Data Source

Digital elevation model

The 1 arcsec (~30 m) Shuttle Radar Topography Mission (SRTM) digital elevation model (DEM) data is used (Farr et al., 2007).

Land use

Land use data used in the model are derived from the European Space Agency Climate Change Initiative (ESA CCI) data set(Kirches et al., 2014). For the small-scale Din Gad model, a land use map is created using the Sentinel-2 image acquired on the 16th of October 2020 (**Error! Reference source not found.**).

Soil

Hydraulic soil properties used in this study were derived from HiHydroSoil (250m) (Simons et al., 2020).

Glacier boundary and ice thickness

The glacier boundaries in this model are derived fromRandolph Glacier Inventory (RGIv6) data.For each glacier, debris-covered and debris-free parts based is classified based on Kraaijenbrink et al., (2017).Farinotti et al., (2019) is used for the initial ice thickness and volume for each glacier.

Glacier mass balance

For the large-scale model, geodetic mass balance data from Shean et al., (2020) is used. For small scale Din Gad model, simulated data from Azam & Srivastava, (2020) and Dobhal et al., (2021) are used.

Snow cover

The MODIS MOD10CM006 (500m) snow cover data (2001–2017) is used to calculate the monthly snow persistence (Hall and Riggs, 2015) for the large-scale Bhagirathi model.

Meteorological data

The meteorological forcing used in this study are derived from topography-based downscaling scheme TopoSCALE(Fiddes and Gruber, 2014) using ECMWFs reanalysis product, ERA5 (Hersbach et al., 2020).

Streamflow

The observed discharge stations dataused to calibrate and validate the Bhagirathi SPHY model were provided by CWC.The modeled outputs from Azam and Srivastava, (2020)arealso used to calibrate and validateDin Gad model.

Climate change

Future climate forcings are based on new Coupled Model Intercomparison Projects phase 6 (CMIP6) ensembles.

Climate change:

Future climate forcings are based on new Coupled Model Intercomparison Projects phase 6 (CMIP6) ensembles. CMIP6 consists of the “runs” from around 100 distinct climate models being produced across 49 different modeling groups. A subset of the full ensemble of climate change scenarios provided in the CMIP6 multi-model ensemble is selected. Two “Shared Socioeconomic Pathways”(SSPs), i.e. SSP2: Middle of the Road (Medium challenges to mitigation and adaptation) and SSP3: Regional Rivalry – A Rocky Road (High challenges to mitigation and adaptation), are selected. For a medium (RCP4.5) and a high temperature and precipitation (RCP7.0) increase scenario, 4 GCM runs each are selected, to represent the full spectrum of projected changes. Models represents the 4 corners of the precipitation and temperature change spectrum, i.e‘Warm-Wet’, ‘Cold-Wet’, ‘Warm-Dry’ and ‘Cold-Dry’.

SSP245 Middle of the Road + medum temperature/precipitation change	EC-Earth3	‘Warm-Wet’
	GFDL-CM4	‘Warm-Dry’
	MPI-ESM1-2-HR	‘Cold-Dry’
	AWI-CM-1-1-MR	‘Cold-Wet’
SSP370 A Rocky Road + higt temperature/precipitation change	EC-Earth3	‘Warm-Wet’
	AWI-CM-1-1-MR	‘Warm-Dry’
	MPI-ESM1-2-HR	‘Cold-Dry’
	INM-CM5-0	‘Cold-Wet’

EC-Earth3:- EC-Earth3 is the third generation of the model and is also the name of the basic standard-resolution atmosphere-ocean physical model configuration. The standard EC-Earth3 model is used in this study. For more information visit https://ec-earth.org/ec-earth/ec-earth3/

GFDL-CM4: GFDL-CM4 is a comprehensive Global Climate Model, featuring a 1degree resolution AM4 atmosphere with 33 levels and advanced chemistry for aerosol simulation. For more information visit https://www.gfdl.noaa.gov/coupled-physical-model-cm4/.

MPI-ESM1-2-HR: The model was run by the Max Planck Institute for Meteorology, Hamburg 20146, Germany (MPI-M) in native nominal resolutions: aerosol: 100 km, atmos: 100 km, land: 100 km, landIce: none, ocean: 50 km, ocnBgchem: 50 km, seaIce: 50 km. For more information visit https://www.wdc-climate.de/ui/cmip6?input=CMIP6.HighResMIP.MPI-M.MPI-ESM1-2-HR

AWI-CM-1-1-MR : This model was run by the Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research, Am Handelshafen 12, 27570 Bremerhaven, Germany (AWI) in native nominal resolutions: atmos: 100 km, land: 100 km, ocean: 25 km, seaIce: 25 km. For more information visit https://epic.awi.de/id/eprint/53702/

INM-CM5-0: The model was run by the Institute for Numerical Mathematics, Russian Academy of Science, Moscow 119991, Russia (INM) in native nominal resolutions: aerosol: 100 km, atmos: 100 km, land: 100 km, ocean: 50 km, seaIce: 50 km. This model assumes1 percent per year increase in CO2 (1pctCO2). For more information regarding the model visit https://www.wdc-climate.de/ui/cmip6?input=CMIP6.CMIP.INM.INM-CM5-0.piControl.