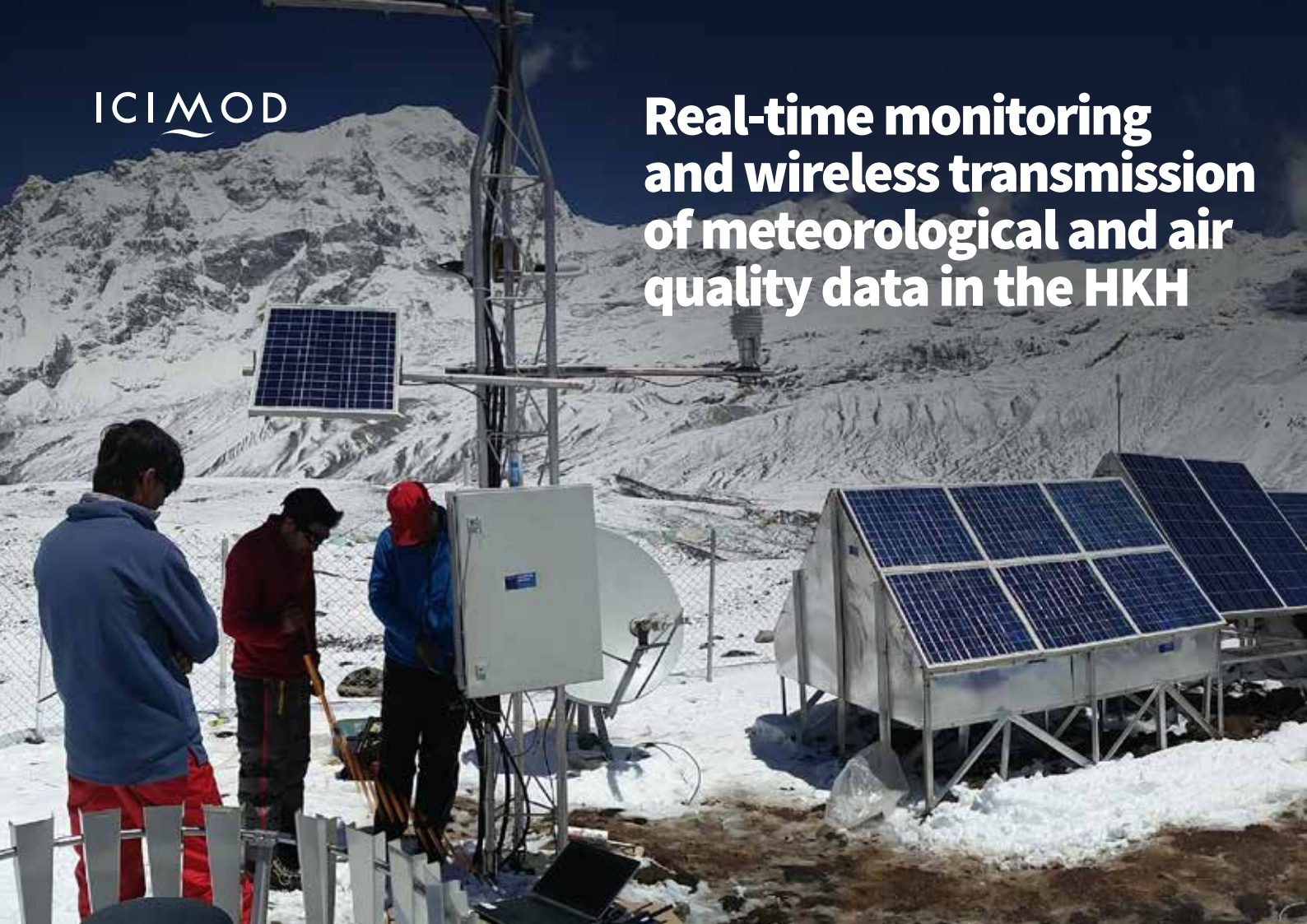


# Real-time monitoring and wireless transmission of meteorological and air quality data in the HKH



## Why real-time air quality monitoring systems?

Robust air quality observations worldwide provide evidence that poor air quality can have adverse impacts on human health and the environment. These data inform policy and action to mitigate air pollution. However, such data are scarce in the Hindu Kush Himalayan (HKH) region (with the exception of India and China). To address the data gap, the Department of Environment (DoEnv), Nepal; National Environment Commission, Bhutan; and the University of the Punjab, Pakistan, in collaboration with the International Centre for Integrated Mountain Development (ICIMOD), have established real-time air quality monitoring systems (AQMSs) across Bhutan, Nepal, and Pakistan.

Real-time AQMSs are a cost and time-efficient solution for effective monitoring of air pollution instruments and for remotely acquiring air quality data in data-scarce Nepal, Bhutan, and Pakistan.

Analysts can monitor instrument status and collect information on a daily basis even in distant locations without frequent travel to individual stations. AQMSs also safeguard collected data for future analysis in case of any physical damage to the instrument.

These systems monitor air quality at different locations in the HKH and consist of various instruments that measure the concentration of aerosols, trace gases, and meteorological parameters, which are relayed through a wireless real-time data transmission system. As of 2019, eight AQMSs are operational in Nepal, six in Bhutan, and one in Pakistan, with prospects for further regional expansion (see Fig 1).

