

Motivation

- South Asia: a major proponent of the Global South
- Large and dense population
- Agriculture and animal husbandry are dominant economic sectors
- Rapidly growing economy with industrial and infrastructure development
- A significant part is identified as ‘drylands’

Figure 1. Land use land cover map of South Asia

Figure 2. Distribution of global drylands (Wang et al., 2022)

Previous Attempts

➤ Patra et al., (2013)

➤ Cervarich et al., (2016)

➤ Jain et al., (2025)

Table 1. Terrestrial carbon fluxes for the countries in South Asia (SA), Southeast Asia (SEA) and South and Southeast Asia (SSEA = SA + SEA) (listed in alphabetic order) for the 2000–2013 period based on the average of the nine TRENDY models. NBP for SSEA for 2000–2013 Positive values are sink of carbon and negative values are source of carbon. Uncertainty is estimated with the 1-σ standard deviation from the terrestrial ecosystem models. Fossil fuel emissions are from the Carbon Dioxide Information Analysis Center (CDIAC) database and averaged over the 2000–2013 period.

Country	NEP (TgC yr ⁻¹)	LULCC (TgC yr ⁻¹)	FIRE (TgC yr ⁻¹)	NBP (TgC yr ⁻¹)	Fossil Fuels (TgC yr ⁻¹)
Bangladesh	10.6 ± 8.8	-1.4 ± 4.6	-0.0 ± 0.0	9.3 ± 9.2	-12.2
Bhutan	2.2 ± 1.9	-0.4 ± 1.1	-0.5 ± 0.0	1.2 ± 2.3	-0.1
India	200.6 ± 137.7	-6.2 ± 44.4	-8.5 ± 0.6	185.9 ± 145.6	-439.9
Nepal	9.2 ± 7.6	-0.2 ± 2.8	-1.0 ± 0.1	8.0 ± 8.4	-0.9
Pakistan	14.2 ± 7.7	-1.1 ± 2.8	-0.4 ± 0.0	12.7 ± 10.9	-38.2
Sri Lanka	3.6 ± 1.6	-3.1 ± 2.2	-0.2 ± 0.0	0.4 ± 3.2	-3.3
SA	240.6 ± 138.4	-12.4 ± 44.8	-10.6 ± 0.6	217.5 ± 146.6	-494.6
Cambodia	11.5 ± 3.61	-5.8 ± 6.6	-8.1 ± 0.5	-2.3 ± 7.4	-0.9
Indonesia	106.3 ± 48.9	-94.9 ± 76.5	-49.6 ± 49.2	-38.2 ± 17.8	-101.4
Laos	24.8 ± 11.1	-6.8 ± 8.0	-10.3 ± 0.7	7.7 ± 16.0	-0.4
Malaysia	22.2 ± 11.9	-14.6 ± 16.6	-4.5 ± 0.4	3.1 ± 26.4	-49.4
Myanmar	53.1 ± 18.7	-10.9 ± 12.4	-17.3 ± 1.9	24.9 ± 25.9	-2.9
Philippines	16.2 ± 5.3	-13.2 ± 9.4	-1.3 ± 1.1	1.8 ± 13.4	-20.5
Thailand	37.4 ± 13.3	-10.1 ± 16.5	-11.2 ± 0.8	16.1 ± 24.2	-70.0
Vietnam	34.7 ± 16.6	-19.1 ± 14.1	-18.6 ± 1.3	-3.0 ± 17.5	-29.5
SEA	306.2 ± 59.2	-175.4 ± 83.4	-120.9 ± 49.3	9.8 ± 55.4	-274.9
SSEA	546.6 ± 200.6	-187.7 ± 192.2	-131.6 ± 3.5	227.3 ± 278.9	-769.5

Table 7
Comparison of UNFCCC-Reported Country-Specific Total Emission Inventories (TgCO₂ eq yr⁻¹) (UNFCCC, 2024a, 2024b)
Mean for the Random Periods With the Top-Down (TD) and Bottom-Up (BU) Models and Their Uncertainty Ranges

Country	Method ^a	Period/Year	Emissions	This study	
				BU	TD
Afghanistan	NC	2012–2013	60.2	44.9 (15.6–74.4)	42.3 (30.7–53.9)
	BUR	2010–2017	40.4	57.5 (33.6–81.5)	46.8 (18.5–75.2)
Bangladesh	NC	2010–2012	152.3	208.5 (169.3–247.8)	199.2 (146.6–251.8)
	BUR	2013–2019	193.8	236.0 (193.6–279.6)	315.5 (248.4–382.6)
Bhutan	NC	2010–2015	-5.7	2.8 ((-3)–8.5)	6.12 ((-5.1)–17.3)
	BUR	2010–2019	-6.5	0.9 ((-2.9)–4.7)	6.5 ((-2.6)–15.7)
India	NC	2011–2019	2394.7	3343 (3048.5–3637.5)	3568.8 (3054.4–4083.4)
	BUR	2011–2016	2271.6	3236.9 (2754.2–3719.5)	3437.6 (2913.5–3961.9)
Nepal	NC	2010–2011	28.2	41 (12.4–69.6)	49.4 (27.1–71.7)
	BUR	–	–	–	–
Pakistan	NC	2012–2015	405.0	426.8 (365.7–487.8)	454 (406.7–501.5)
	BUR	2012, 2015, 2018	359.6	481.8 (381.7–581.9)	503.3 (397.3–609.3)
Sri Lanka	NC	2010	3.7	10.1 ((-6.6)–26.9)	27.2 (16.1–38.2)
	BUR	–	–	–	–

