ASSESSMENT OF METHANE EMISSION FROM PIT LATRINES IN BANGLADESH CONSIDERING HYDROLOGICAL VARIATIONS

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BACKGROUND INFORMATION

- On-site sanitation systems (OSS) is a significant source of CH_4, a greenhouse gas
- Pit latrines are responsible for
  - ~ 0.3% of global CO_2 emissions (van Eekert et al., 2019)
  - ~ 4% of the world's total CH_4 emissions (Reid et al., 2014)
- About **62.8% of the population** uses pit latrines in Bangladesh (MICS, 2019)
- Most researches are concentrated on septic tanks
- Pit latrines are more susceptible to ground water inundation than septic tanks

BACKGROUND INFORMATION

- Seasonal flooding increases CH_4 emissions due to groundwater inundation.
- Increasing groundwater levels create anaerobic conditions
- More CH_4 is emitted under anaerobic conditions
- Previous studies mostly
  - Were specific location wise
  - Used IPCC general formula
  - Didn’t consider pit latrine inundation by GW level across the whole country

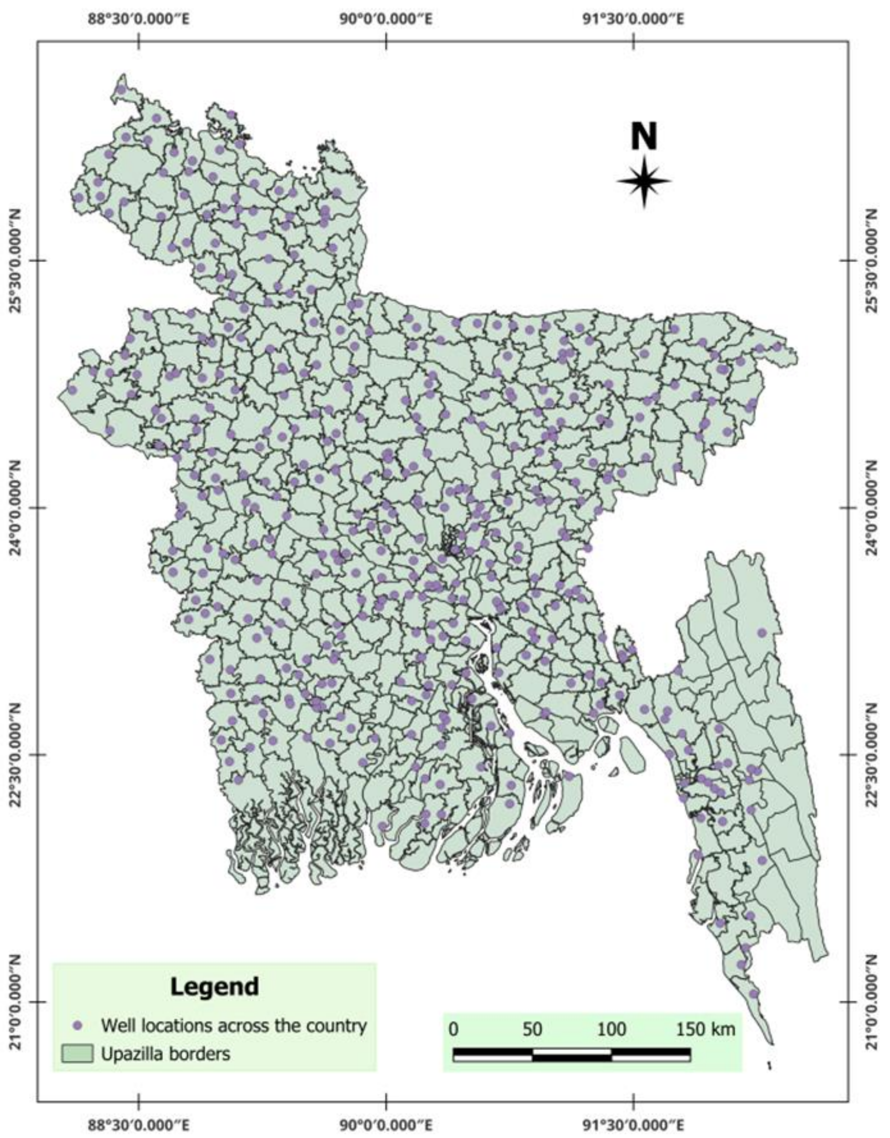
HOW WE ADDRESSED THIS ISSUE

- We made an inundation map using QGIS
- QGIS has a built in interpolation technique like IDW
- IDW interpolated the difference between pit latrine depth and GW level
- The interpolation showed the pit latrine inundation across the whole country
- CH_4 emission was calculation considering those inundated areas
- A sensitivity analysis was done by varying flood inundation durations

