Cosmic-ray soil water content monitoring: development of the COSMOS-India network

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Main Objective

To develop a network of field-scale soil moisture monitoring stations across India (COSMOS-India) using cosmic-ray soil moisture sensors (CRS; Fig.1). CEH are working in partnership with IISc Bangalore, IIT Kanpur, IITM Pune, UAS Dharwad and NIH Roorkee to develop the COSMOS-India network, and to deliver high temporal frequency observations of soil moisture at the intermediate spatial scale in near real-time.

COSMIC-ray soil moisture sensor (CRS) technology

- Cutting-edge field scale (c. 200 m radius) CRS (Fig. 1) measure average near-surface (to c.25 cm depth) volumetric soil water content (VWC) over heterogeneous soils without contact (non-invasive).
- VWC is inferred by counting fast neutrons which are naturally generated by incoming cosmic-rays, and are slowed or captured by hydrogen atoms contained primarily within water residing in the upper soil profile.
- CRS sensors are calibrated to local site conditions. Data are telemetered over mobile networks and processed in near-real time.

Figure 1. Cosmic-ray soil moisture sensors (CRS) installed at IIT Kanpur (left), Berambadi (centre) and Singanalur (right).

COSMOS-India network development

- Three COSMOS-India sites were installed in Karnataka (Fig. 2) between February and September 2015. The forth COSMOS-India site was installed at IIT Kanpur (Fig. 2) in February 2016.
- CRS sensors will be installed at UAS Dharwad, IITM Pune and NIH Roorkee (Fig. 2) by early 2017.
- Three CRS sensors will be co-located with CEH eddy covariance towers at Berambadi (see example data shown in Fig. 3), IIT Kanpur and UAS Dharwad, providing direct observations of latent heat (evapotranspiration) and sensible heat fluxes, as well as net ecosystem CO_2 exchange, micrometeorology and soil physics.

Example applications

- Water resources, groundwater, irrigation scheduling
- Hydro-meteorological, land surface and ecological studies
- Ground-truth for remotely sensed soil moisture products
- Flood and drought forecasting
- Water use efficiency of crop production