^a“NC” values are based on National Communication (NC) submissions from Non-Annex I Parties (UNFCCC, 2024a), and Biennial Update Report (BUR) values are based on BUR submissions from Non-Annex I Parties (UNFCCC, 2024b).

Caveats

1. In situ observations are sparse and insufficient
2. Significant heterogeneities in the land use and land cover
3. Remotely sensed products remain invalidated
4. Models have high uncertainty
5. Mismatch between top-down and bottom-up estimates

Present Synthesis of Knowledge over India: the heart of the subcontinent

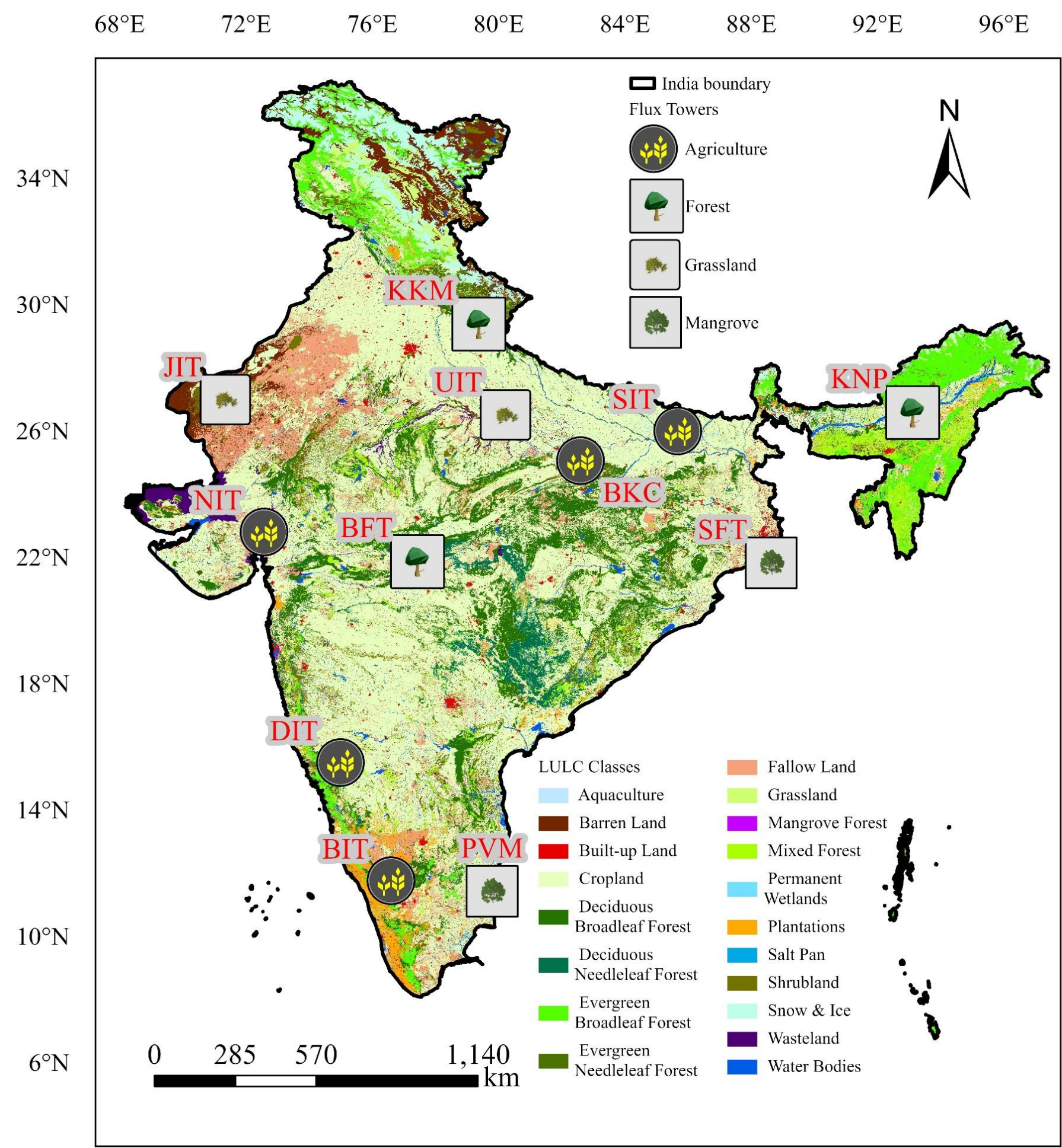


