Hydrology and Human Health: An Intersection for Nutrition Research in Bangladesh

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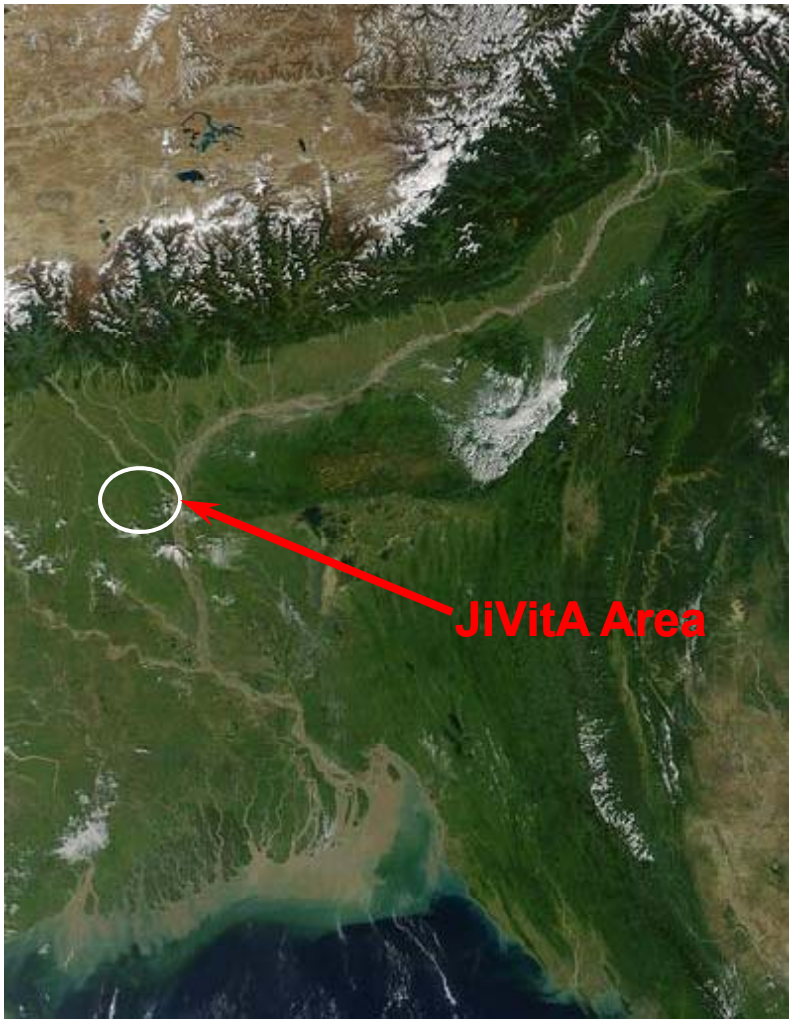
Summary

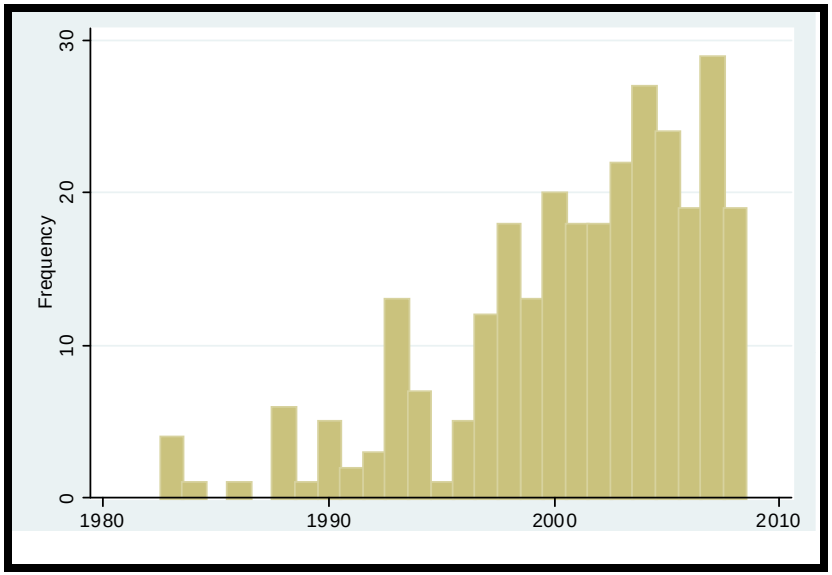
- Groundwater in Bangladesh
  - JiVitA
  - Chemistry & micronutrients
- Trace elements in groundwater
  - Consequences of exposure to arsenic heavily studied
  - Health impact of exposure to other constituents – Mn, Ca
- Need to broaden research
  - How consumption of these minerals impacts dietary intake and nutritional status
  - Iron in groundwater as a source of dietary iron (JiVitA PANI study)



Transition to Groundwater

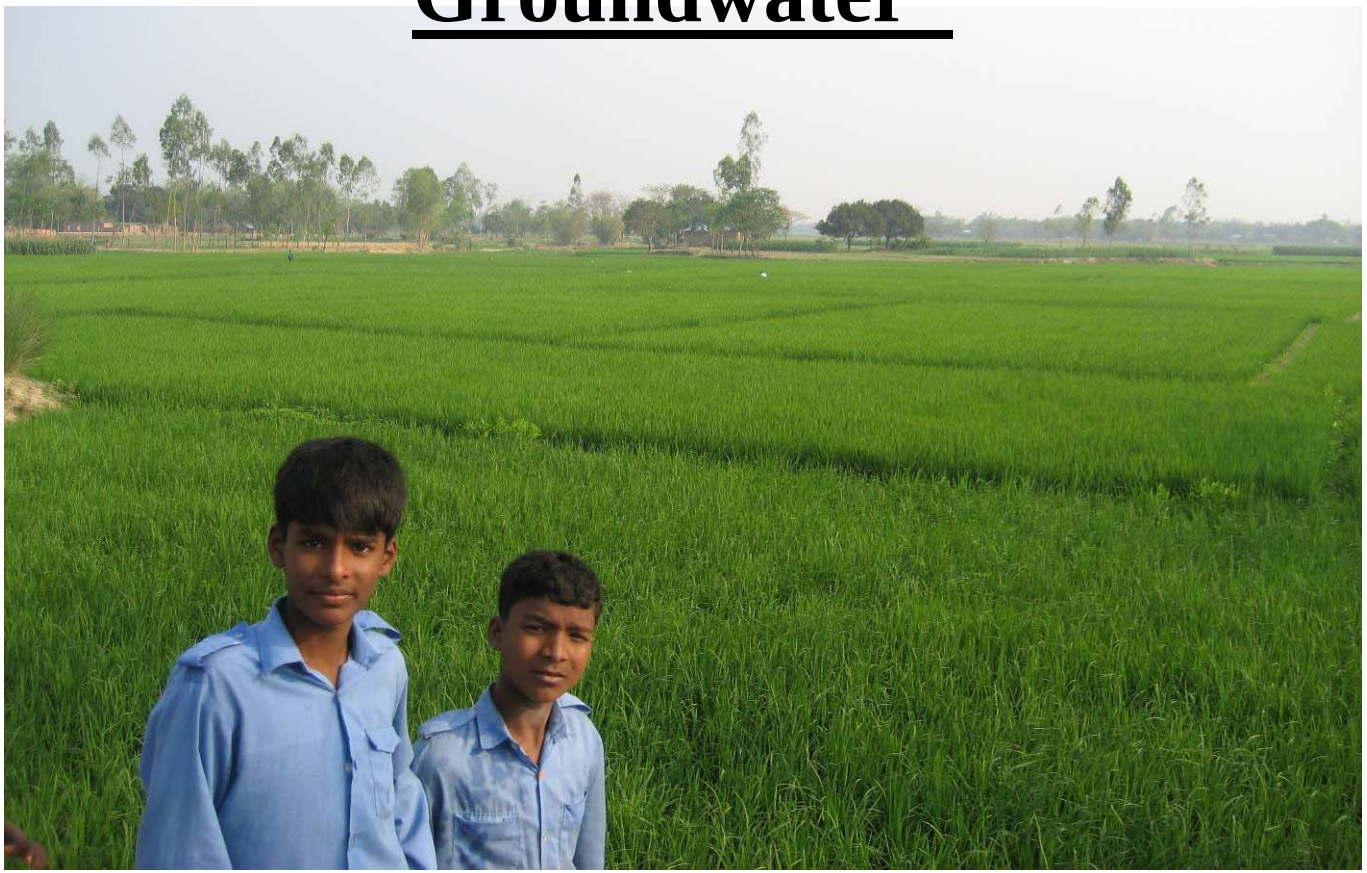
- 1970s: Surface water serves as main water source
- 1980s: "International Drinking Water Decade"
  - UN agencies launch campaign to make access to clean drinking water available across the world
  - Increase use of groundwater
  - Decreased rates of cholera & dysentery
- 1990s: Government of Bangladesh develops laws to control groundwater use:
  - National Policy for Safe Water Supply and Sanitation, 1998
  - National Water Policy, 1999

