REQUEST FOR AN EMI R&D PROJECT 2027–2029

Country/Organisation:	Türkiye
Principal Investigator[1]:	Emirhan CEMEK
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Other researchers:	İsmail YÜCEL
Project Title:	Future Hydrology of Türkiye's River Basins under Climate Change

To make changes to an existing project please submit an amended version of the original form

If this is a continuation of an existing project, please state the computer project account assigned previously.	**SP** …………..	
Starting year: (A project can have a duration of up to 3 years, agreed at the beginning of the project.)	2027	
Would you accept support for 1 year only, if necessary?	YES ☒	NO ☐

Computer resources required for project year:		**2027**	**2028**	**2029**
High Performance Computing Facility	[SBU]	20 000 000	20 000 000	
Graphics Processing Unit Cluster-A	[GBU]			
Graphics Processing Unit Cluster-B	[GBU]			
Accumulated data storage (total archive volume)[2]	[GB]	40960	40960	

[1] The Principal Investigator will act as contact person for this EMI R&D Project and, in particular, will be asked to register the project, provide annual progress reports of the project's activities, etc.

[2] These figures refer to data archived in ECFS and MARS. If e.g. you archive x GB in year one and y GB in year two and don't delete anything you need to request x + y GB for the second project year etc.

[3]The number of vGPU is referred to the equivalent number of virtualized vGPUs with 8GB memory.

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Extended abstract

This EMI R&D Project will use the TR-3km Climate Dataset to produce high-resolution hydrological projections for the 25 river basins of Türkiye. The dataset was produced under the project "EU Partnership for Local Climate Action in Türkiye", funded by the European Union, implemented by the United Nations Development Programme Türkiye Country Office, and carried out with Türkiye's Directorate of Climate Change as the final beneficiary. It includes six climate projection members and ERA5 reanalysis fields dynamically downscaled with WRF to 3 km resolution over Türkiye. The present project will not repeat atmospheric downscaling; it will use these downscaled meteorological fields to force WRF-Hydro and LISFLOOD.

The ERA5 component is available for 1950-2024 and will be used for calibration, validation and reference diagnostics over selected periods to be defined during model setup. This does not mean that the full 1950-2024 period will be used for calibration. The ERA5-based simulations may also be used to generate additional reference-period diagnostics where these support interpretation of the projection results. ERA5 is used here as a reanalysis-based meteorological reference dataset (Hersbach et al., 2020).

The climate-change assessment will be based on internally consistent historical-to-future comparisons within the TR-3km climate projection members. For each of the six projection members, the 1985-2014 historical forcing segment will be used as that member's hydrological baseline. The corresponding 2015-2100 future forcing segments under SSP2-4.5 and SSP5-8.5 will then be compared with the same member's historical baseline. This avoids comparing a future projection directly against the ERA5-driven reference simulation. The use of historical and scenario simulation segments follows the CMIP6 experiment logic described by Eyring et al. (2016). The SSP scenario framework follows ScenarioMIP (O'Neill et al., 2016).

The scientific objective is to quantify possible changes in runoff, streamflow, evapotranspiration, soil moisture, snow-related hydrological components and basin-scale water budget indicators. Results will be analysed at monthly, seasonal and annual time scales. Selected high-flow and low-flow indicators will be used where they are supported by the model outputs and observation-based evaluation. The analysis will be reported for individual basins and then compared across the main hydroclimatic regions of Türkiye.

Scientific plan and technical workflow

The work will proceed in four technical stages. First, meteorological variables required by WRF-Hydro and LISFLOOD will be extracted from the TR-3km Climate Dataset, checked for temporal consistency, harmonized in units and calendars, and converted into model-specific forcing files. Static datasets such as topography, drainage direction, river network, land use, soil properties and basin masks will be prepared for the 25 river basins.

Second, the ERA5-based forcing will be used to calibrate and validate both hydrological models where sufficient observed hydrological information is available. The calibration will focus on streamflow dynamics, seasonal water balance, runoff volumes, low-flow behavior and high-flow response, rather than on a single score alone. The selected parameter sets will then be held fixed for the projection simulations.

