

Council on Energy, Environment and Water (CEEW), Vasant Kunj Institutional Area, New Delhi, 03 October 2024

Effect of Modern Agriculture Practices on Air Pollution in north-west India

RIHN Aakash Project Leader: Prabir K. PATRA* (2023-2024), S. HAYASHIDA (2019-2022)
 An interdisciplinary study toward clean air, public health, and sustainable agriculture: *case of crop residue burning in north-western India*

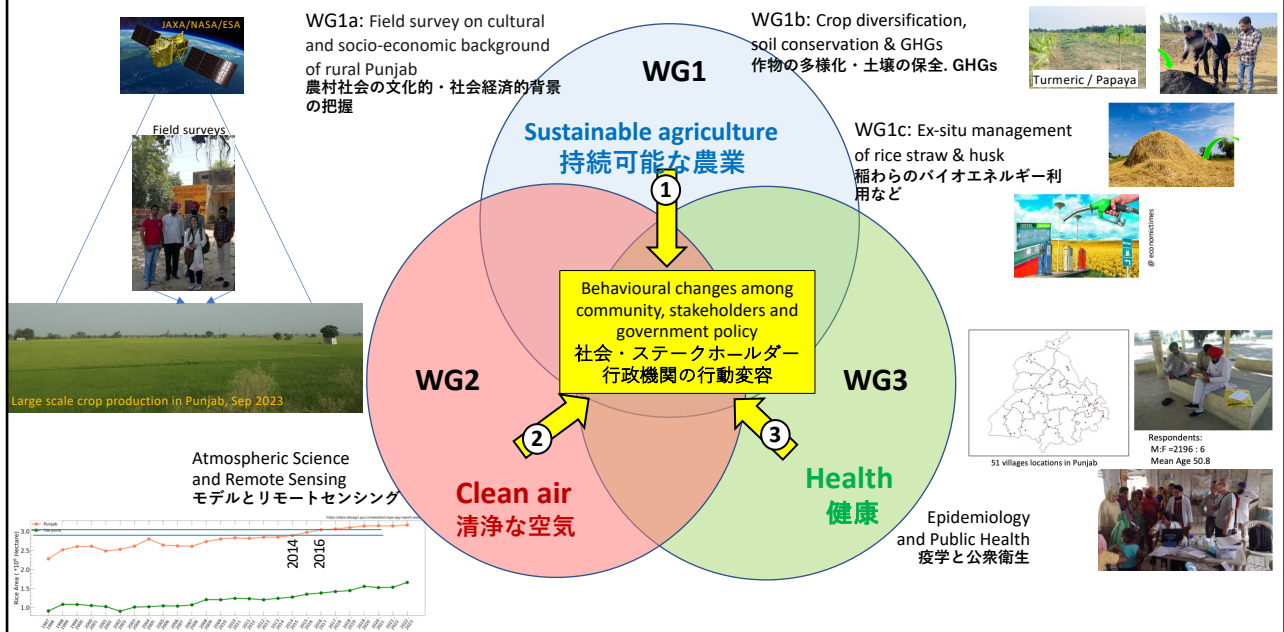
...acknowledging contributions from all the project members, in Japan, India and several other countries



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(bottom-up) Structure and goals of Aakash Project

Revised from:
S. Hayashida



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Aakash (CUPI-G) measurement networks in 2022 & 2033

Nakayama et al., 2018

Existing Indian measurement networks

SAFAR-India
(<http://safar.tropmet.res.in>)