2000s: Current Groundwater Use



- **At least 10 million tubewells**
  (Wasserman *et la*, 2007)
  - **Groundwater use ubiquitous**
  - **1 for every 15 people**
- **90% of drinking water**

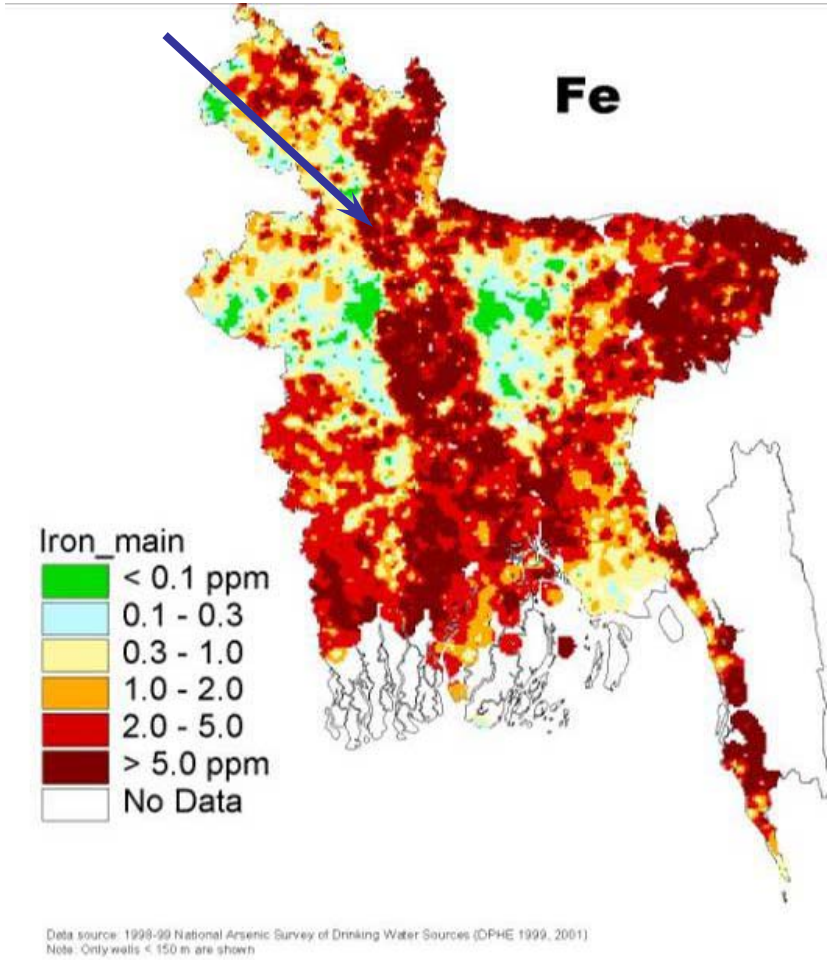
75% of Dry Season Irrigation from Groundwater*

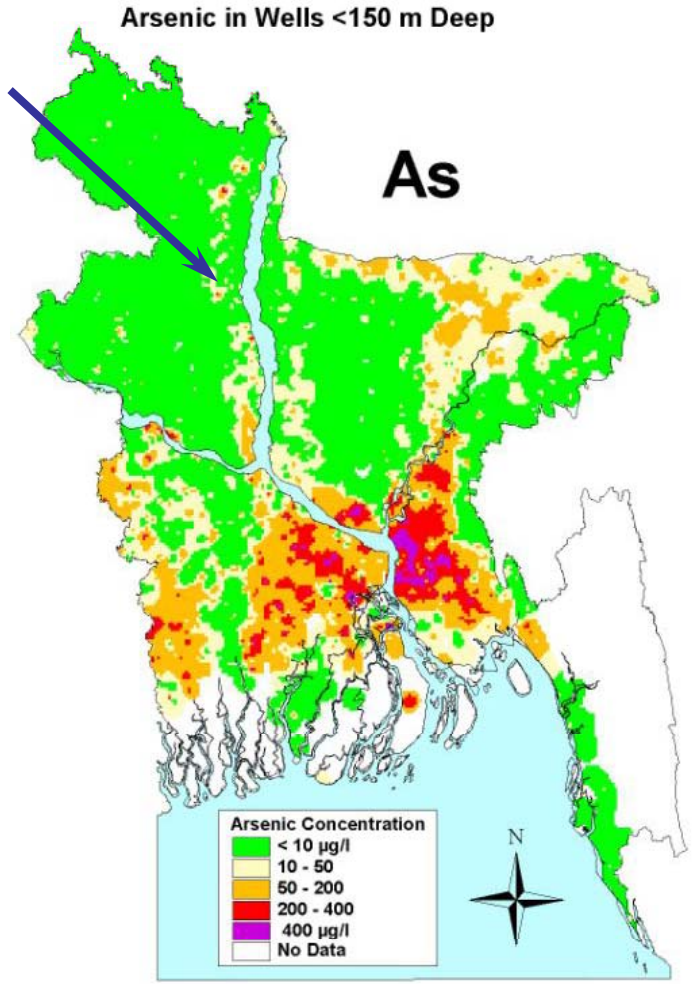


Inexpensive diesel motors and dry season irrigation with groundwater enable 2 crops per year

