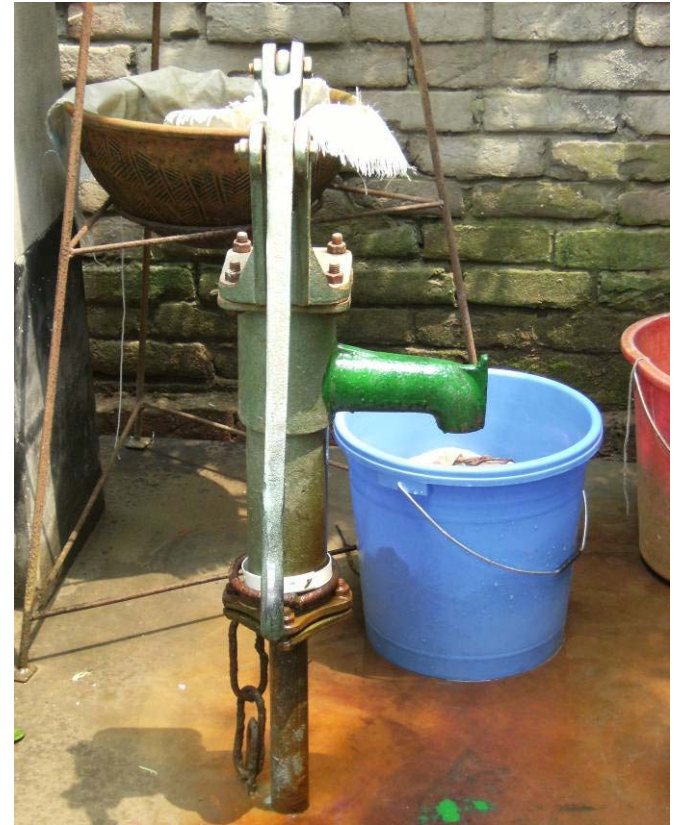


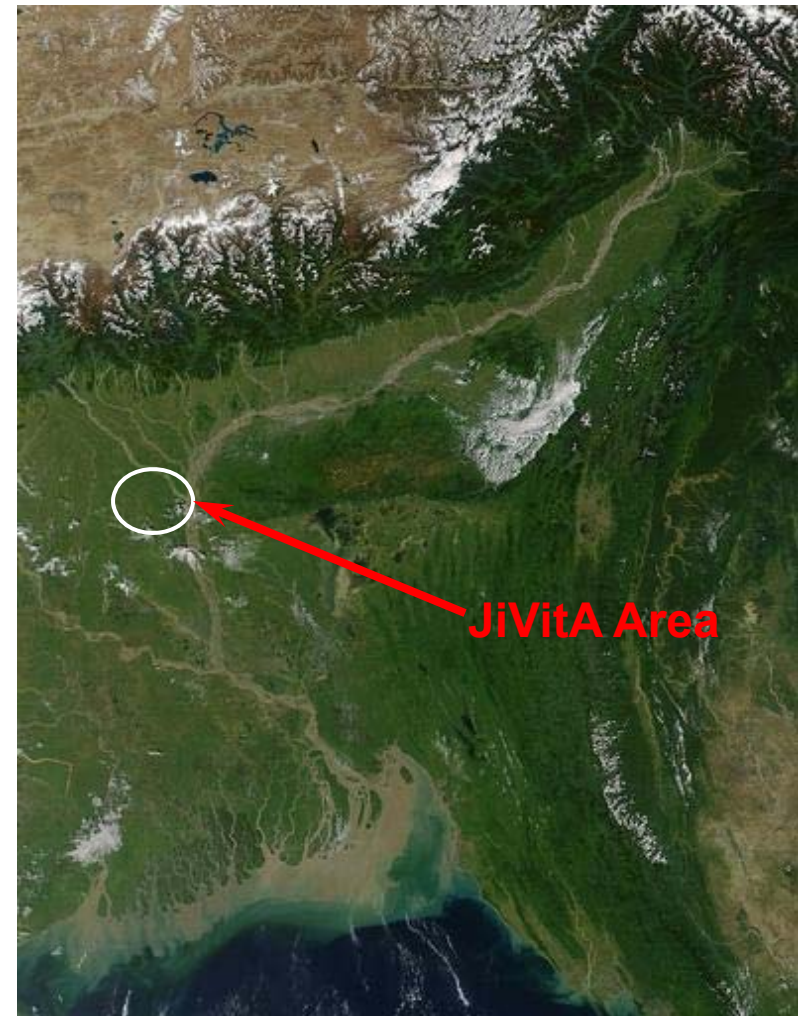
Hydrology and Human Health: An Intersection for Nutrition Research in Bangladesh



**R. D. Merrill, R. K. Merrill, A. A. Shamim,
A. Labrique, H. Ali, M. Rashid, K. P. West, Jr.**

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)

