Valuing seasonal streamflow forecasts in power system operations

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1. BACKGROUND, METHODOLOGY AND EXPERIMENTS

I. RESEARCH QUESTIONS

- How does the value of streamflow forecasts propagate through the power grid?
- What are the key interdependencies between water and power systems?

II. MODELLING FRAMEWORK

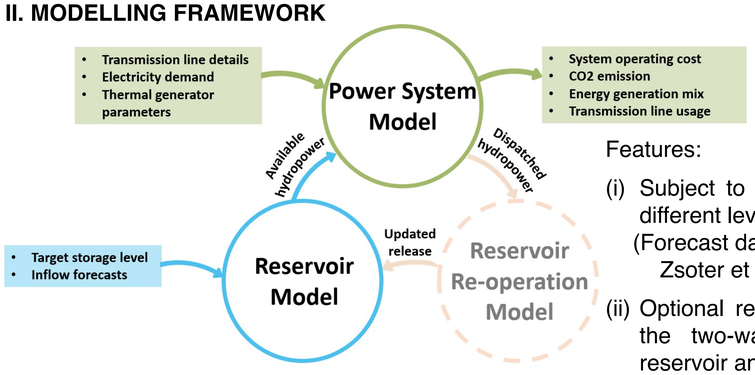

Fig 1. Modelling framework.

Features:

(i) Subject to reservoir inflow forecasts with different levels of accuracy (Forecast data source: GloFAS; Zsoter et al., 2020)

(ii) Optional re-operation model to represent the two-way interactions between the reservoir and power systems (see Koh et al., 2022 for details)

III. STUDY SITE

Cambodian power grid

Generating capacity:

- Hydropower: 1048 MW
- Coal: 400 MW
- Oil: 282 MW
- Import from Vietnam: 200 MW
- Import from Thailand: 120 MW

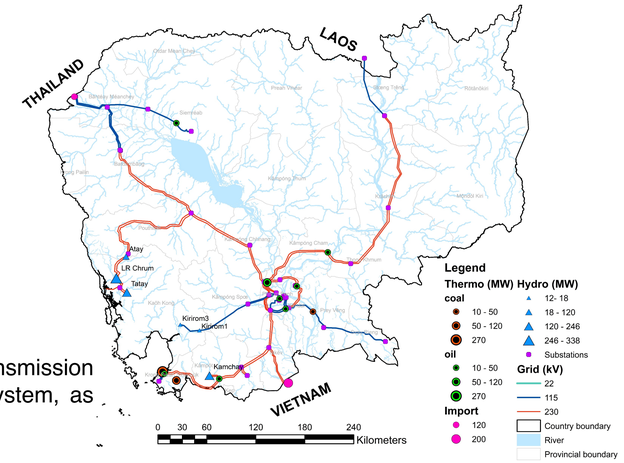

Fig 2. Main generation and transmission components of the Cambodian power system, as of 2016. Data retrieved from EDC (2016).

Table 1. Design specifications of the Cambodian hydropower dams

Reservoir	Installed cap (MW)	Dam ht. (m)	Storage (Mm^3)	Design Q (m^3/s)	Hydr. head (m)	Basin area (km^2)
Kamchay	194.1	110	680	163.5	122	710
Kirirom I	12	34	30	20	373.5	99
Kirirom III	18	40	30	40	271	105
Atay	240	45	443.8	125	216	1157
LR Chrum	338	68	62	300	132	1550
Tatay	246	77	322	150	188	1073

IV. EXPERIMENTS

- Simulation period: 2000-2018 (19 years)
- Reservoir operating schemes: (i) Rule curves; (ii) Forecast-informed; and (iii) (i) and (ii) with re-oper.
- No. of forecast scenarios: 14 (Perfect forecast, 11 forecast members, Ensemble mean, Climatology)

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2. RESULTS

System stressors:

- Forecast error
- Reservoir inflow
- Load

Performance metrics:

- Available, dispatched, and unused hydropower
- System operating costs
- CO_2 emissions
- No. of N-1 violations