***(Rahman & Ravenscroft 2003)**

BGS Groundwater Study





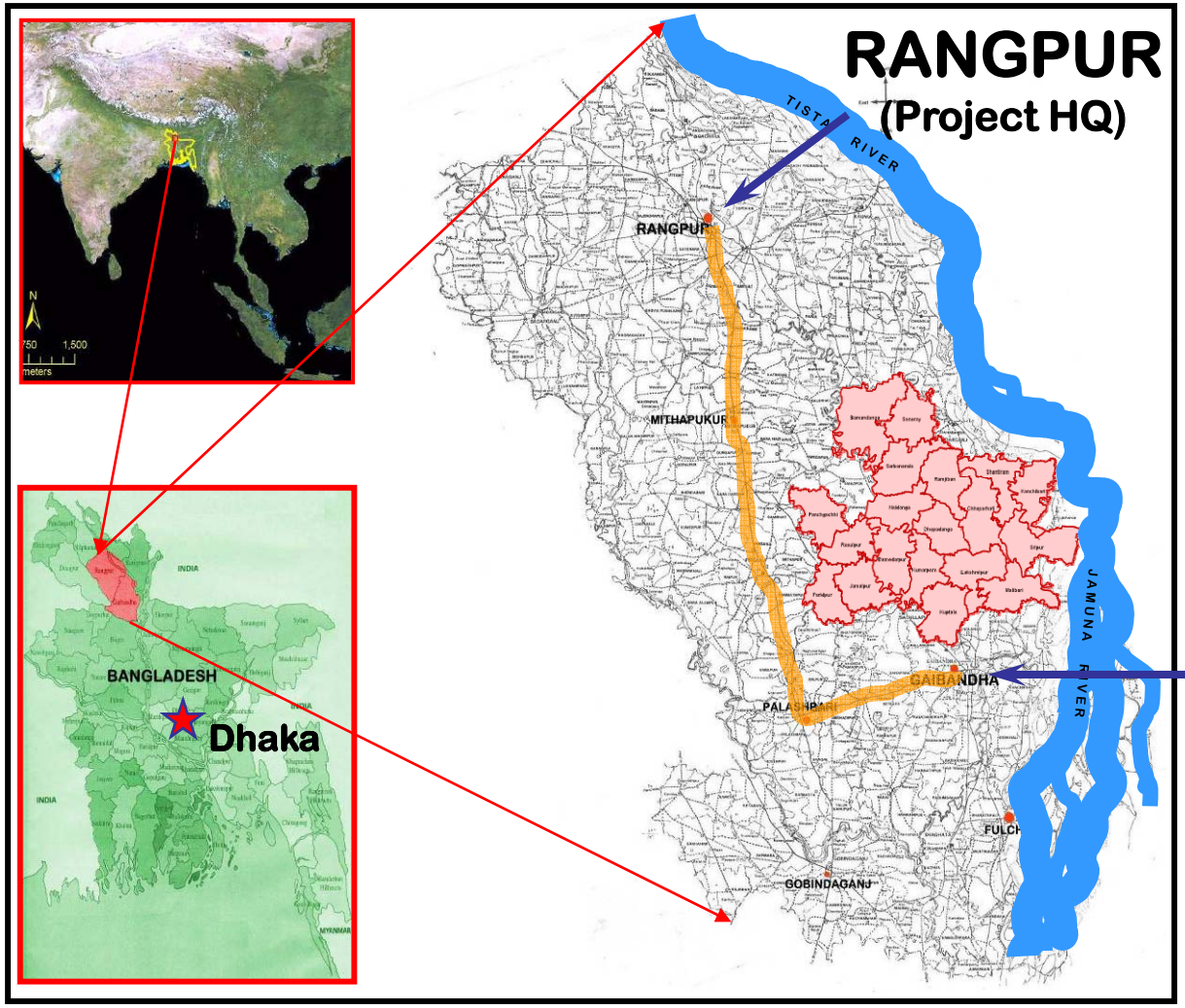
Rangpur/Gaibanda Area

- Unconsolidated sediments deposited in the last 2 million years form prolific aquifers
- Household Tubewells 8m – 60m deep
- Sediments deposited over the last 20 thousand years
- Several zones important
  - Upper Aquitard 5 – 25 m thick
  - Upper Shallow Aquifer 20 – 40 m thick (about 5,000 to 8,000 years old)
  - Lower Aquitard 2 – 10 m thick
  - Lower Shallow Aquifer 25 – 60 m thick (10,000 to 18,000 years old
- Local water tables controlled by rivers & streams

Bangladesh Ground Water Cycle

- December to March – Groundwater withdrawal
- Towards the end of April with the onset of the monsoon, water levels begin to rise
- May and June, melt water from the Himalaya reaches Bangladesh
- August with onset of main monsoon
  - Flooding
  - Aquifer recharge
- With the end of the monsoon in December, ground water level adjusts to main channel