GROUND WATER DATA

- Data from Bangladesh Water Development Board (BWDB)
- 425 static level well observations (1995-2024)
- Most water level readings are from the month of September

Well locations considered in our study



CONTEXTUAL DATA

- Pit latrine depth

  -A pit latrine should ideally be deeper than 3 meters

  -3 to 4 meter depth was reported in a study (Evans et al., 2009)

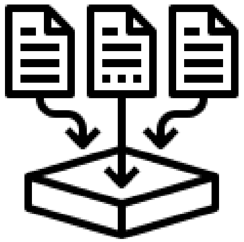
  -So, we selected a 3m pit latrine depth

- Percentage of pit latrine use

  -Division Wise

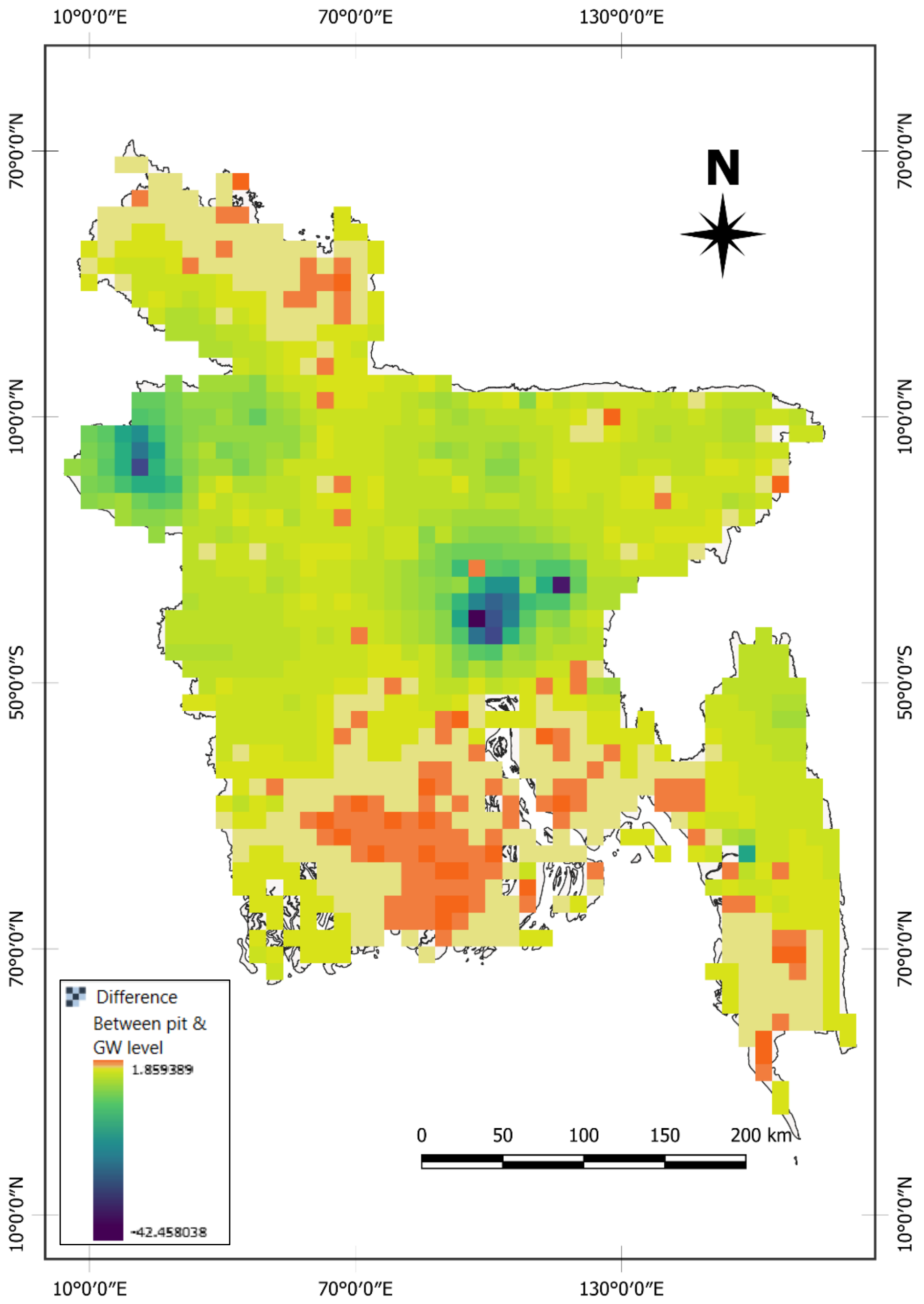
- Population density

  -District wise



INUNDATION MAP

- Interpolated Plot of difference between pit depth and GW level
- Pixels
  - 'shades of **Red**': Inundated pits
  - 'shades of **Blue**': GW level below pits (deeper in the ground)
  - 'shades of **Green**': GW level close to pits