Third, production simulations will be carried out with the TR-3km historical and future projection-member forcing. The preferred design is a unified Türkiye-scale hydrological setup, with the 25 basins extracted by masks and post-processing. If routing, grid consistency or numerical stability constraints make this unsuitable for either model, the workflow may be split into a limited number of regional or basin-group setups. The resource estimate allows for this flexibility, but it does not assume 25 fully independent basin-by-basin domains.

Fourth, outputs will be aggregated into basin-scale diagnostics and uncertainty ranges. The main comparison will be member-specific: each future hydrological simulation will be assessed against the historical simulation forced by the same TR-3km climate projection member. This structure separates model calibration and reference evaluation from the climate-change signal assessment.

WRF-Hydro will be run in stand-alone hydrological mode, and the atmospheric WRF model will not be run in this project. WRF-Hydro is selected because it can operate as a stand-alone hydrological modelling architecture and can run on high-performance computing systems (Gochis et al., 2020). LISFLOOD is selected because it is a distributed rainfall-runoff-routing model developed for river-basin scale water balance and flood simulation (Van Der Knijff et al., 2010). The implementation will use NetCDF-based processing, Python, CDO/NCO utilities, GIS tools, model-specific preprocessing scripts and ECMWF-compatible batch workflows.

Justification of computing and storage resources

The request covers production simulations, calibration and validation experiments, sensitivity tests, failed or repeated jobs, post-processing diagnostics and limited setup adjustments. The resource estimate is based on the ECMWF HPCF accounting formula SBU = P x N x T, where P = 424,074,479 / (8090 x 128 x 86400) = 0.0047399079, N is the number of allocated physical cores, and T is elapsed wall-clock time in seconds.

Table 1. Planned hydrological simulation workload.

Simulation block	Period	Members	Years per member	Total simulation years
ERA5-based calibration/reference simulations	1950-2024	1	75	75
TR-3km historical projection-member simulations	1985-2014	6	30	180
TR-3km future projection simulations	2015-2100	6 members x 2 SSPs	86	1,032
Total forcing years per hydrological model				**1,287**
Total for two hydrological models	**WRF-Hydro + LISFLOOD**			**2,574 model-years**

The ERA5 line is an upper planning allowance for calibration, validation and reference diagnostics; it is not a commitment to calibrate over the full 1950-2024 period.

Table 2. Annual HPCF SBU estimate.

Component	Runtime assumption	Simulation years	Estimated SBU
WRF-Hydro production simulations	4.0 h/year on 64 cores	1,287	5,622,001
LISFLOOD production simulations	1.0 h/year on 16 cores	1,287	351,375
Production subtotal			**5,973,376**
Calibration, validation, sensitivity tests and re-runs	110% of production subtotal		6,570,714
Pre-processing, post-processing and diagnostics	15% of production subtotal		896,006
Technical contingency and limited regional setup flexibility	25% of subtotal including overheads		3,360,024
Total estimated annual requirement			**16,800,120**
Rounded annual HPCF request			**20,000,000 SBU/year**

Table 3. Annual storage estimate.

Storage component	Estimated storage
Model-ready subsets of the TR-3km Climate Dataset and static inputs	12-15 TB
WRF-Hydro and LISFLOOD raw/intermediate outputs	12-15 TB
Restart files, calibration outputs, test runs and limited regional setup products	5-7 TB
Processed basin-scale diagnostics, maps, tables and figures	2-3 TB
Technical margin for temporary files and repeated simulations	5 TB
Rounded annual storage request	**40 TB/year**

The requested annual allocation is therefore 20,000,000 SBU and 40 TB of accumulated storage. This is below the maximum annual EMI R&D Project allocation, but large enough to support the two-model ensemble, calibration and validation, repeated runs, post-processing and possible limited regional setup adjustments. Storage growth will be controlled through variable selection, NetCDF compression and periodic removal of non-essential intermediate files.

Expected outputs

The project will deliver calibrated and validated WRF-Hydro and LISFLOOD configurations, ERA5-based reference simulations, TR-3km historical and future hydrological simulations, basin-scale indicators of water budget change, and uncertainty ranges across climate projection members and hydrological models. The final products will provide a technical basis for assessing how Türkiye's river-basin water budget may evolve under SSP2-4.5 and SSP5-8.5.

References

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