JiVitA Project Area



Overview

Area: 435 km²

Population: 650,000

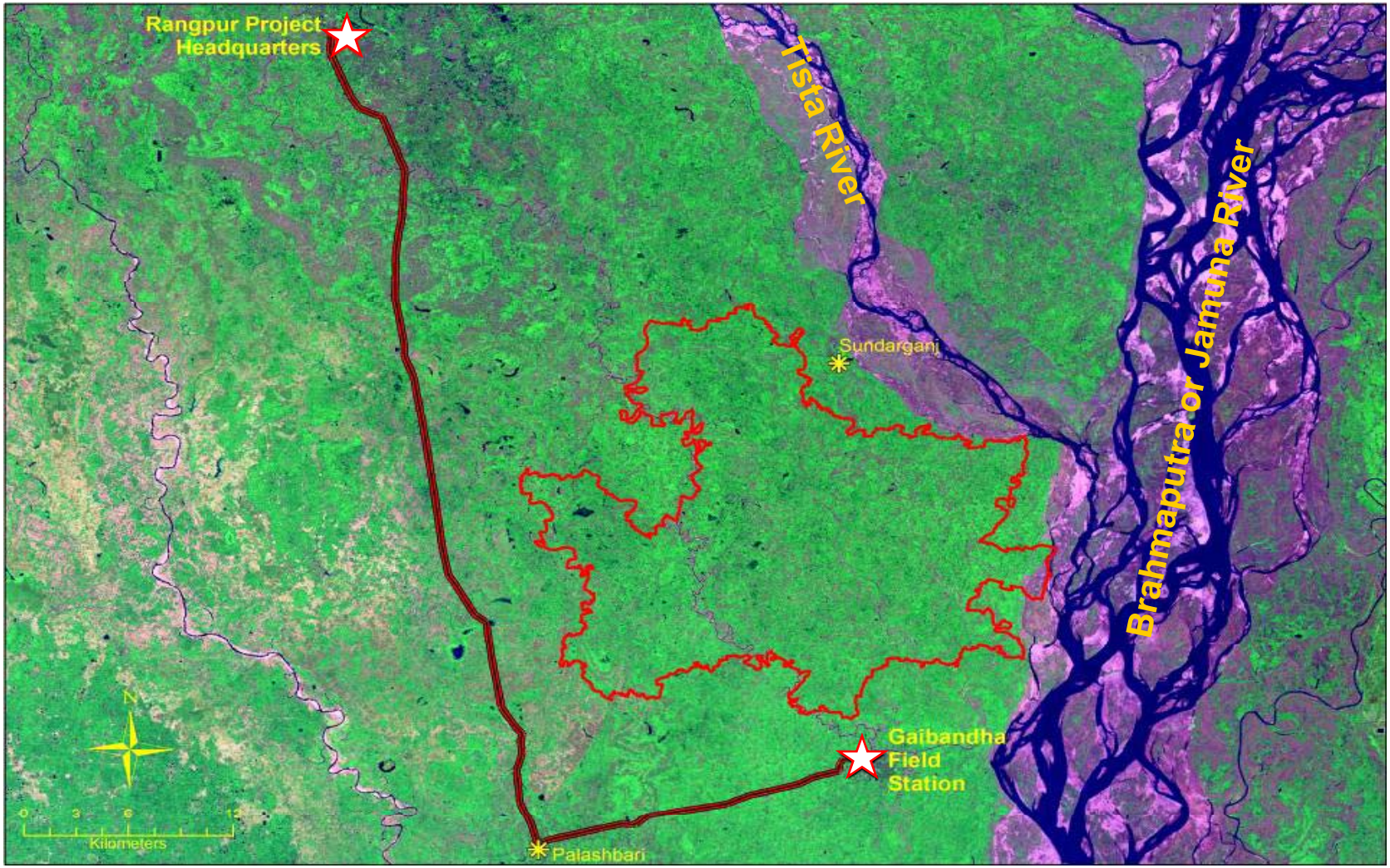
Density: 1150 persons/km²

70 JiVitA Field Offices

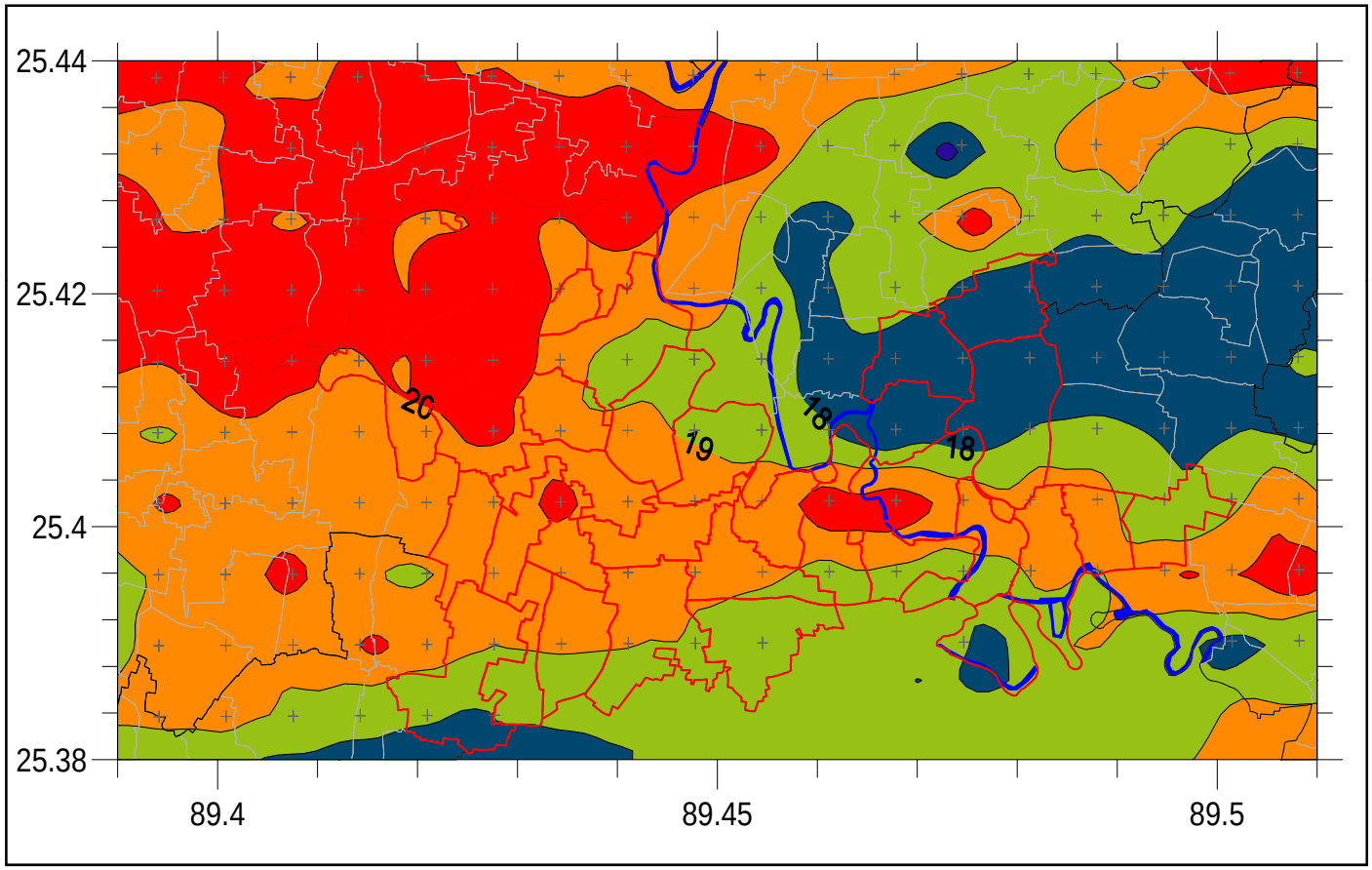
850 + Field Staff

GAIBANDHA
(Field Station)