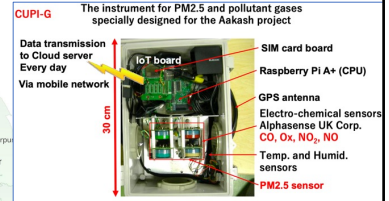
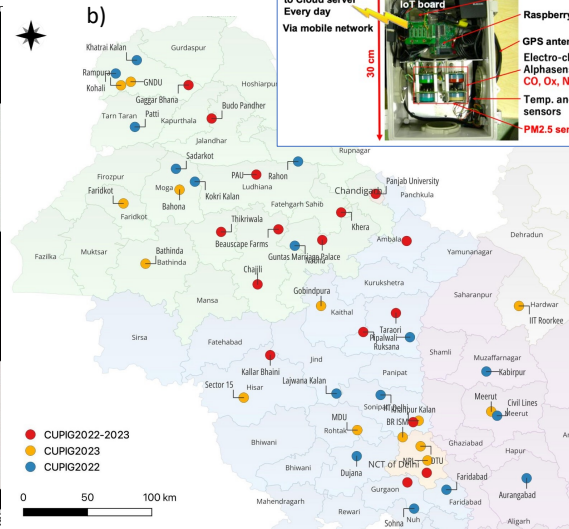
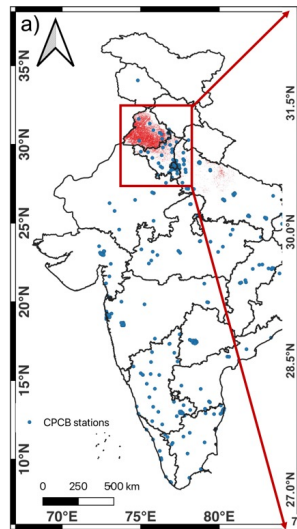
Central Pollution Control Board: CPCB (India)

US Embassy (BAM[®]), JP Embassy...

<https://aakash-rihn.org>



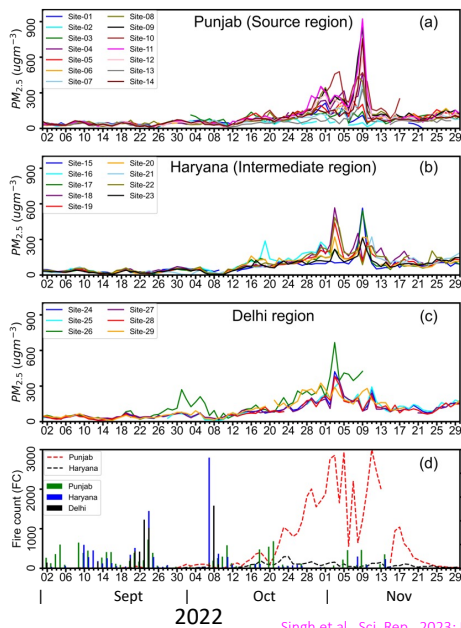
Tanbir Singh et al., Sci. Rep, 2023 (updated for 2023 CRB campaign)



CUPI-G: Compact and Useful PM_{2.5} Instrument with Gas sensors

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Daily-mean PM_{2.5} variations in Punjab, Haryana and Delhi

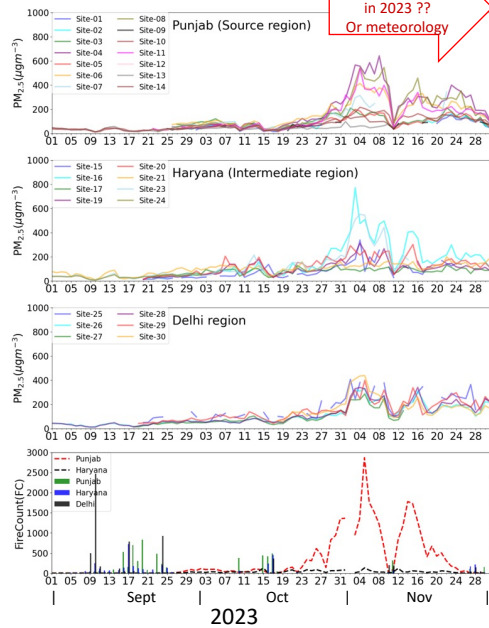


Measurements of September are homogeneous over the region – all sites showing similar PM_{2.5} values.

A check for the the CUPI-Gs stability !

