

# Quantifying and Forecasting Heat Risks for Cotton Farmers in Bangladesh

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The Combat Against Climate Change on Cotton Communities (C5) pilot project uses Earth observation and meteorological data to improve the health of cotton workers in Bangladesh. The project has three core activities: mapping cotton fields in Bangladesh, **creating an operational heat risk alert system**, and quantifying the amount of time outdoor workers lose to heat.

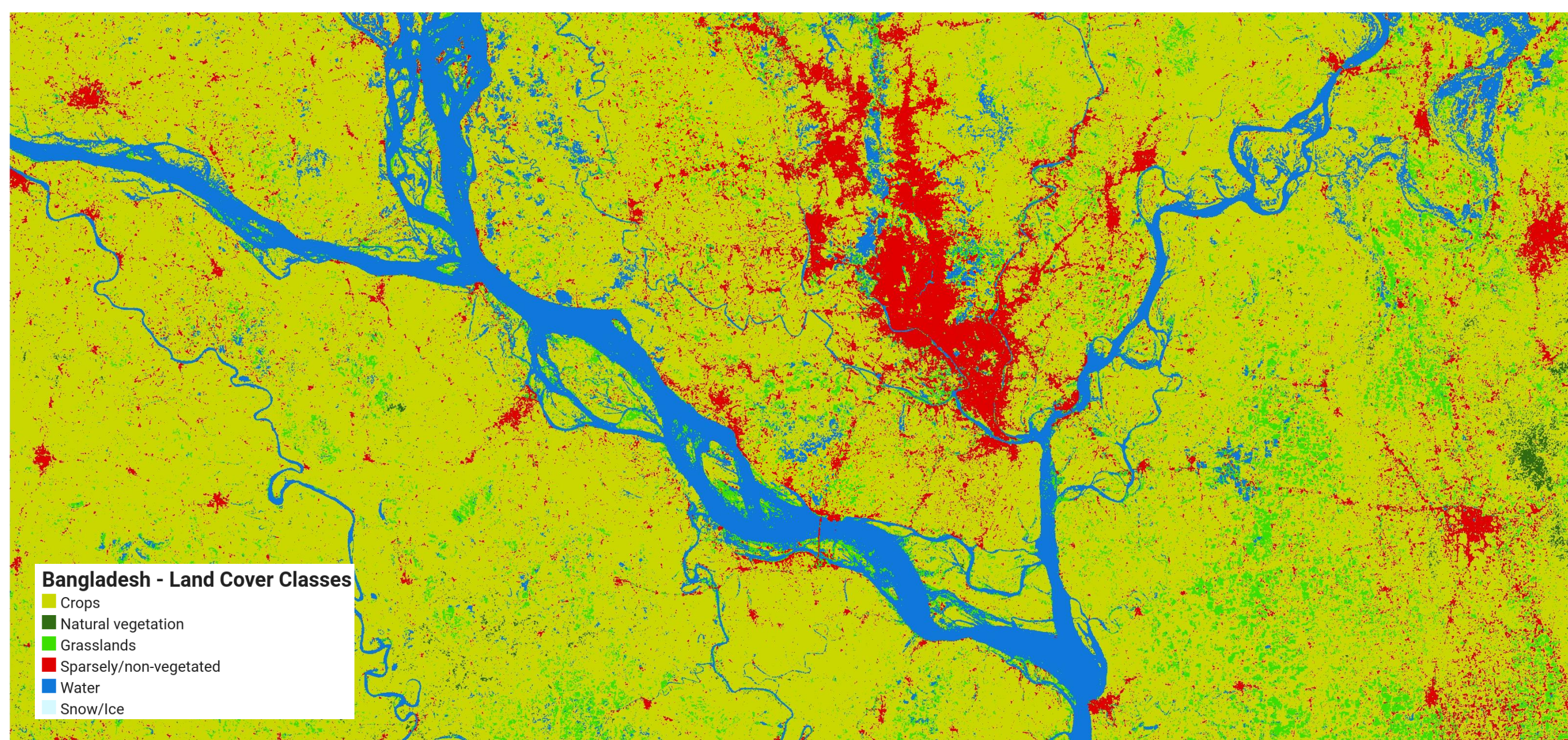
## Mapping Cotton Fields



Cloud free composite generated using all Sentinel-2 images from January to March 2020. Image is shown in a true-colour composite (red, green, blue) RGB. The image was used as part of the land cover classification framework to capture seasonal changes in vegetation.