Proximal to BhramaPutra River

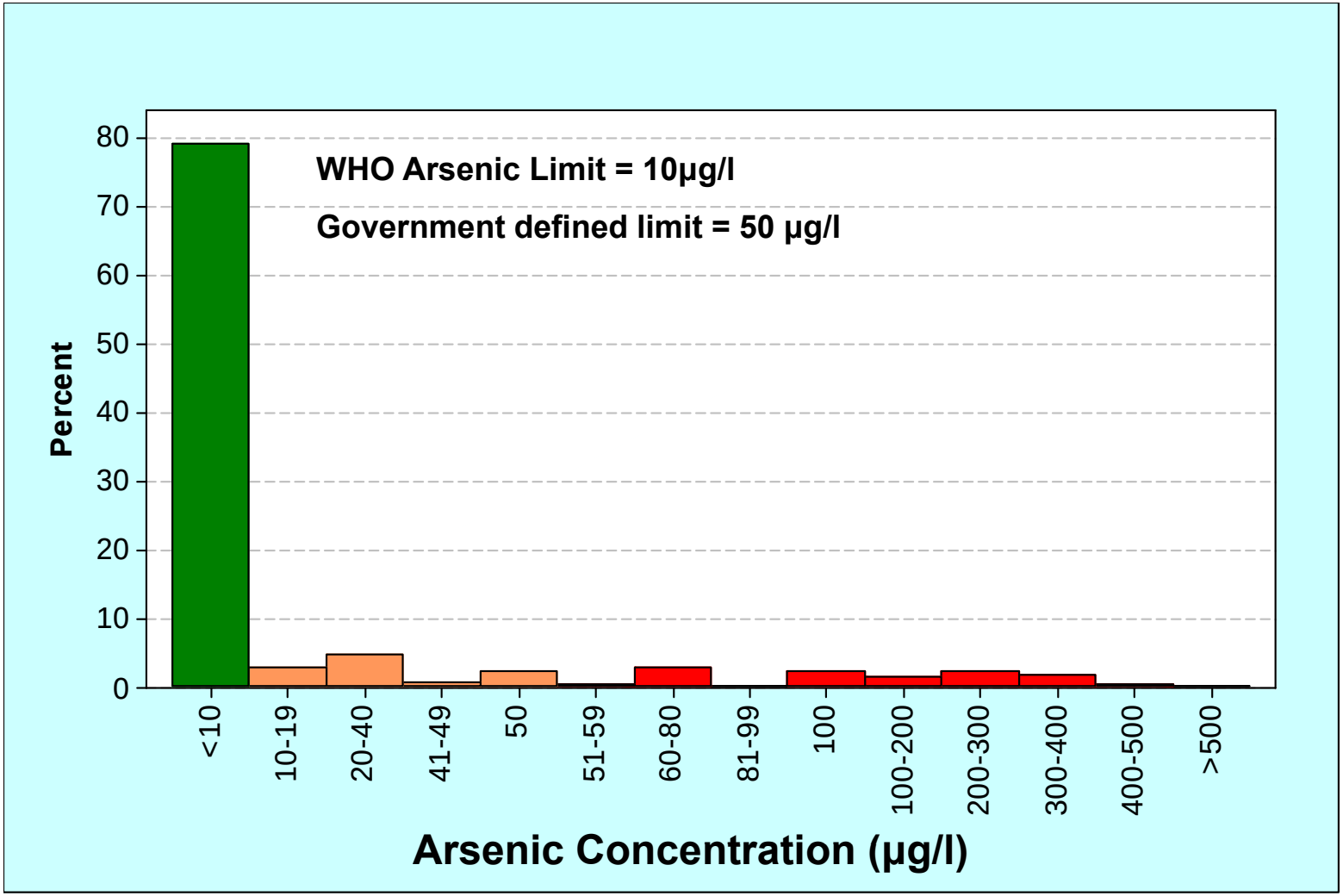


Elevation (m)
JiVitA 1 Substudy Area

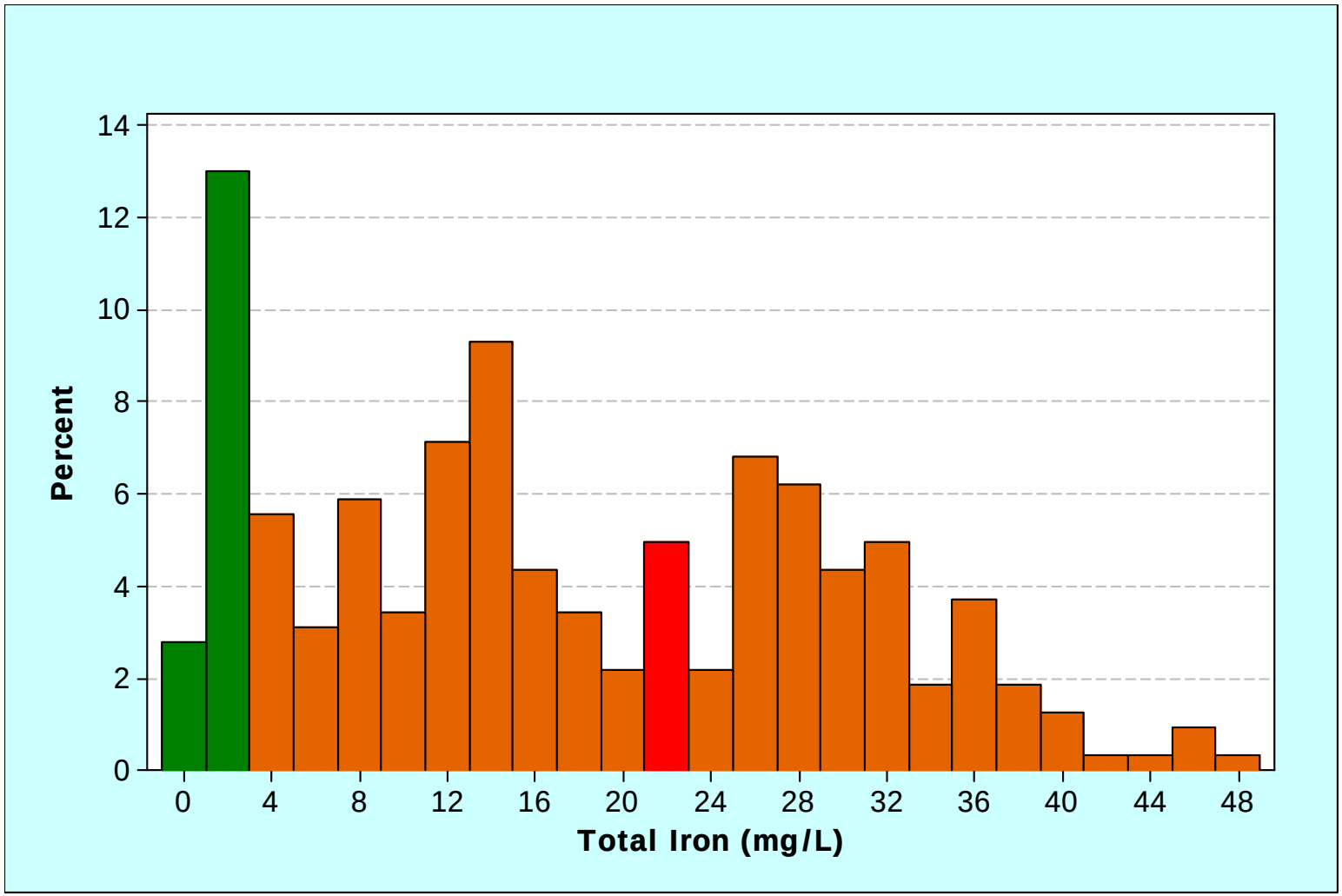