After mid-October, large variations over the source region is observed

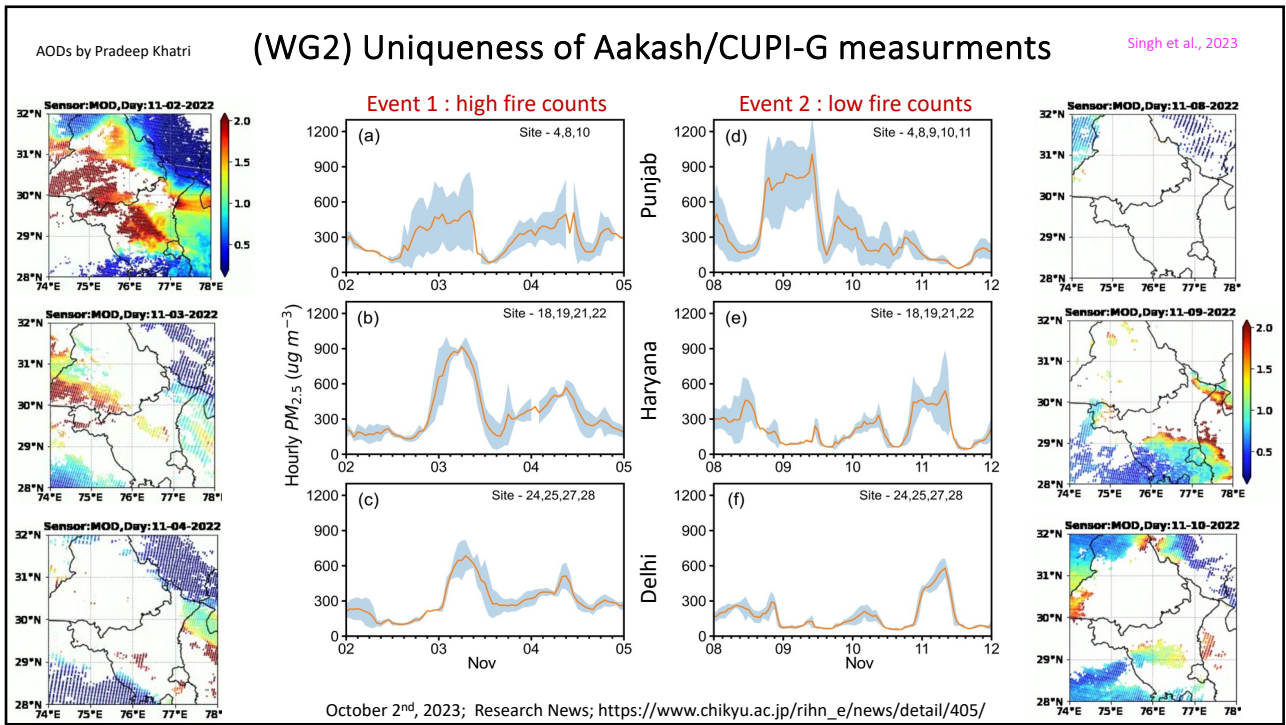
Toward the end of November, regional sites show consistent behaviour



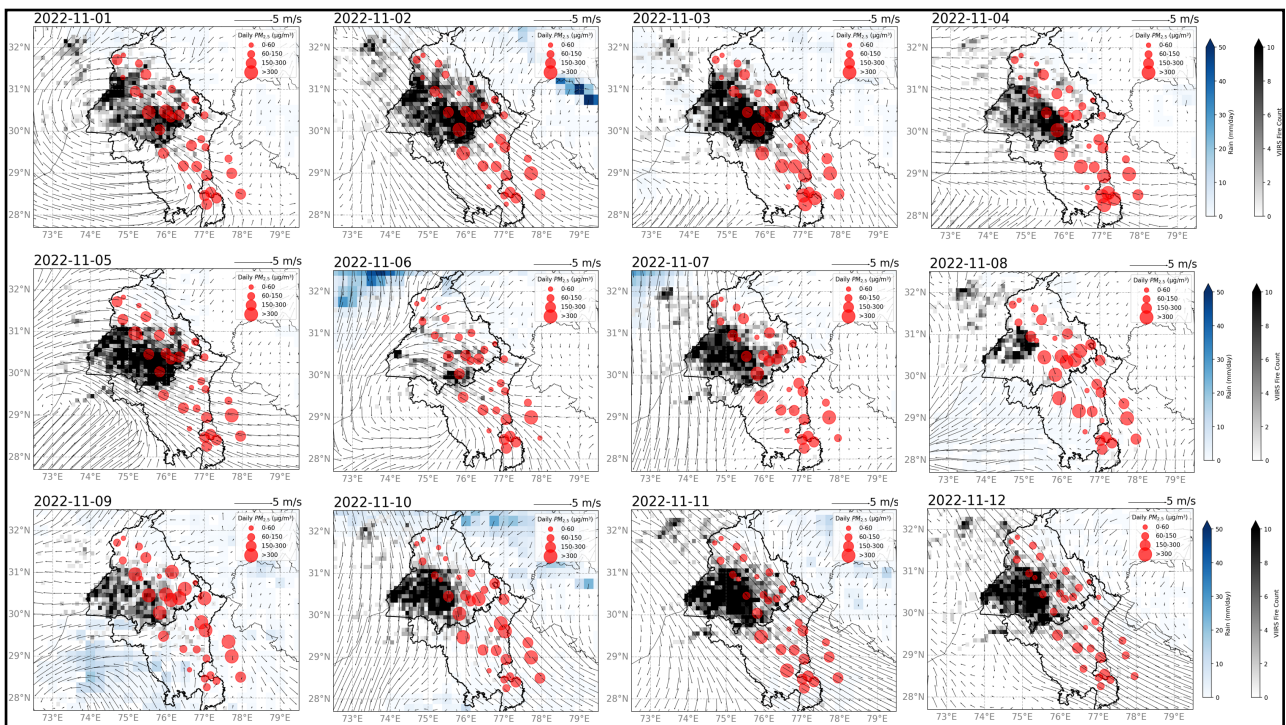
Delayed burning in 2023 ?? Or meteorology