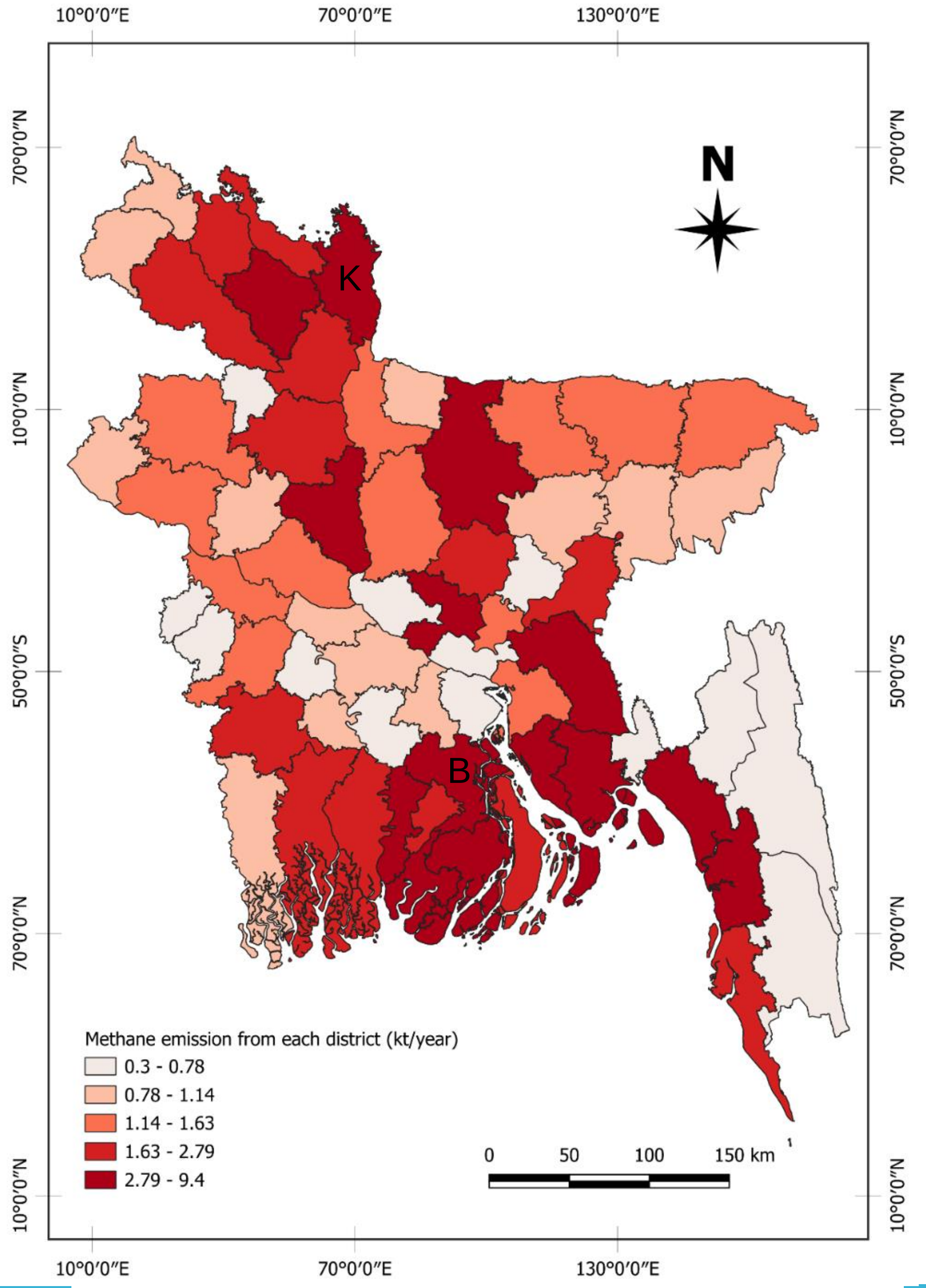


METHANE CORRECTION FACTORS AND METHANE PLOT

❑ Methane Correction Factors (MCFs):

- Wet pits: MCF = 0.7
- Dry pits: MCF = 0.1

- Annual emission = multiplying the monthly value by 12
- Total yearly CH_4 = summing emissions from all districts.
