-RCA4	Precipitation Max Temperature Min Temperature
CCma-CanESM2	SMHI-RCA4	Max Temperature Min Temperature
MIROC-MIROC5	SMHI-RCA4	Max Temperature Min Temperature
CNRM-CERFACS-CNRM-CM5	IITM–RegCM4-4	Precipitation Max Temperature Min Temperature
IPSL-IPSL-CM5A-LR	IITM–RegCM4-4	Precipitation Max Temperature Min Temperature
CCma-CanESM2	IITM–RegCM4-4	Precipitation Max Temperature Min Temperature
CSIRO-QCCCE-CSIRO-Mk3-6-0	IITM–RegCM4-4	Precipitation Max Temperature Min Temperature

NOAA-GFDL/GFDL-ESM2M	IITM–RegCM4-4	Precipitation Max Temperature Min Temperature
MPI-M-MPI-ESM-MR	IITM–RegCM4-4	Precipitation Max Temperature Min Temperature

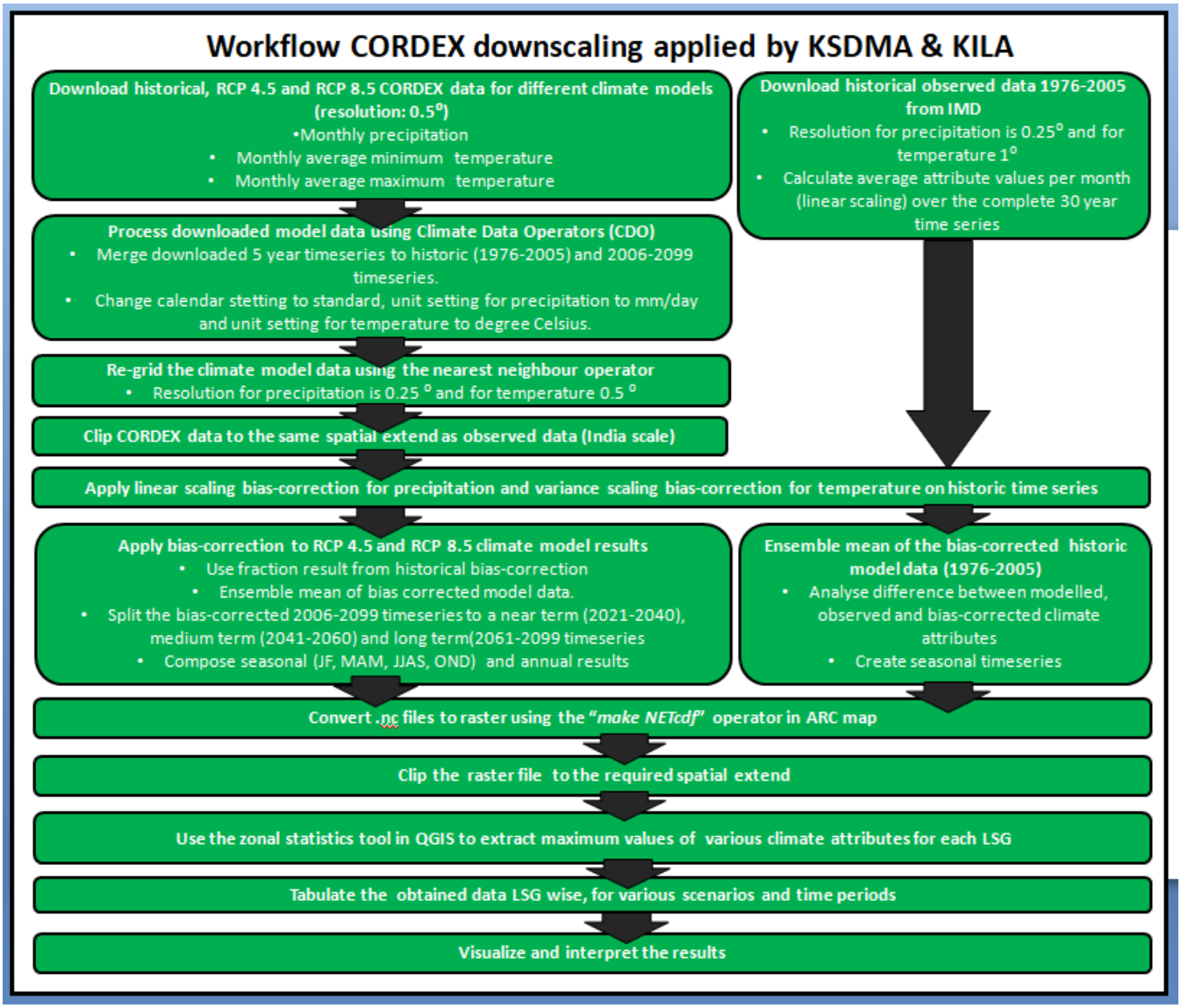
The observed daily precipitation gridded data with spatial resolution 0.25° latitude × 0.25° longitude (Pai et al. 2014) and maximum and minimum temperature data with 1° latitude x 1° longitude spatial resolution (Srivastava et al. 2009) provided by Indian Meteorological Department (IMD) for the historical baseline period 1976–2005 is taken for the bias correction of model data