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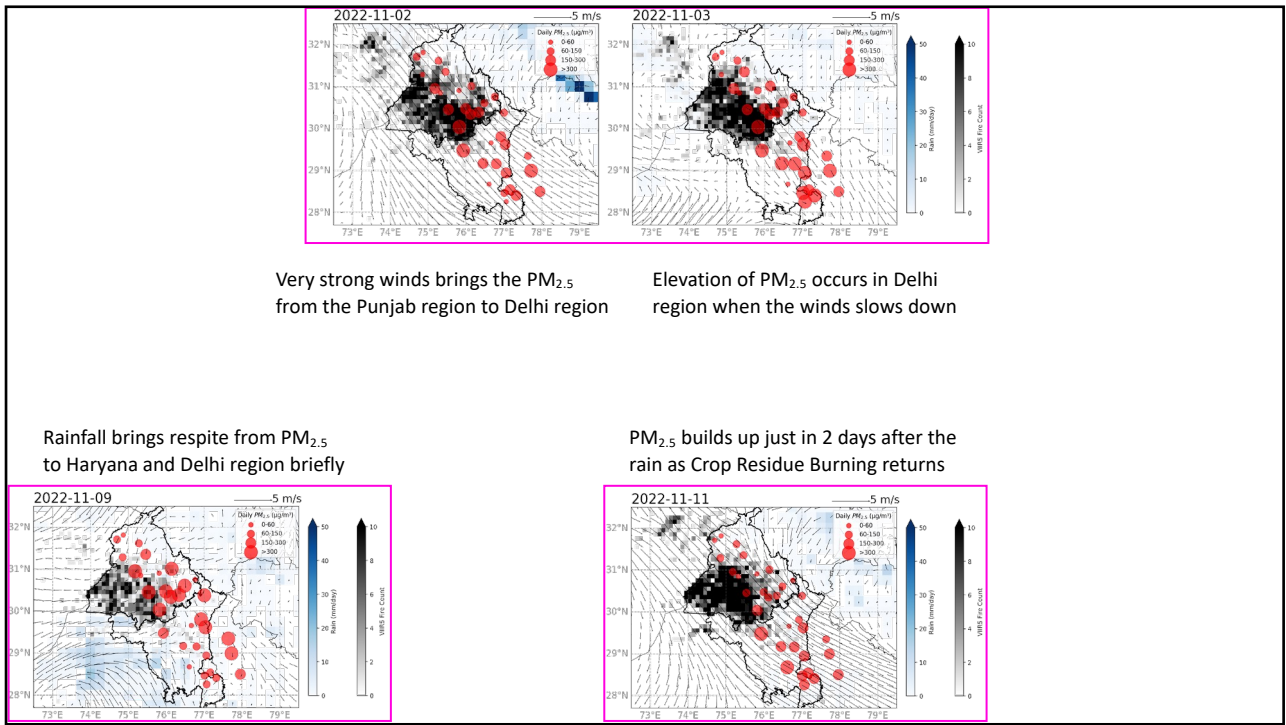
Singh et al., Sci. Rep., 2023; RIHN Press release