- Higher methane emissions are shown as dark red pixels
- High-emission districts: Flood-prone areas like Kurigram and Barisal



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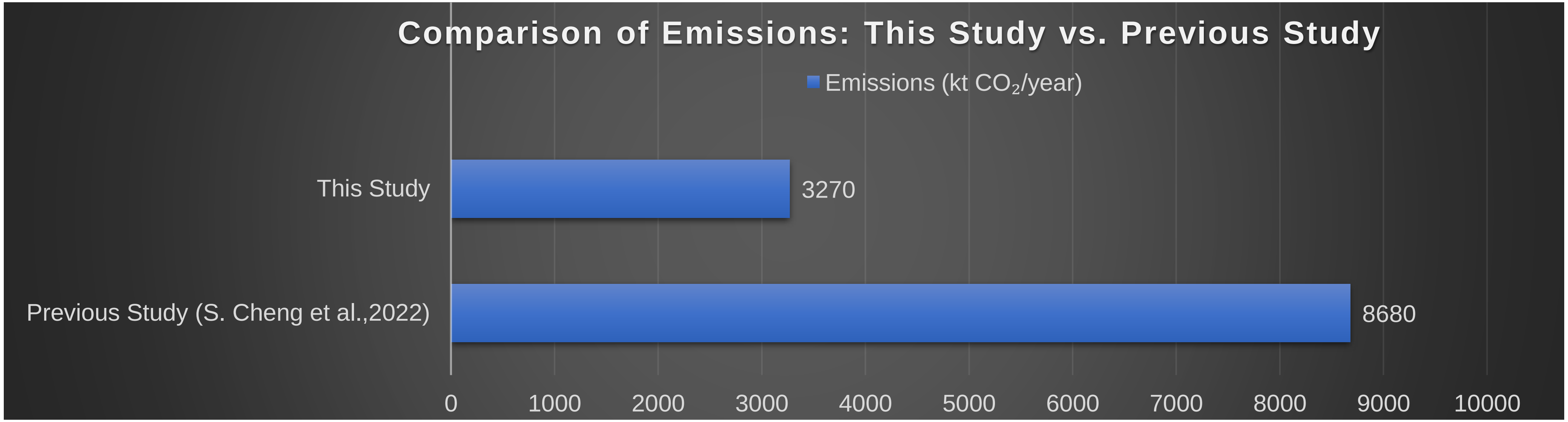
YEARLY EMISSIONS FROM THIS STUDY AND A PREVIOUS STUDY