3. Methodology

The regional climate model (RCM) outputs have a certain amount of systematic bias, which is not recommended for direct use in impact studies. Due to systematic bias, the climate variable outputs provided by RCMs do not match the statistical properties of the observed time series. Therefore, bias correction (BC) is a necessary step for RCM-simulated meteorological variables before being used. The CORDEX South Asia model data on precipitation, maximum temperature and minimum temperature were bias corrected with the observed data provided by India Meteorological Department (IMD). Multimodel ensemble is widely recommended to reduce uncertainties associated with climate models. Hence, ensemble mean of the bias corrected CORDEX simulation listed in the table 1 were used for estimating climate change projections. The model simulated historical data is available from 1951 to 2005 and the projected data is available from 2006 to 2099. In this work, thirty-year base line period data, from 1976 to 2005, is considered. The projected period is classified into three., viz., Near term (2021-2040), Medium term (2041-2060) and long term (2061-2099). The bias corrected monthly precipitation, maximum and minimum temperature were analysed for the 1034 local self government (LSG) of Kerala for the above-mentioned period. Change in temperature and rainfall during the projected period was derived as the difference between the average of the projected period (near/medium/long) and the 30-year historical period.

The variables, precipitation, maximum temperature and minimum temperature and its change, are mapped for the four districts in the Pamba basin. Also, the maximum value of the variables are tabulated LSG wise for the whole State.

The procedure adopted for the analysis is presented in the following flow chart



4. Results

This report contains the downscaled climate change information of all local governments in worksheet format and maps of the districts with local government boundary maps overlaid. The following links will provide access to these outputs.

1. Table containing predicted maximum temperature of all local governments of Kerala for RCP 4.5 and RCP 8.5 scenarios for near term (2021-40), medium term (2041-2060) and long term (2061-2099)
2. Table containing predicted minimum temperature of all local governments of Kerala for RCP 4.5 and RCP 8.5 scenarios for near term (2021-40), medium term (2041-2060) and long term (2061-2099)
3. Table containing predicted precipitation of all local governments of Kerala for RCP 4.5 and RCP 8.5 scenarios for near term (2021-40), medium term (2041-2060) and long term (2061-2099)
4. Maps containing predicted maximum temperature, minimum temperature and precipitation of Pathanamthitta, Alappuzha, Kottayam and Idukki of Kerala for RCP 4.5 and RCP 8.5 scenarios for near term (2021-40), medium term (2041-2060) and long term (2061-2099)

5. Reference

1. Pai, D.S., Latha Sridhar, Rajeevan M., Sreejith O.P., Satbhai N.S. and Mukhopadhyay B., (2014) https://www.imdpune.gov.in/Clim_Pred_LRF_New/ref_paper_MAUSAM.pdf, Mausam, 65 (1), 1-18
2. Srivastava, A. K., Rajeevan, M., and Kshirsagar, S. R (2009). Development of High Resolution Daily Gridded Temperature Data Set (1969-2005) for the Indian Region. Atmos. Sci. Let. (2009) DOI: 10.1002/asl.232.
3. Taylor, K. E., Stouffer, R. J., and Meehl, G. A. (2012). An Overview of CMIP5 and the Experiment Design, Bulletin of the American Meteorological Society, 93(4), 485-498.

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