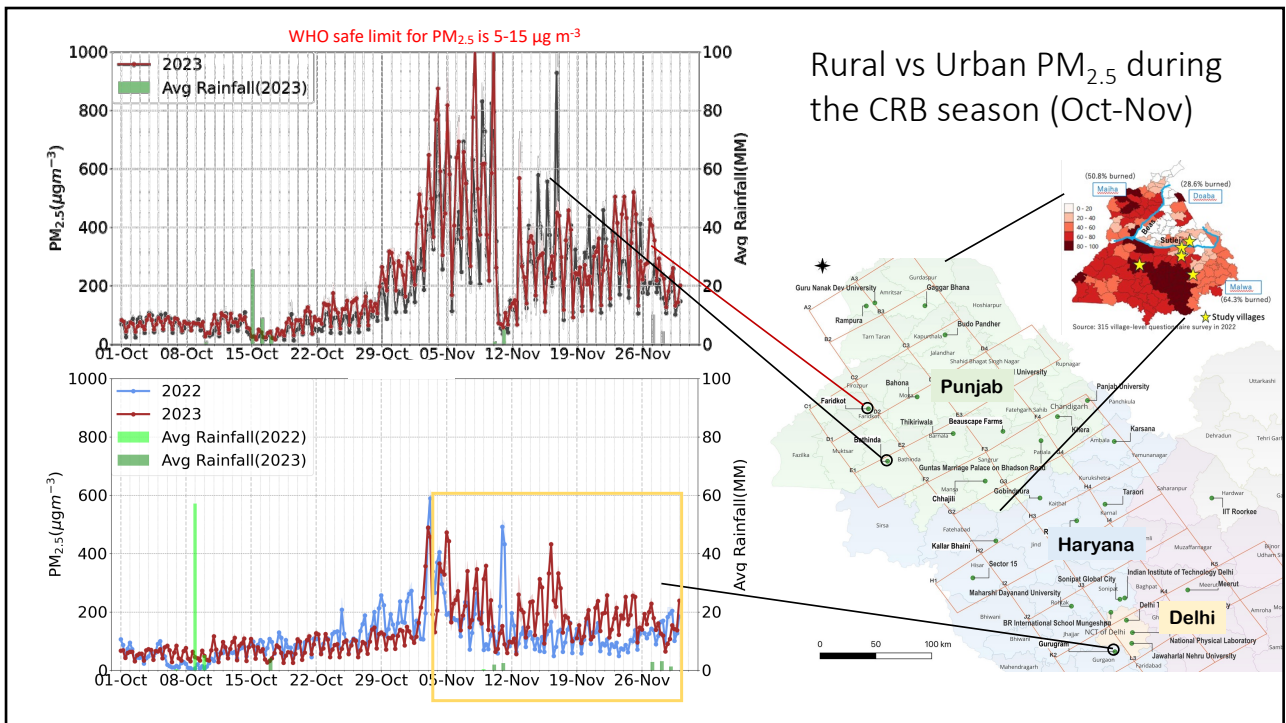
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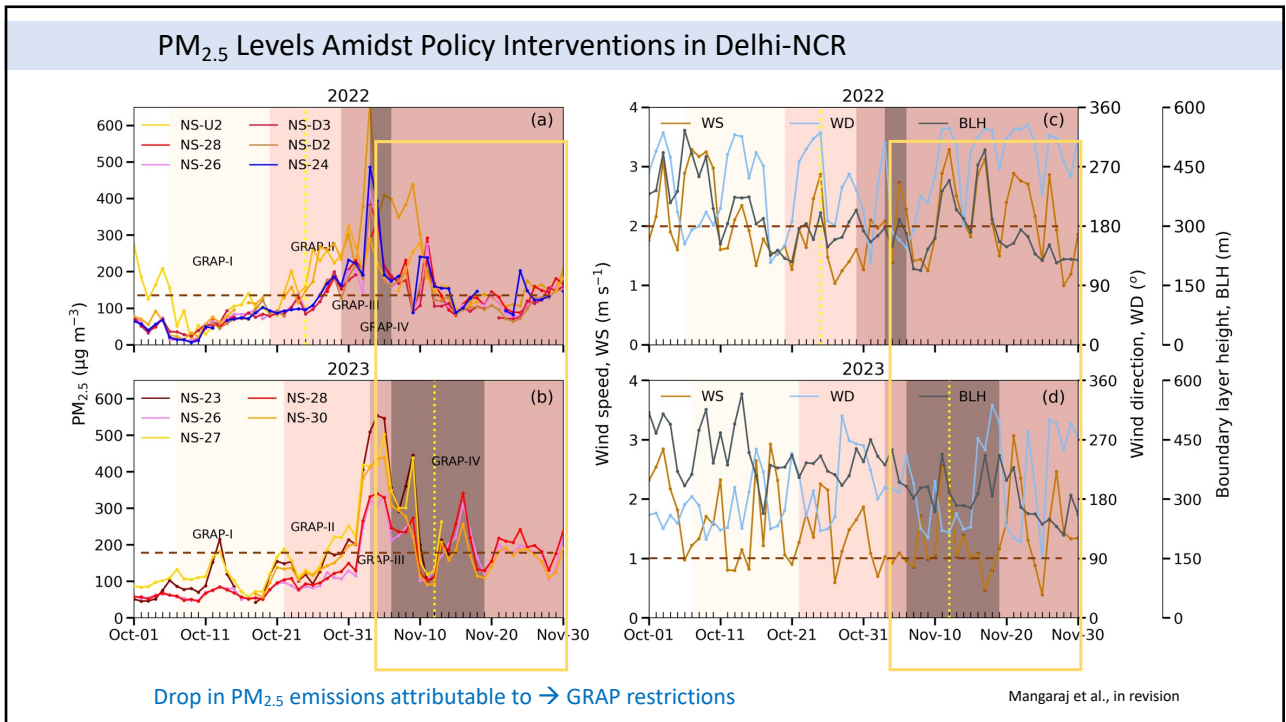
