



Utilization of SWOT-simulator along with other nadir altimeter observations for estimation of river discharge over Narmada River

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Narmada River Basin **Aim:** Quantification of the amount of **River discharge** by making use of SWOT observations and hydrological modelling. N 300 Kilometers **Objectives CWC Stations** Retrieval of river water level using altimetry data Sentinel- 3A tracks Sentinel- 3B tracks Surface water extent using optical (Landsat-8) remote sensing dataset 73°10'0"E 73°30'0"E 73°50'0"E 74°10'0"E 74°30'0"E Estimation of water surface elevation, slope, river 22°30'0"| 22°30'0"N discharge using SWOT retrieved river 22°20'0"N 22°20'0"N Sardar Sarovar Reservoir 22°10'0"N -22°10'0"N characteristics and other auxiliary datasets. 22°0'0" 22°0'0"N Varmada 21°50'0"N -21°50'0"N River Hydrological modelling for Narmada river basin 21°40'0" -21°40'0"N 21°30'0"N 21°30'0"N for estimation of river discharge. 21°20'0"N 21°20'0"N Model Discharge Location ver Outlete 21°10'0"N -21°10'0"N Tapi Ukai Reservoir 21°0'0"N -21°0'0"N River

HE Rada

20°50'0" 73°10'0"E 73°30'0"E 73°50'0"E 74°10'0"E 74°30'0"E 74°50'0"E



Methodology for estimation of Water Surface Elevation







Sentinel-3 altimetry derived water level time series after correcting geophysical range corrections like dry tropospheric correction, wet tropospheric correction, ionosphere correction at the virtual station near Hoshangabad for the period 2016-2020





The inundated areas within a stretch of nearly 10 km was found to be fluctuating between 404 to 575 Ha during the period 2014-2020, where the maximum extent was taken from the wetbnd layer from national Wetland inventory and assessment (NWIA) dataset



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Hydrological Modelling: WRF-Hydro Model



• Physics-based runoff processes



Overland Flow -Diffusive wave Kinematic^{*} Catchment aggregation^{*}



Groundwater Flow – Boussinesq flow Catchment aggregation*



Channel Flow – Diffusive wave Kinematic^{*} Reach-based Muskingum^{*}



Table 1: Summary of physics options in NOAH-MP model, and details of each scheme is presented in Niu et al. (2011) and Gochis et al. (2018).

Noah-MP Namelist Option	Namelist Selected value
Dynamic Veg Option	4
Canopy stomatal resistance option	1
BTR option	1
Runoff option	3
Surface drag option	1
Frozen soil option	1
Surface cooled option	1
Radiative transfer option	3
PCP partition option	1
Temp time scheme option	3
Surface resistance option	4
WRF-Hydro Namelist Option	
Channel routing option	3 (Diffusive wave)
Groundwater/Baseflow Routing Option	1

Table 2: Meteorological forcing variables for the WRF-Hydro (NOAH-MP) simulation

Variable	Unit
Incoming shortwave radiation	W/m2
Incoming longwave radiation	W/m2
Specific Humidity	kg/kg
Air temperature	К
Surface pressure	Pa
Near surface wind in the u-component	m/s
Near surface wind in the v-component	m/s
Liquid water precipitation rate	mm/s

Continuity Equation

 $\frac{\partial h}{\partial t} = \frac{\partial q_x}{\partial x} + \frac{\partial q_y}{\partial x} = i_e$

Momentum Equation

 $S_{fx} = S_{ox} - \frac{\partial h}{\partial x}$



WRF-Hydro Model Setup over Narmada River Basin



×10⁴ 2.5

1.5

0.5





River Discharge rating Curves: ADCP and CWC dataset





Acoustic Doppler current profiler (ADCP) and DGPS profiles were taken during the in-situ field trip synchronous with altimeter overpass on 8 February 2020







Conclusions



- The altimetry retrieved water levels over the VS close to Hoshangabad (Narmada River) were found to be fluctuating between 281.76 meter to 287.97 meter.
- SWOT Hydrology Simulator was setup over the virtual station and water surface elevation along with river width was estimated for the duration 2016-2022.
- WRF Hydro model was setup over the Narmada basin and derived river discharge close to altimeter VS was observed to be in the range more than 4000 m³/s in August 2021.
- SWOT estimated SWE was used for estimating the river discharge using rating curve generated from CWC dataset.
- Present nadir altimetry input (i.e. 27 days for Sentinel-3) misses many high water level/discharge events, further efforts is required to fill those gaps and actual SWOT swath measurements will help in addressing these issues.
- High-quality 2D maps of river surface will help hydrologist to answer some of the interesting questions about the river hydraulic properties.



SWOT simulated discharge at Narmada river close to Hoshangabad during 2016-2022