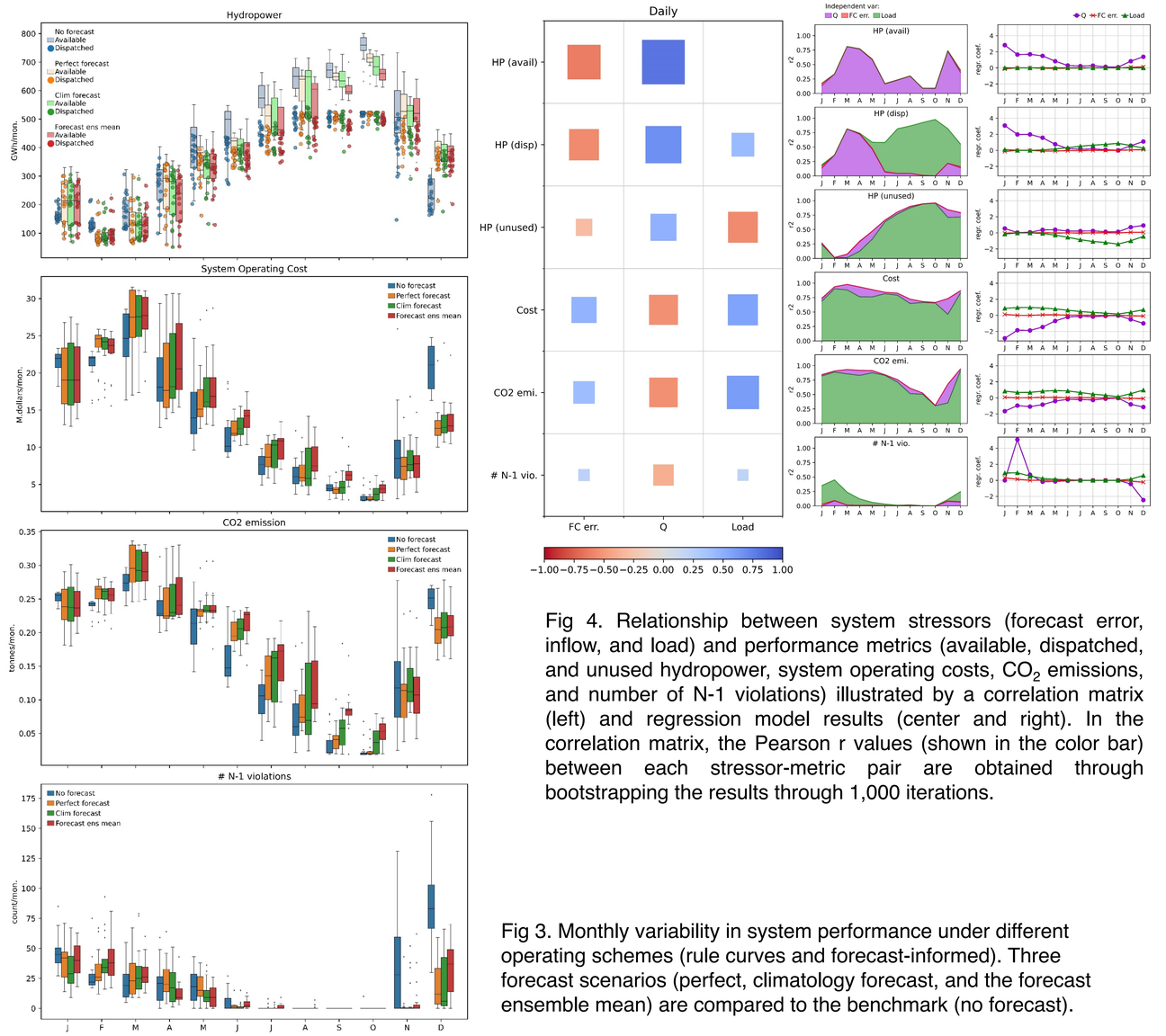

Fig 4. Relationship between system stressors (forecast error, inflow, and load) and performance metrics (available, dispatched, and unused hydropower, system operating costs, CO_2 emissions, and number of N-1 violations) illustrated by a correlation matrix (left) and regression model results (center and right). In the correlation matrix, the Pearson r values (shown in the color bar) between each stressor-metric pair are obtained through bootstrapping the results through 1,000 iterations.

Fig 3. Monthly variability in system performance under different operating schemes (rule curves and forecast-informed). Three forecast scenarios (perfect, climatology forecast, and the forecast ensemble mean) are compared to the benchmark (no forecast).

3. REFERENCES

EDC. Annual report 2016. Technical report, Electricité du Cambodge (EDC); 2016.

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Zsoter, E., Harrigan, S., Barnard, C., Blick, M., Ferrario, I., Wetterhall, F., Prudhomme, C. (2020): Reforecasts of river discharge and related data by the Global Flood Awareness System, v2.2, Copernicus Climate Change Service (C3S) Climate Data Store (CDS). (Last accessed: 27 Oct 2022), 10.24381/cds.2d78664e