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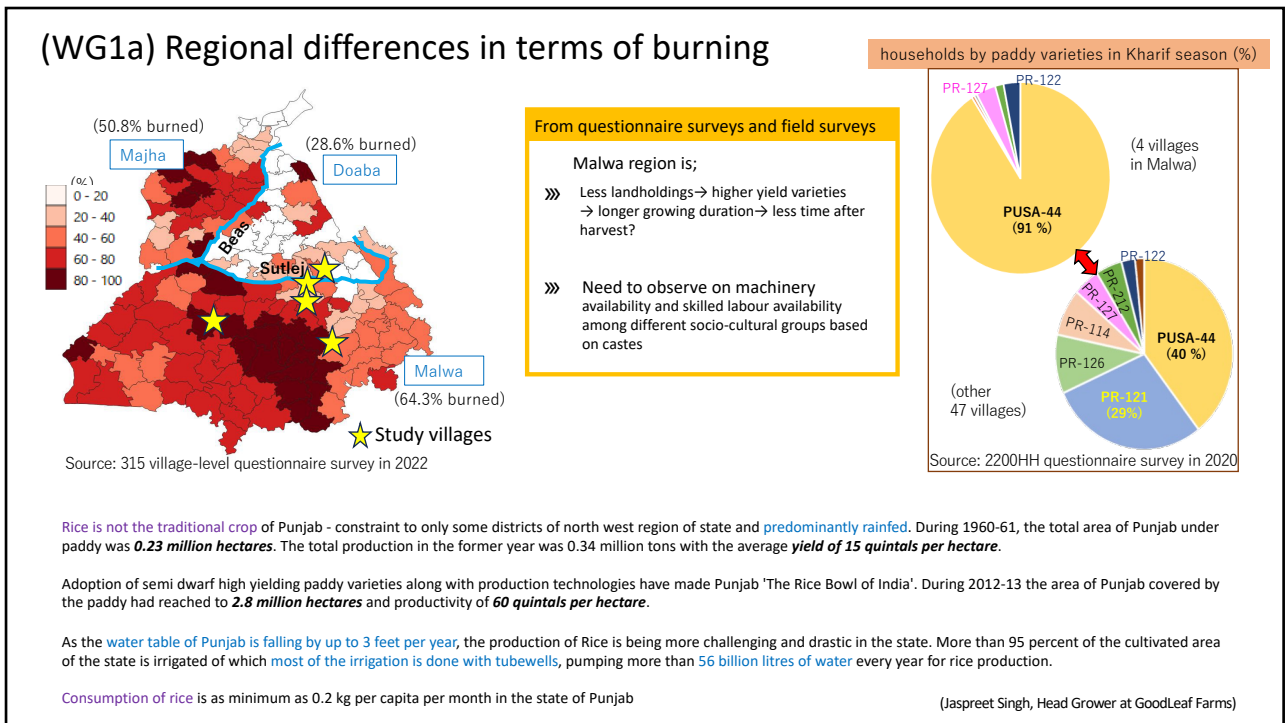
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