Annual CH_4 emission=116.8 kt/year

Using GWP of 28 for CH_4

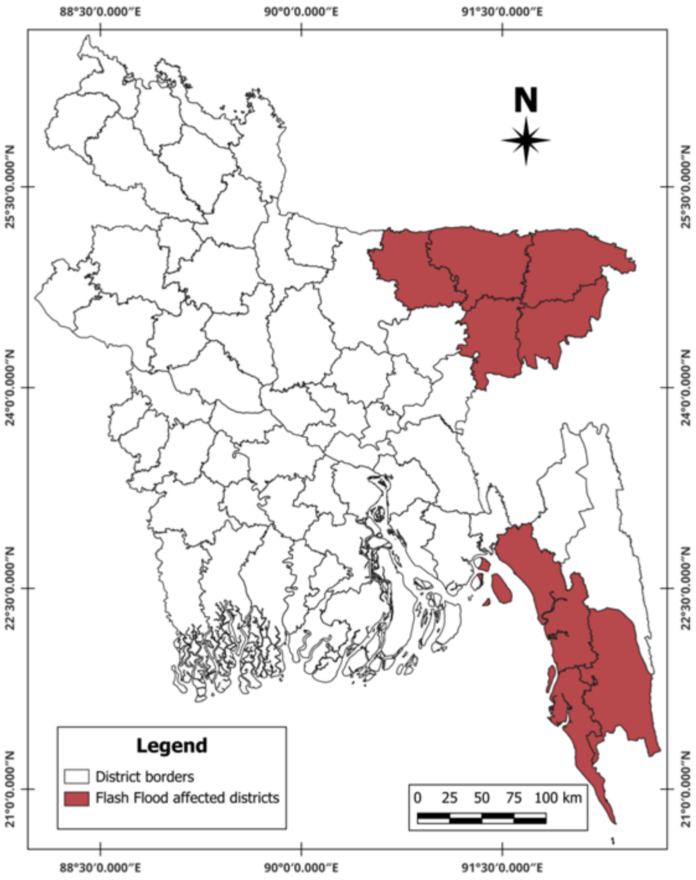
Annual CO_2 emission=3270 kt/year



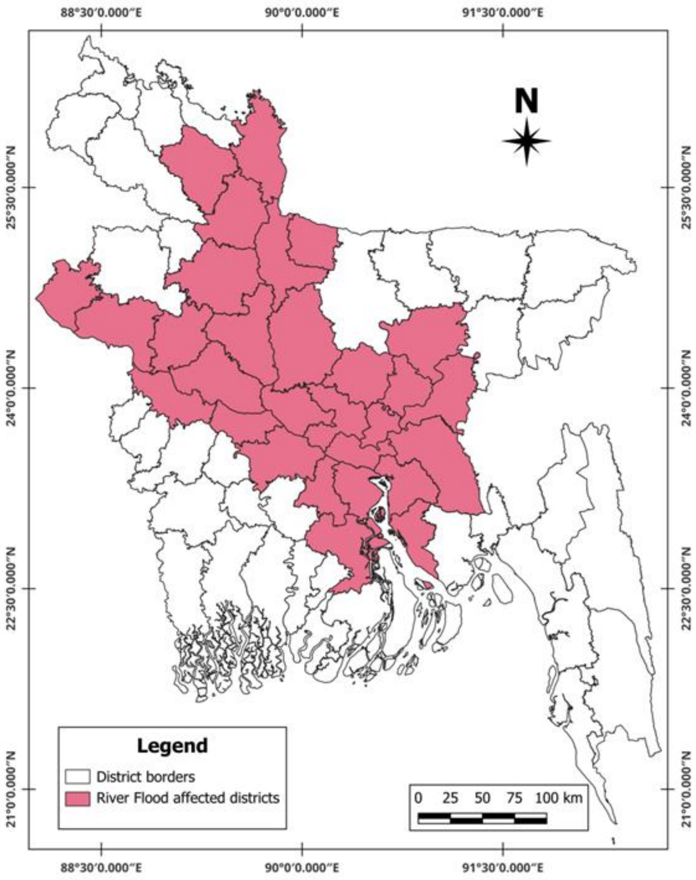
This chart compares yearly emissions between this study and a previous study using the IPCC general formula