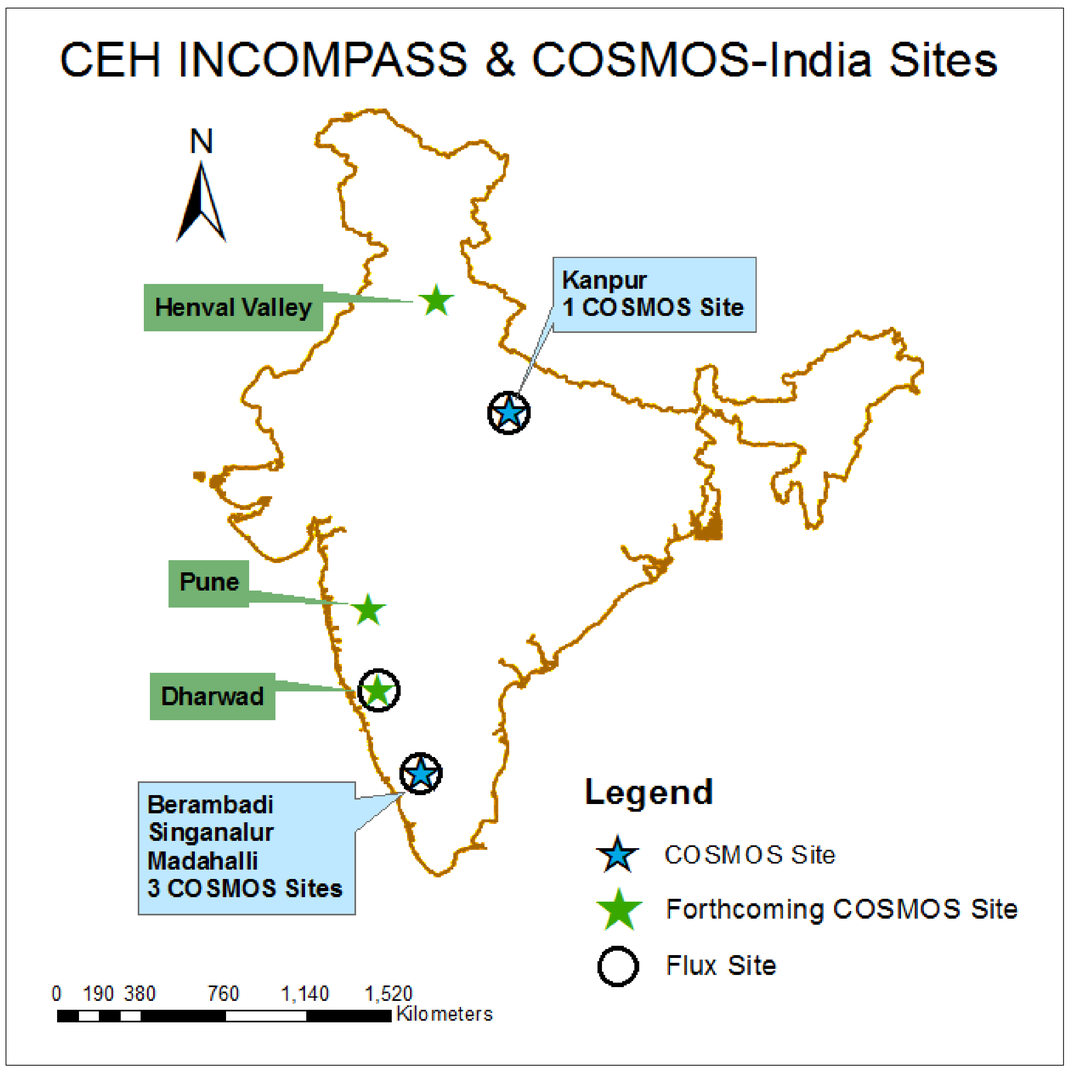

Figure 2. Map showing current and forthcoming COSMOS-India sites.

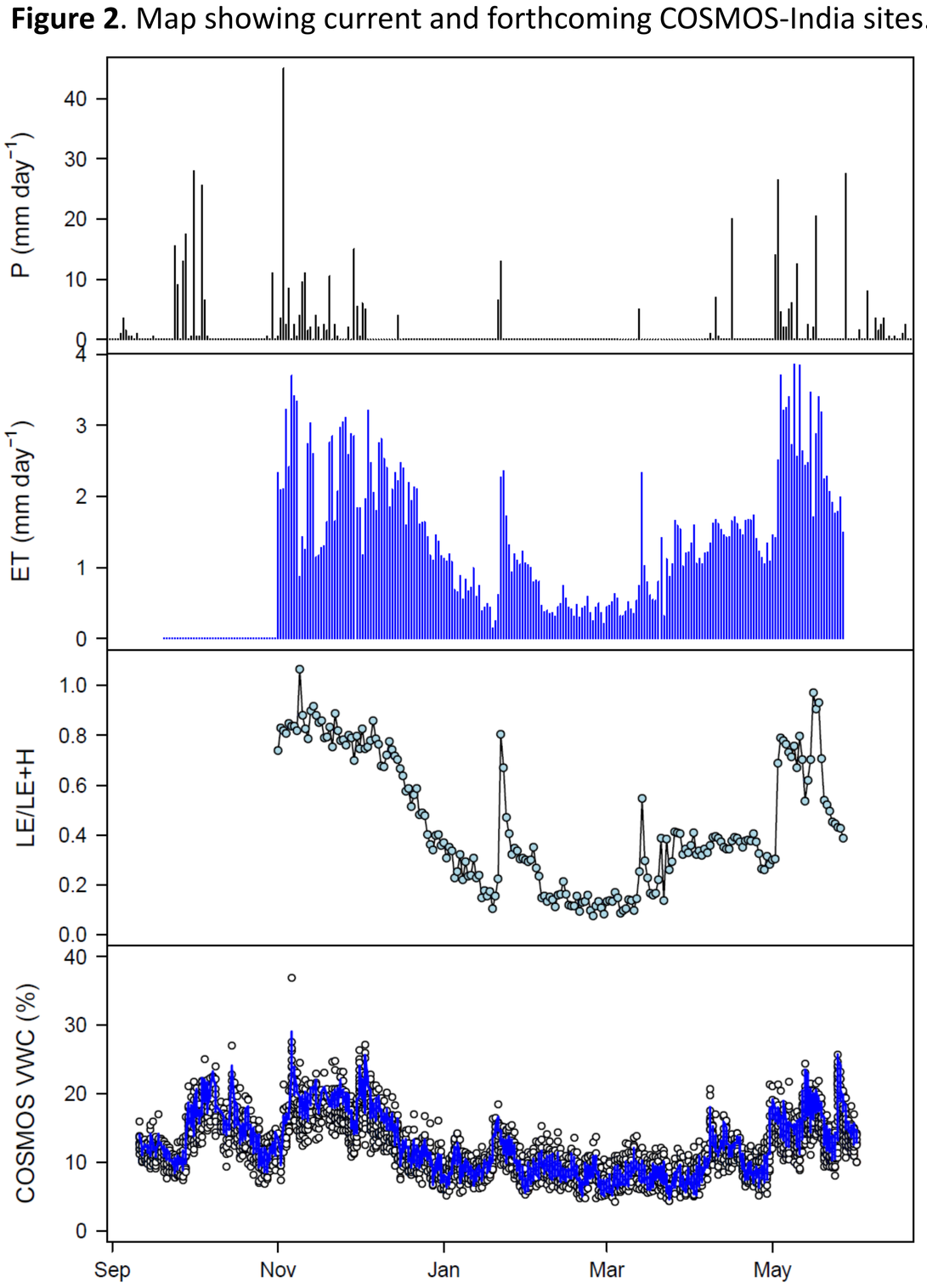

Figure 3. Examples of co-located measurements of precipitation (P), evapotranspiration (ET), evaporative fraction (LE/LE+H) and COSMOS VWC at Berambadi, Karnataka. Note that a provisional calibration procedure was used to estimate COSMOS VWC from fast neutron counts.

More information on COSMOS:
cosmos.ceh.ac.uk; Twitter: @CosmosCEH