Contour Interval 1m

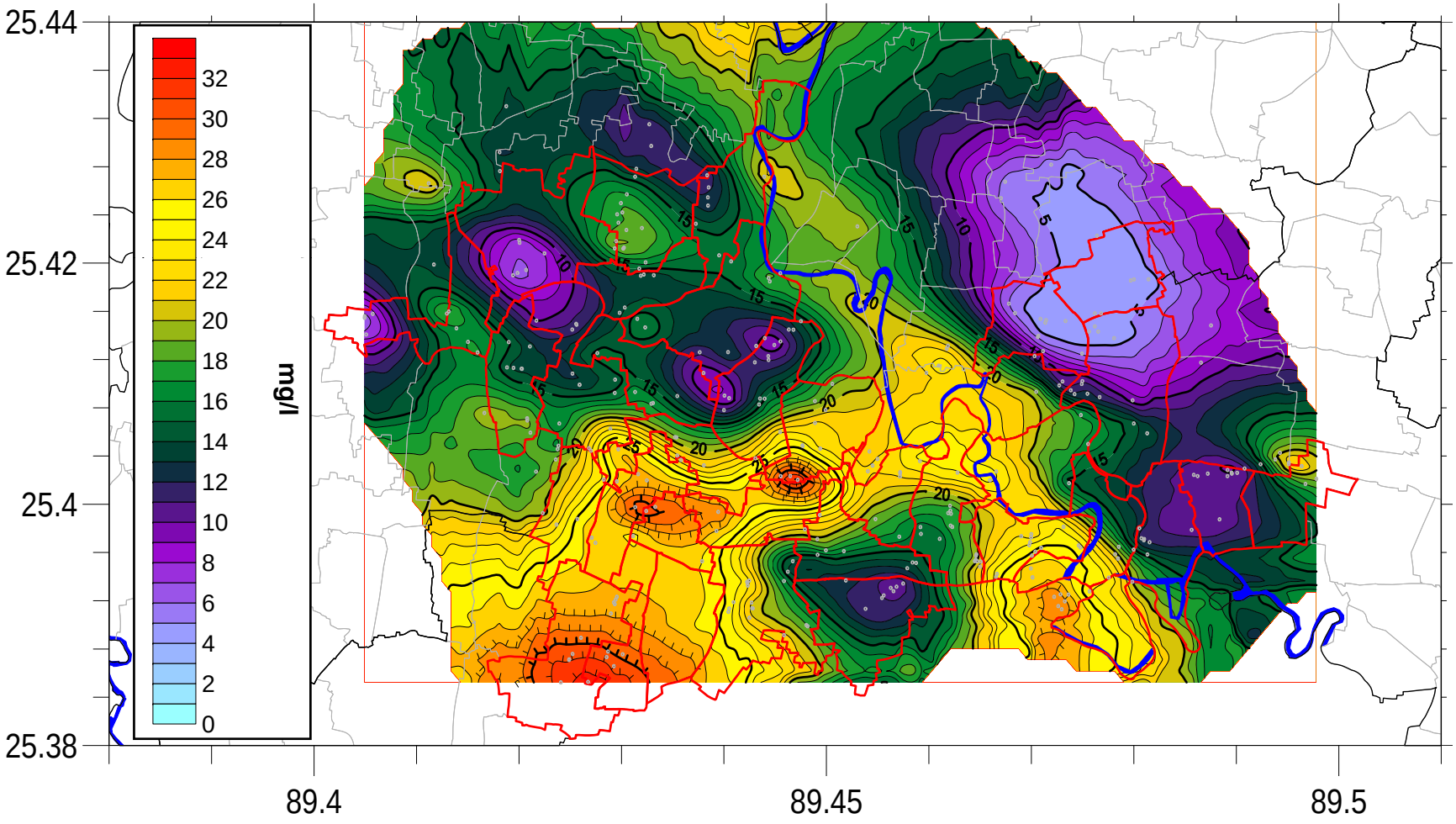
Arsenic in PANI 5 Area



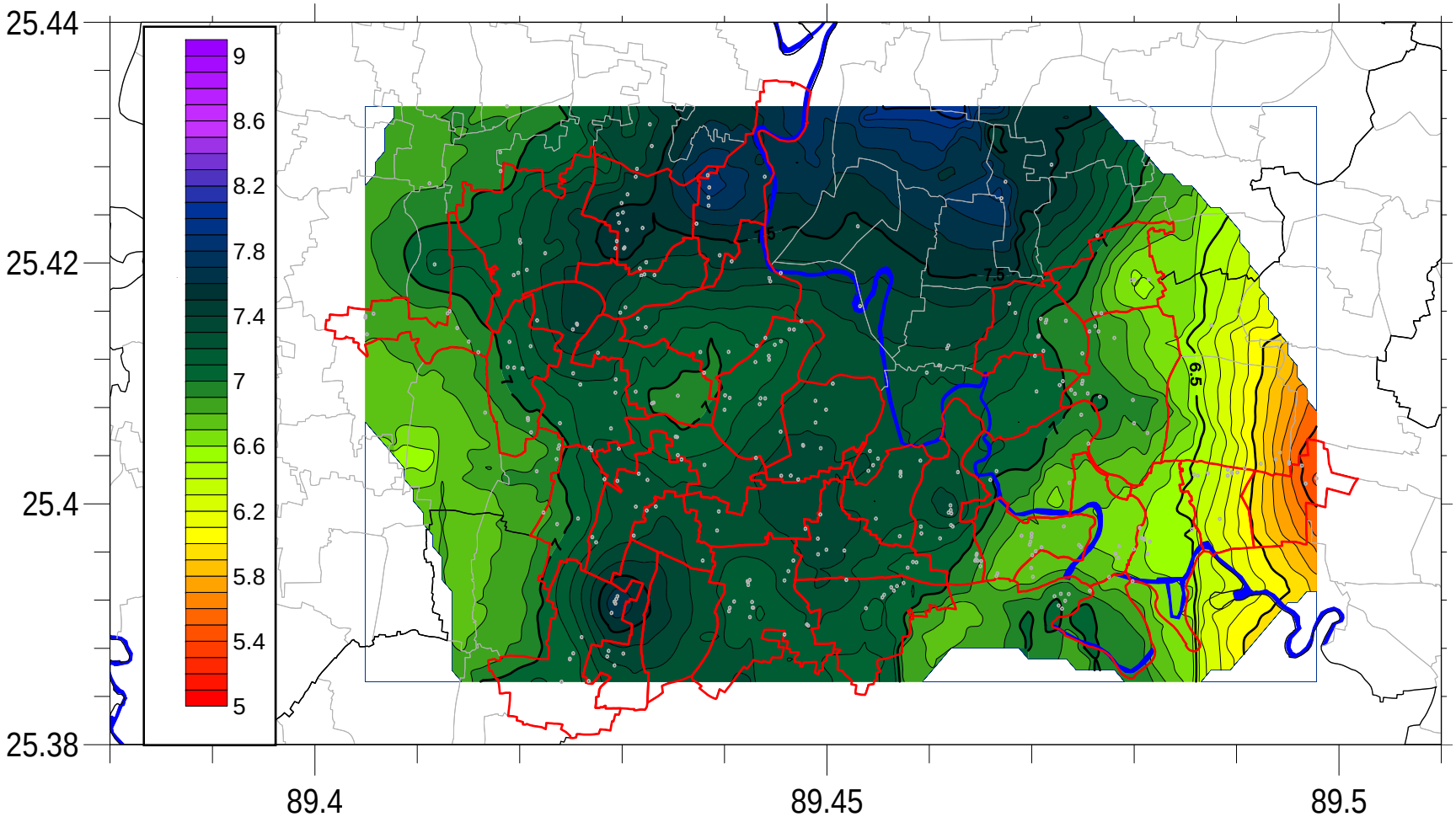
PANI 5 Area Total Iron (mg/l)