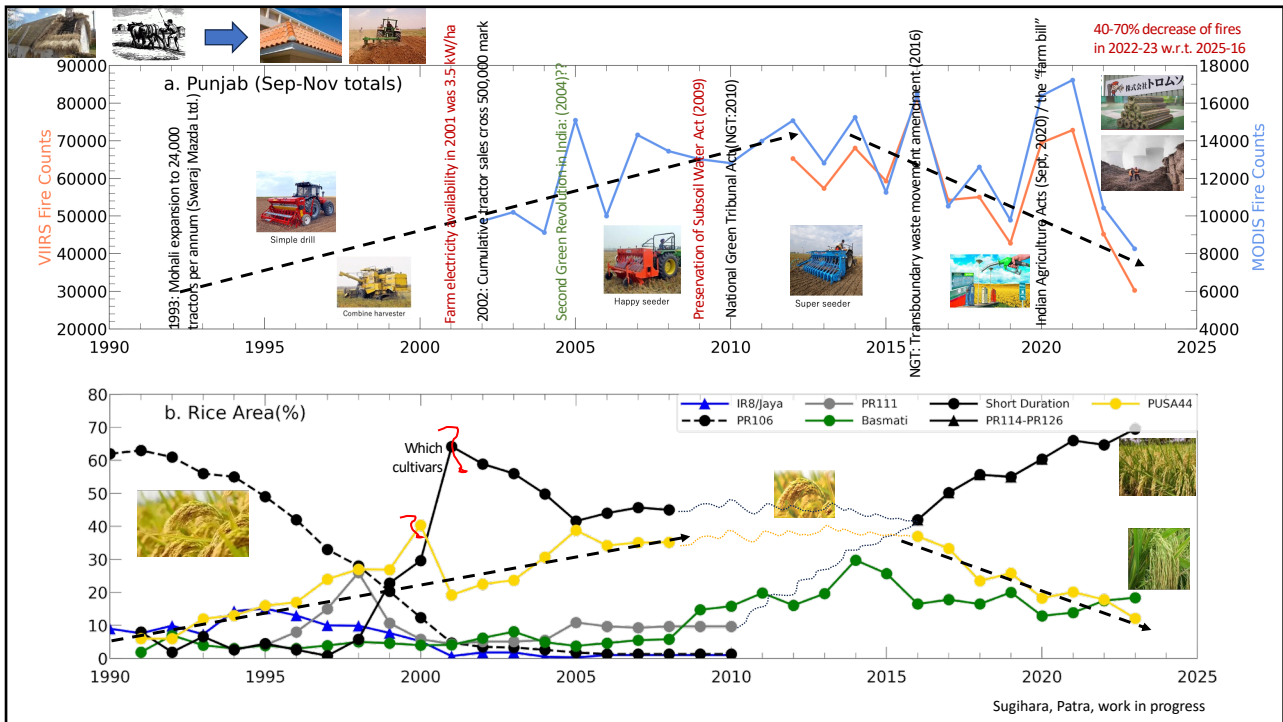
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Human health effects: estimating the short-term burden (mortality)