CH_4 EMISSION CONSIDERING FLOOD INUNDATION

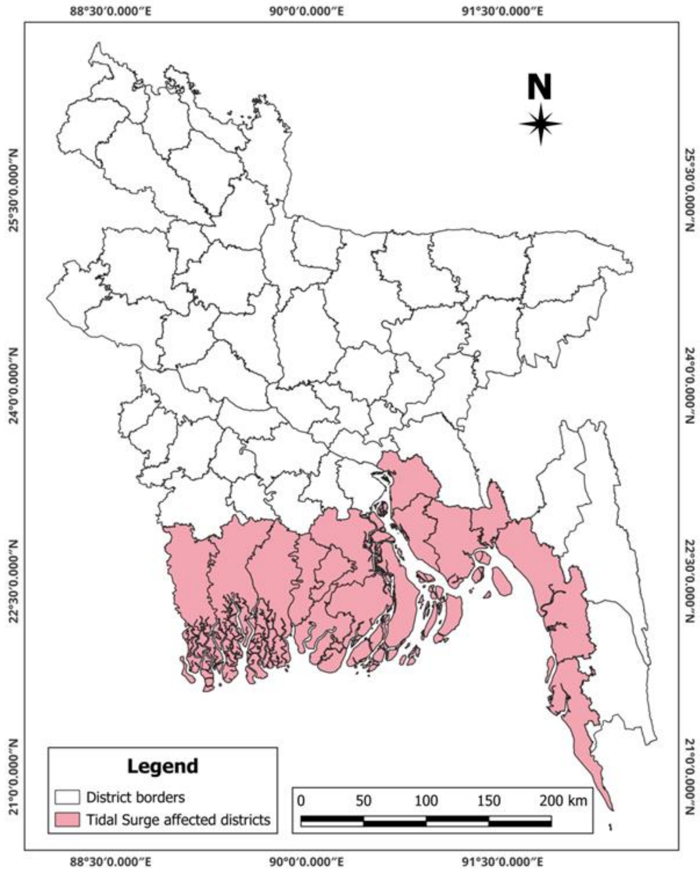
Districts affected by flash flood



Districts affected by river flooding



Districts affected by tidal surge



ANNUAL EMISSION CONSIDERING FLOOD INUNDATION

Calculated from	CO_2 (kt/year)
This study	3270.1
This study with 4 months inundation	6129.6
This study with half year inundation	7559.3
This study with full year inundation	11848.5

BENEFITS	LIMITATIONS
• More accurate methane estimates and contribution to GHG • Adaptable with variable data	• Observations from wells are not from the same year • Assumes all aquifers in a location are isotropic

IMPLICATIONS

- Improved sanitation management through localized data.
- Recommendations:

-Empty pit latrines before monsoon seasons

-Design elevated pit latrines in flood prone areas

-Promote eco-friendly sanitation solutions in shallow GW areas

REFERENCES

1. M. H. A. van Eekert et al., “Anaerobic digestion is the dominant pathway for pit latrine decomposition and is limited by intrinsic factors,” *Water Sci. Technol.*, vol. 79, no. 12, pp. 2242–2250, Jun. 2019.
2. M. C. Reid, K. Guan, F. Wagner, and D. L. Mauzerall, “Global Methane Emissions from Pit Latrines,” *Environ. Sci. Technol.*, vol. 48, no. 15, pp. 8727–8734, Aug. 2014.
3. MICS Bangladesh, Multiple Indicator Cluster Survey, 2019.
4. BWDB (Bangladesh Water Development Board), Groundwater Data (1995–2024).
5. B. Evans, C. Colin, H. Jones, and A. Robinson, *Sustainability and Equity Aspects of Total Sanitation Programmes - A Study of Recent WaterAid-Supported Programmes in Three Countries: Global Synthesis Report*, WaterAid, May 2009
6. IPCC, *Guidelines for National Greenhouse Gas Inventories*, 2006.
7. G. Myhre, D. Shindell, and J. Pongratz, *Anthropogenic and Natural Radiative Forcing*, 2024.
8. Bangladesh Flooding Disaster Summary Sheet - 20 May 2018 - Bangladesh | ReliefWeb
9. Low-lying areas of 15 coastal districts face flood risk,” *Dhaka Tribune*, 2024
10. S. Cheng *et al.*, “Non-negligible greenhouse gas emissions from non-sewered sanitation systems: a meta-analysis,” *Environ. Res.*, vol. 212, p. 113468, 2022.

Thank You

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