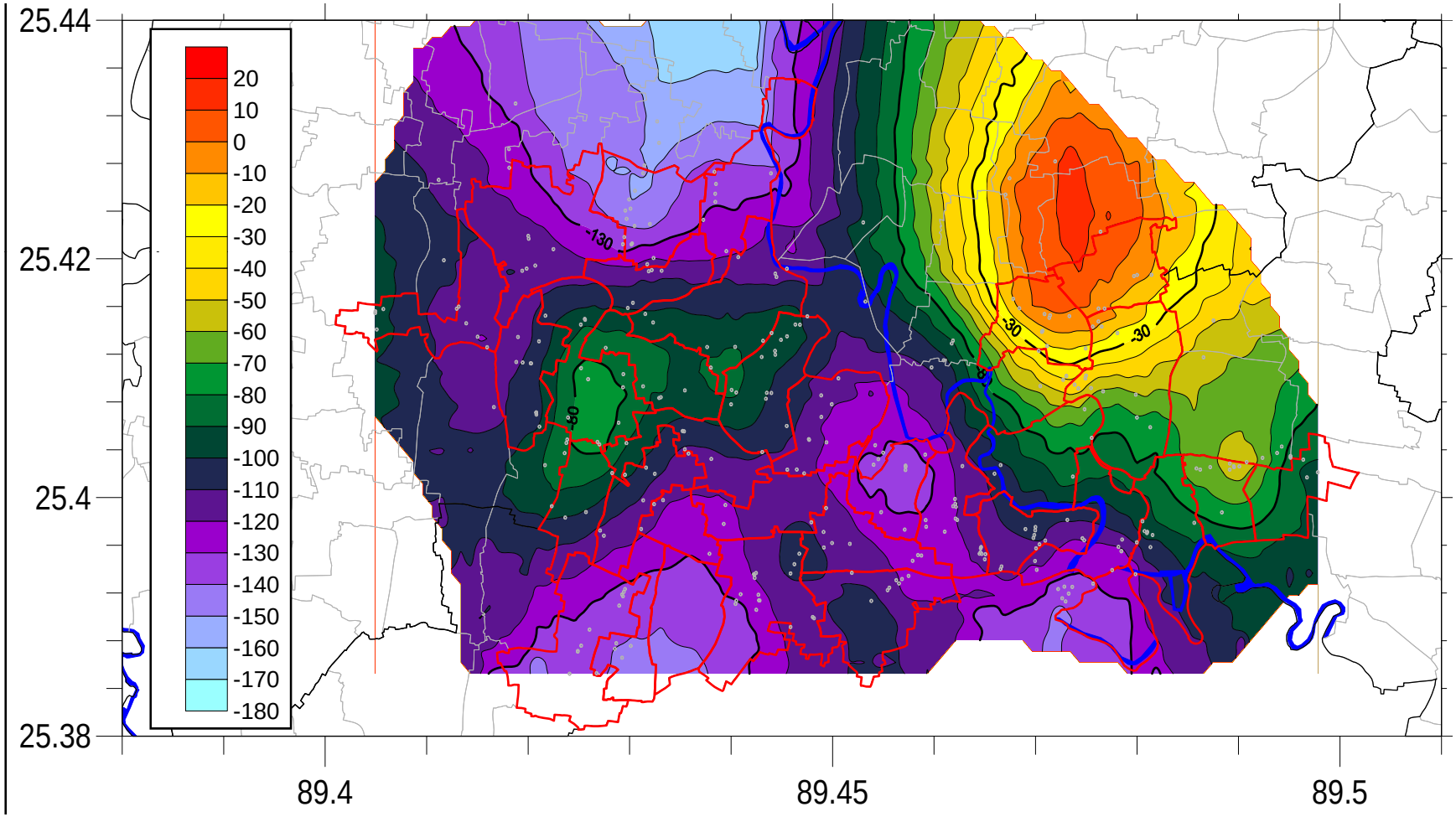
Iron Concentration (mg/l)
JiVitA 1 Substudy Area