FIGURE 1

AQMSs SETUP BY ICIMOD IN COLLABORATION WITH PARTNERS IN THE HKH



RATNA PARK, NEPAL



CHITWAN, NEPAL



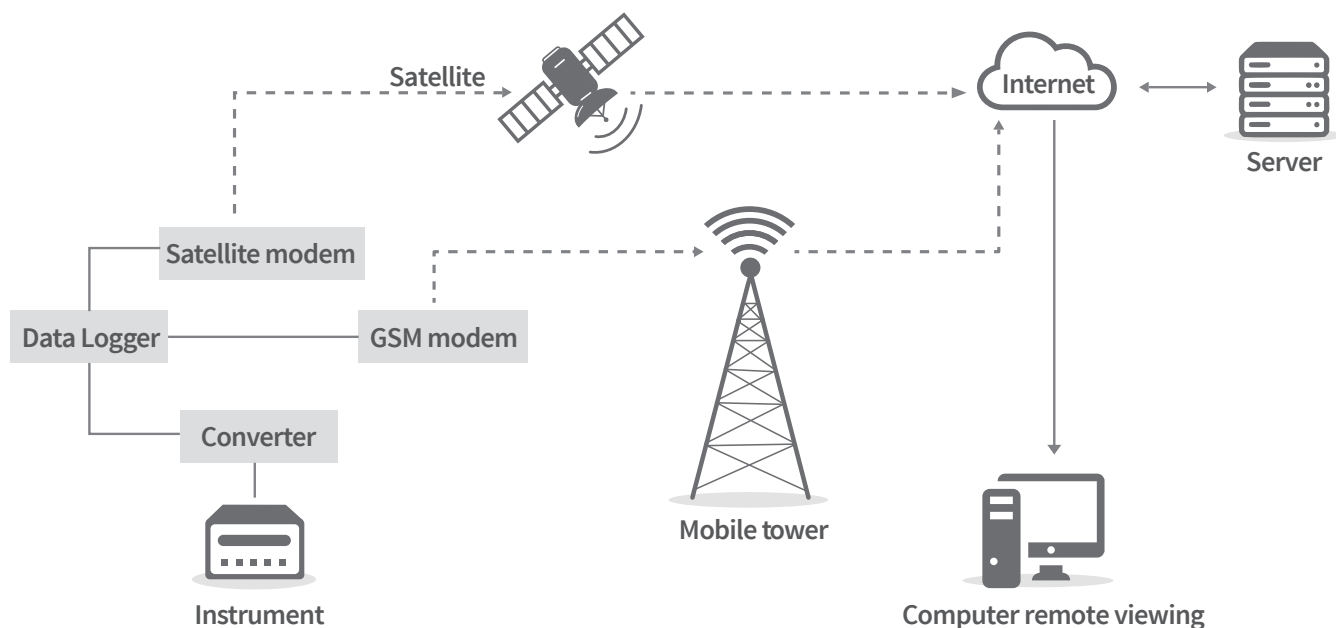
LAHORE, PAKISTAN



CHELE LA, BHUTAN

FIGURE 2

SYSTEM ARCHITECTURE FOR REAL-TIME DATA TRANSMISSION IN AN AQMS



The inaccessibility and remoteness of the AQMS sites, coupled with the complex terrain, makes regular data collection very difficult. The only alternative is to establish real-time remote monitoring of instruments and data generation.

## How the system works

All components of AQMSs have unique data formats and mode of data transfer systems (see Fig 2). The data are transferred to the data logger via electronic devices called converters. The converter receives and reformats data from the instrument so that it can be directly read by the data logger.

Some instruments have data formats that are directly accepted by the data logger. These are connected to the data logger directly without the use of a converter. Every minute, the data logger retrieves data from the connected instruments and stores them in a memory card. After a fixed time interval, the data logger transmits the data to the servers. Generally, the transmitting device is a Global System for Mobile (GSM) modem that uses Subscriber Identity Module (SIM) cards. In remote locations, data transmission is done by satellite modems.

In the GSM modem, the data are transmitted via a 3G internet connection. With the satellite modem, the data are transmitted directly to the satellite and from there to

the internet, making it very expensive. The data logger has a configurable option of transmitting real-time data to two servers simultaneously. In Nepal, the data are transmitted to ICIMOD's server and DoEnv's server ([pollution.gov.np](http://pollution.gov.np)). In Bhutan and Pakistan, data are transmitted only to ICIMOD's server. The website hosted by ICIMOD's server is not open to the public and is accessible only to authorized personnel. The website hosted by the DoEnv server is open to the public and consists of data from 17 AQMSs across Nepal. Of these, eight are being operated in partnership with ICIMOD and nine solely by DoEnv.

## The many benefits of AQMSs

- AQMSs are a cost and time-efficient solution for effective monitoring of air pollution instruments and remote data acquisition.
- AQMSs provide a platform through which the general public can learn about air quality status in various locations from home.
- Analysts can monitor the status of instruments even in distant locations on a day-to-day basis without frequent travel to individual stations. Hence, in-person monitoring of AQMSs is necessary only for troubleshooting or strategic planning.
- AQMSs safeguard collected data for future analysis in case of any physical damage to the instrument.

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