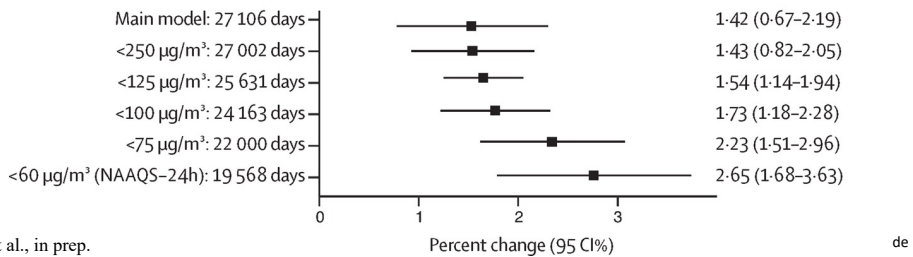
We estimate the short-term (daily) burden (mortality) using WHO log-linear risk function from de Bont et al. (2024) at a grid resolution of 9x9 km to identify the hotspot of burden in the rural areas and urban centres

WHO suggests a relative risk (RR) to mortality of 1.006 (1.0044-1.0086) for every 10 µg m⁻³ of PM_{2.5} concentration increase

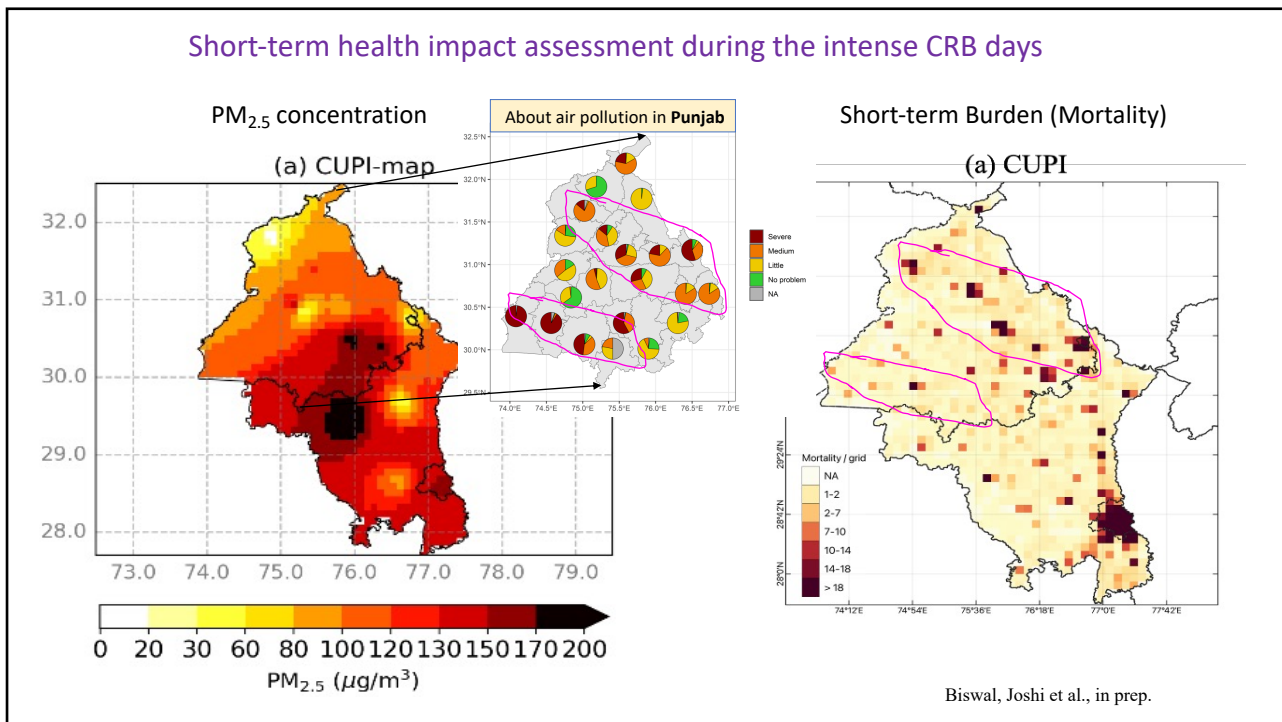
$$\Delta mort_{i,t} = (RR_{i,t} - 1) / RR_{i,t} \times D_{i,t}$$

where, *i* is grid index, *t* is time, Δ*mort*_{*i,t*} is daily premature mortality counts at, *D*_{*i,t*} is daily average number of deaths, *RR*_{*i,t*} is the relative risk of mortality associated with exposure to daily PM_{2.5}

RR for every 10 µg m⁻³ of concentration increase based on 10 cities of India



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Conclusions

- Aakash Project is working with large number of researchers in India and Japan on Kharif crop residue burning caused by intensive rice farming in the north-western states of India
- Our network of measurements are providing critical information on emissions of air pollution from the kharif crop residue burning, and their transport to the megacity Delhi
- Concentration of PM_{2.5} is found to be twice greater in the emission regions of Punjab (~400 µg m⁻³) compared to those over Delhi (~200 µg m⁻³) during Oct-Nov period
- The results of controlling crop residue burning is clear in the states of Punjab (and Haryana) – reduction in fire counts, reduction in PUSA-44 variety – but the history of CRB evolution is not fully explained
- Estimated mortality rate due to PM_{2.5} air pollution reveals large increase in the rural districts of Punjab which were not evident earlier because of missing observations in the region

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