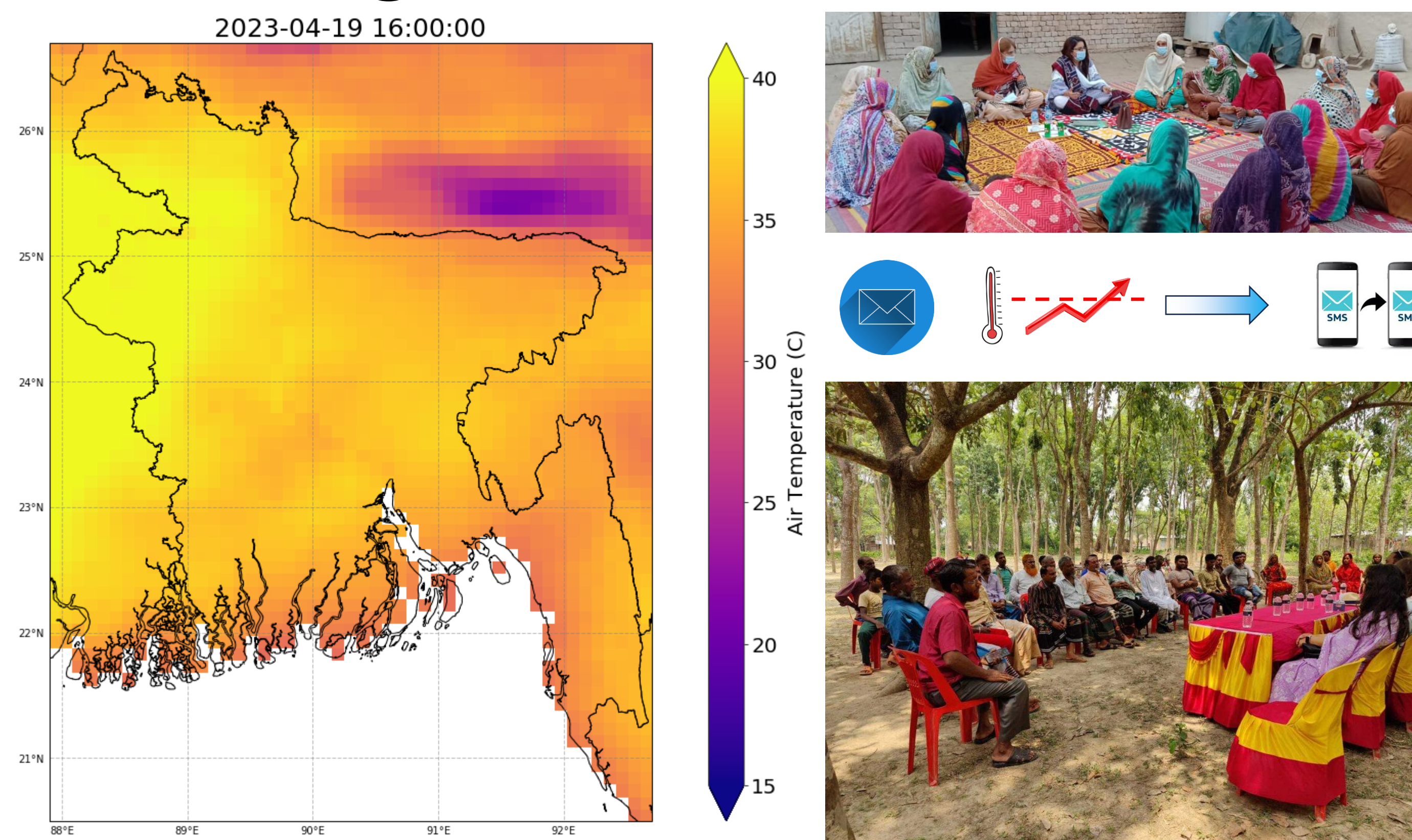
Annual maps of all cotton fields in Bangladesh allow us to:

- 1) Understand of the range of heat conditions facing cotton farmers
- 2) Identify where workers are facing the most hazardous conditions
- 3) Provide heat advisory messages tailored to messaging capacity (potentially down to individual farms)



Discrete map of Bangladesh land cover. The landscape is dominated by crops, urban and sub-urban areas and water bodies. The following iteration of the C5 Crop Context data product will aim to discriminate specifically cotton growing areas.

## Heat Risk Advisories for Rural Agricultural Workers



Left panel: Example of spatial variability of air temperature across Bangladesh during the April 2023 heatwave (ERA5 Land). Right panel: Stakeholder workshops discussing the impact of increased heat on farmers.

We are collaborating with experts and farm workers to develop a **heat risk warning service for rural outdoor workers**, which meets the following needs:

- Actionable advice relevant to farm workers in rural areas
- Accessible regardless of internet access, electricity, and literacy levels
- Forecast data that is accessible and accurate for Bangladesh
- Heat risk metrics and thresholds relevant to Bangladeshi outdoor workers

Initial trial will include a fortnightly bulletin containing health advice related to heat risks, and a summary of near-future heat conditions (3-5 days). This will be combined with an SMS alert system that will notify key community members whenever dangerous heat conditions are forecasted. Heat alerts will initially be based on ECMWF open access forecast data, and risk thresholds identified from the literature (heat index > 38 or air temperature > 37 °C for > 2 consecutive days).

## Quantifying Labour Lost to Heat

*“Usually we work outside from 6 am to 1 pm. But when the temperatures are high, we can only work from 6am to 10 am. That loss of 3 working hours means that jobs can take 2-3 times as long if the hot temperatures persist.”*

*Male cotton farmer in Bangladesh*

*“ We are stuck in a 5am to 9pm work hour cycle, with a lot of home, farm and livestock responsibilities. It leaves us hardly any time to rest. Our work at home and field has increased, so we have the same or more expenses but the income is not much.”*

*Female cotton farmer in Pakistan*

Stakeholder workshops revealed that loss of time due to heat is a key issue facing cotton farmers. We are making a long-term dataset (hourly data for 40 years, 0.1° x 0.1°) to quantify this lost time across Bangladesh. The dataset uses work-rest guidelines, which are based on safe metabolic rates for outdoor workers, as a proxy for total possible work.

Example of wet bulb globe temperature values near Chandagram village (Kushtia District of Bangladesh) on 15/04/2023, calculated from ERA5 and ERA5 Land data using Thermofeel Python package. Work rest recommendations are based on OSHA safe working guidelines for 70 kg heat adapted worker. Lost labour is a proxy derived from these guidelines, validation data is being collected from farm workers to test its efficacy.

Hour	Wet Bulb Globe Temperature (°C)	Approximated work/rest cycles (minutes)	Lost Labour (minutes)
06:00	22.07	No recommendations	0
07:00	24.01	45/15	15
08:00	26.05	30/15	20
09:00	27.94	30/15	20
10:00	29.39	30/30	30
11:00	29.97	30/30	30
12:00	30.62	15/45	45
13:00	30.81	15/45	45