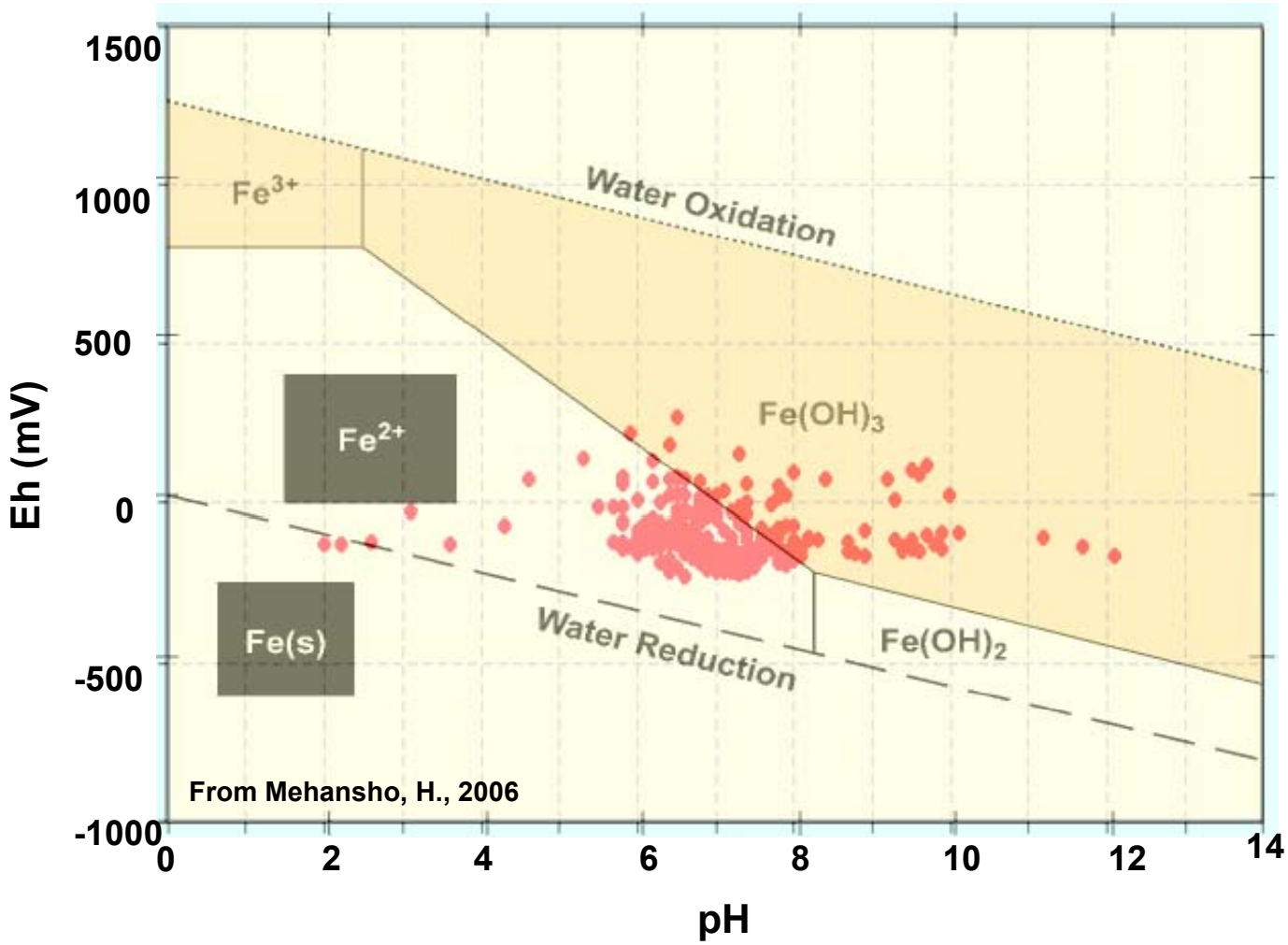
pH – JiVitA 1 Substudy Area



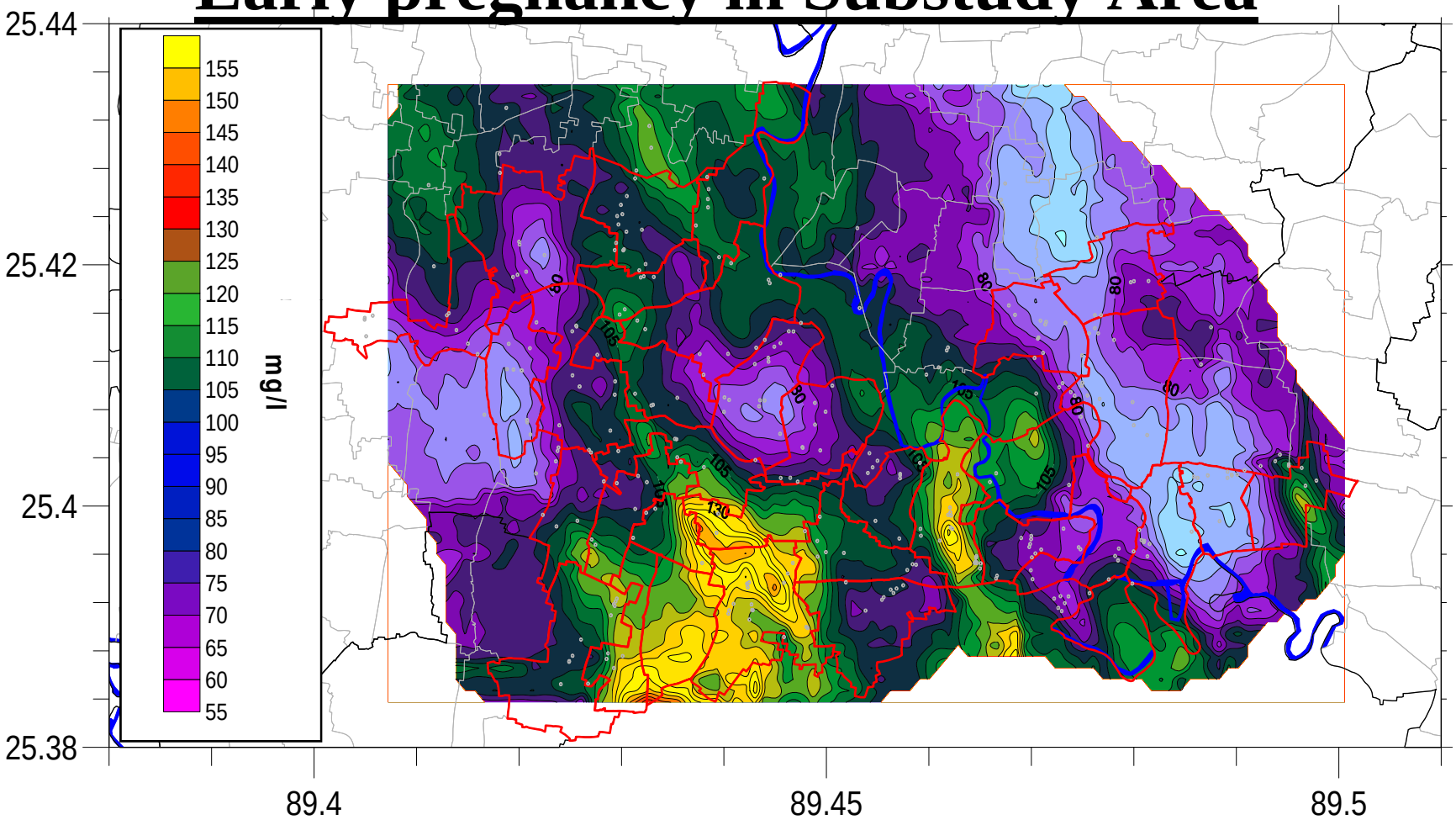
Eh – JiVitA 1 Substudy Area



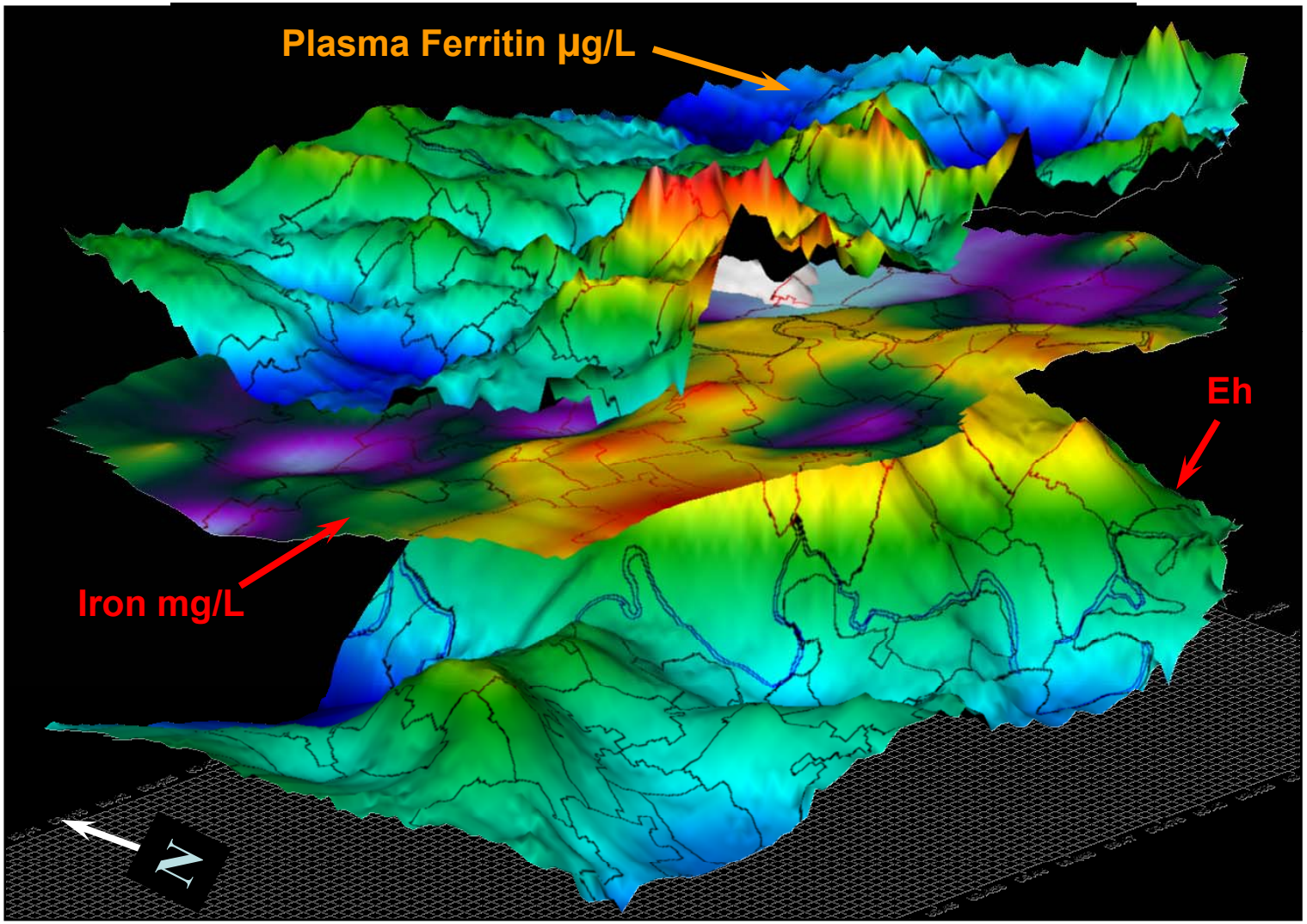
Ferrous Iron Dominant in Groundwater



Plasma Ferritin (µg/l) Concentration Early pregnancy in Substudy Area



Plasma Ferritin – Iron - Eh



Hydrology and Human Health in Bangladesh

- Rapid transition from surface water to groundwater
  - Largely free from microbiologic contamination
  - Trace elements have led to public health problems – e.g. arsenic
- In the JiVitA study area over 80% of tubewells have iron concentration above the WHO "aesthetic limit" of 0.3 mg/L
  - High bioavailable ferrous iron
  - High plasma ferritin
  - Affect on human health over long term unknown
- JiVitA is continuing to study the relationship between groundwater iron exposure and human health

Painting the Tubewells