Figure 1: India: Land Use Land Cover pattern and Flux towers

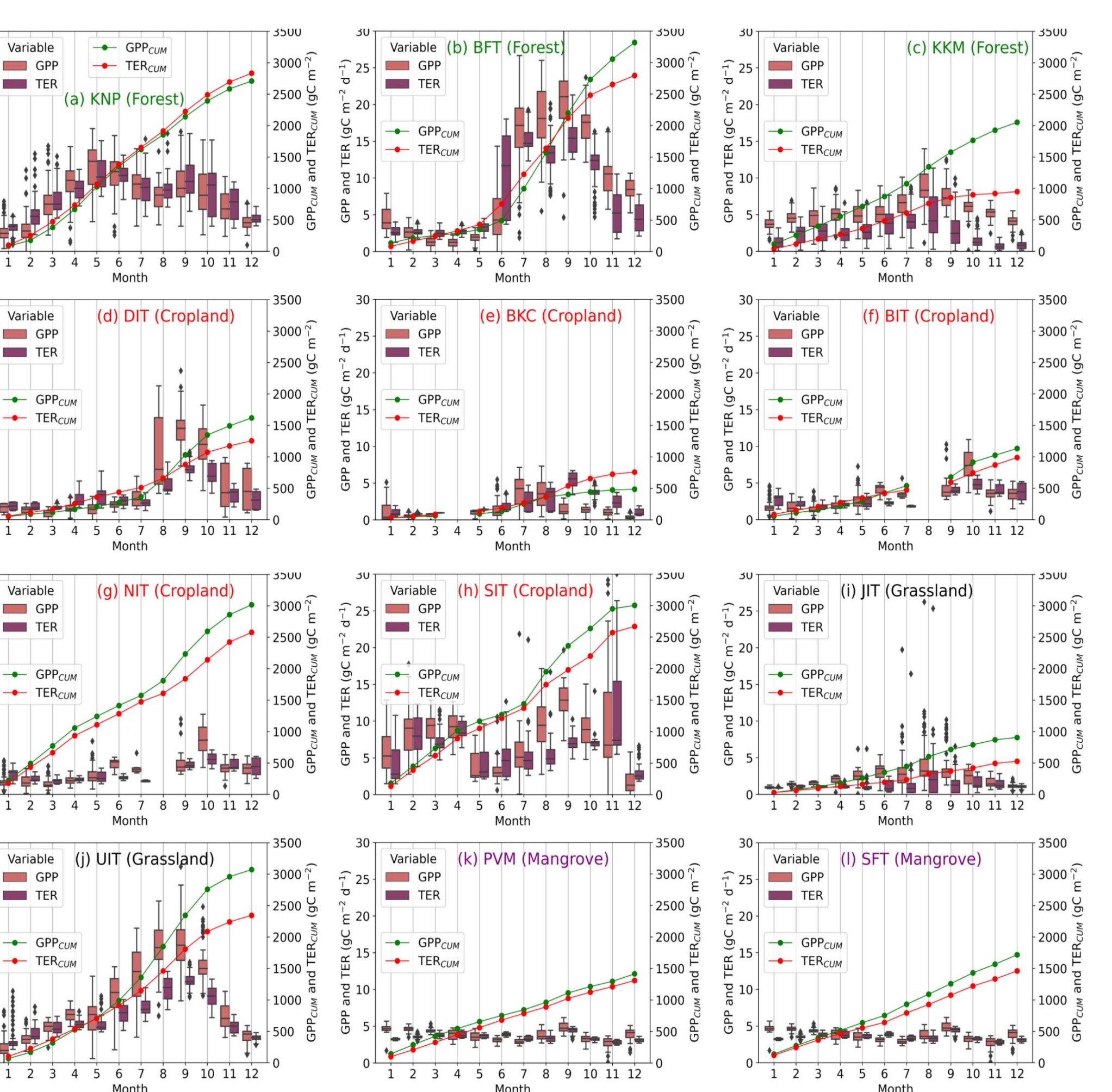


Figure 2: Carbon exchange pattern over India

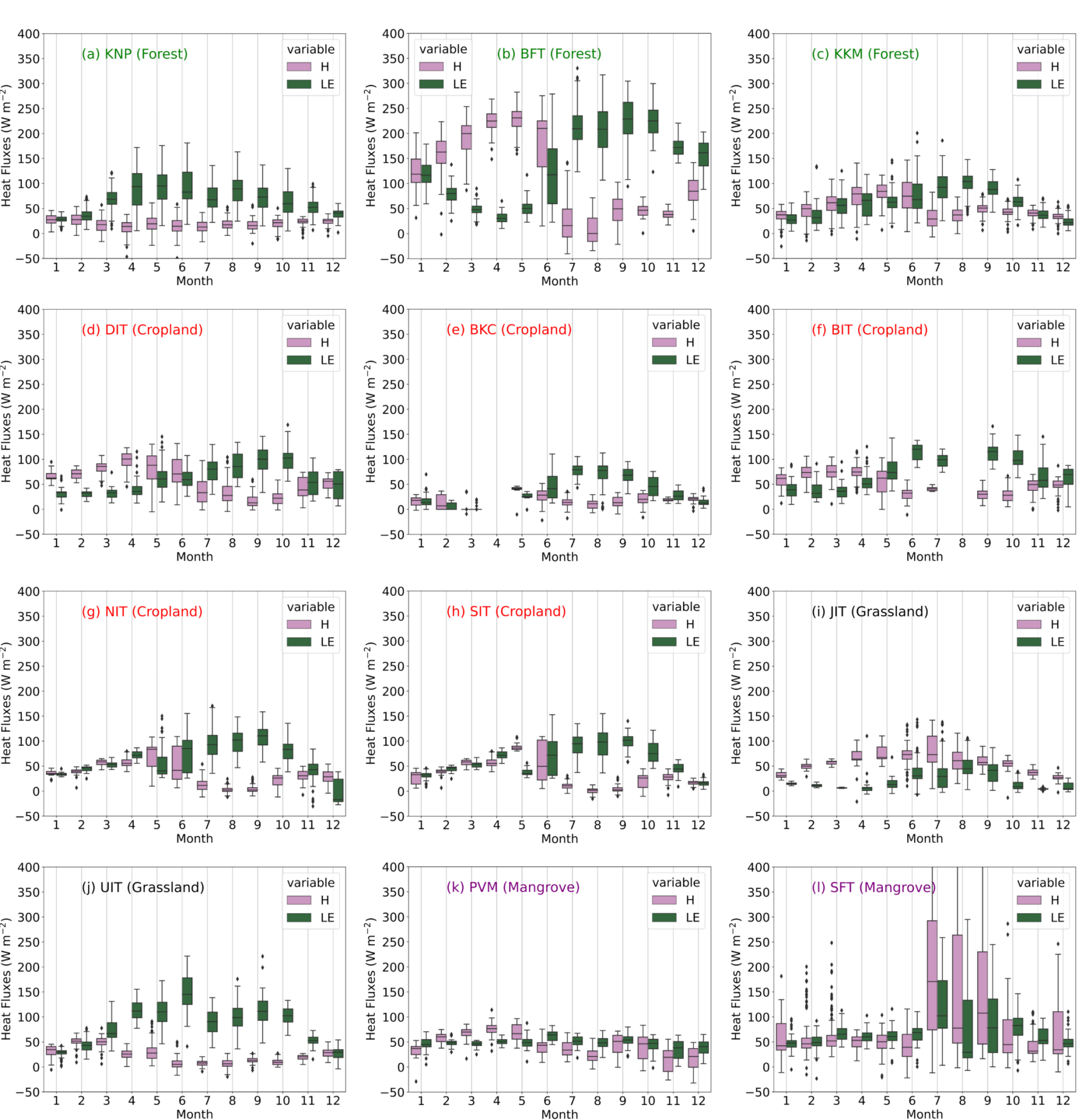


Figure 3: Heat and water exchange patterns over India

References

1. Patra P. et al. (2013). The carbon budget of South Asia. *Biogeosciences*, 10(1), 513–527. <https://doi.org/10.5194/bg-10-513-2013>
2. Cervarich M. et al. (2016). The terrestrial carbon budget of South and Southeast Asia, *Environmental Research Letters*, 11(10), 105006. <https://doi.org/10.1088/1748-9326/11/10/105006>
3. Jain, A. et al. (2025). South Asia's ecosystems are a net carbon sink, but the region is a major net GHG source to the atmosphere. *Global Biogeochemical Cycles*, 39(4), e2024GB008261. <https://doi.org/10.1029/2024GB008261>
4. Deb Burman, P. K. et al. (2025). Ecosystem-atmosphere exchanges of carbon dioxide, water vapour and energy in India: A synthesis of insights from eddy covariance measurements. *Agricultural and Forest Meteorology*, 372(15 September 2025), 110730. <https://doi.org/10.1016/j.agrformet.2025.110730>
5. Wang et al.. (2022). Dryland productivity under a changing climate. *Nature Climate Change*, 12(11), 981–994. <https://doi.org/10.1038/s41558-022-01499-y>