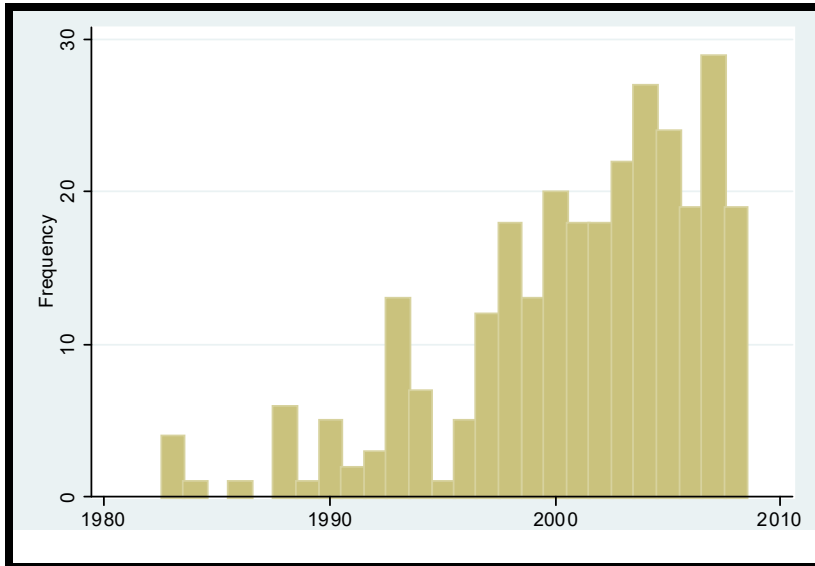


Transition to Groundwater

- **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



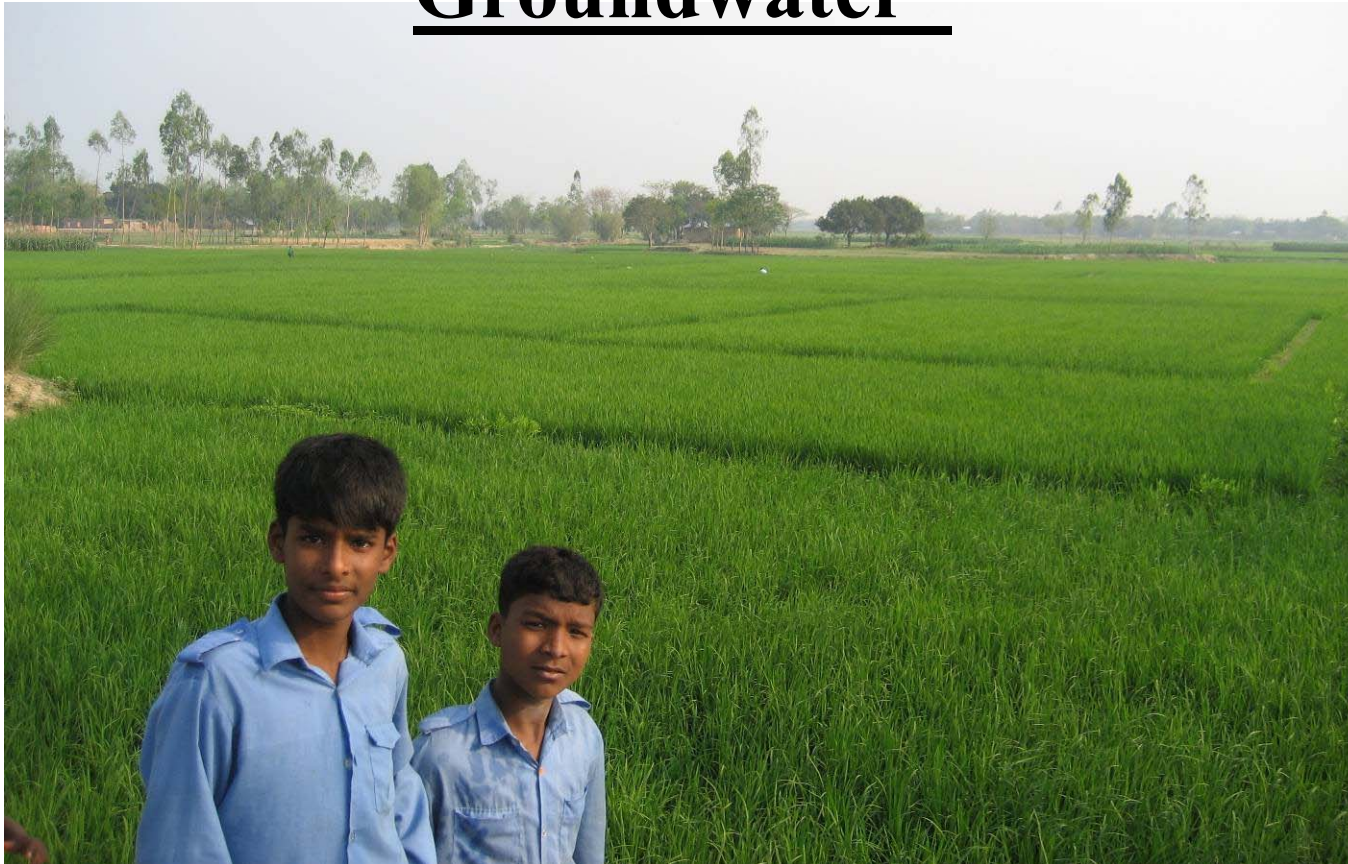
2000s: Current Groundwater Use



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



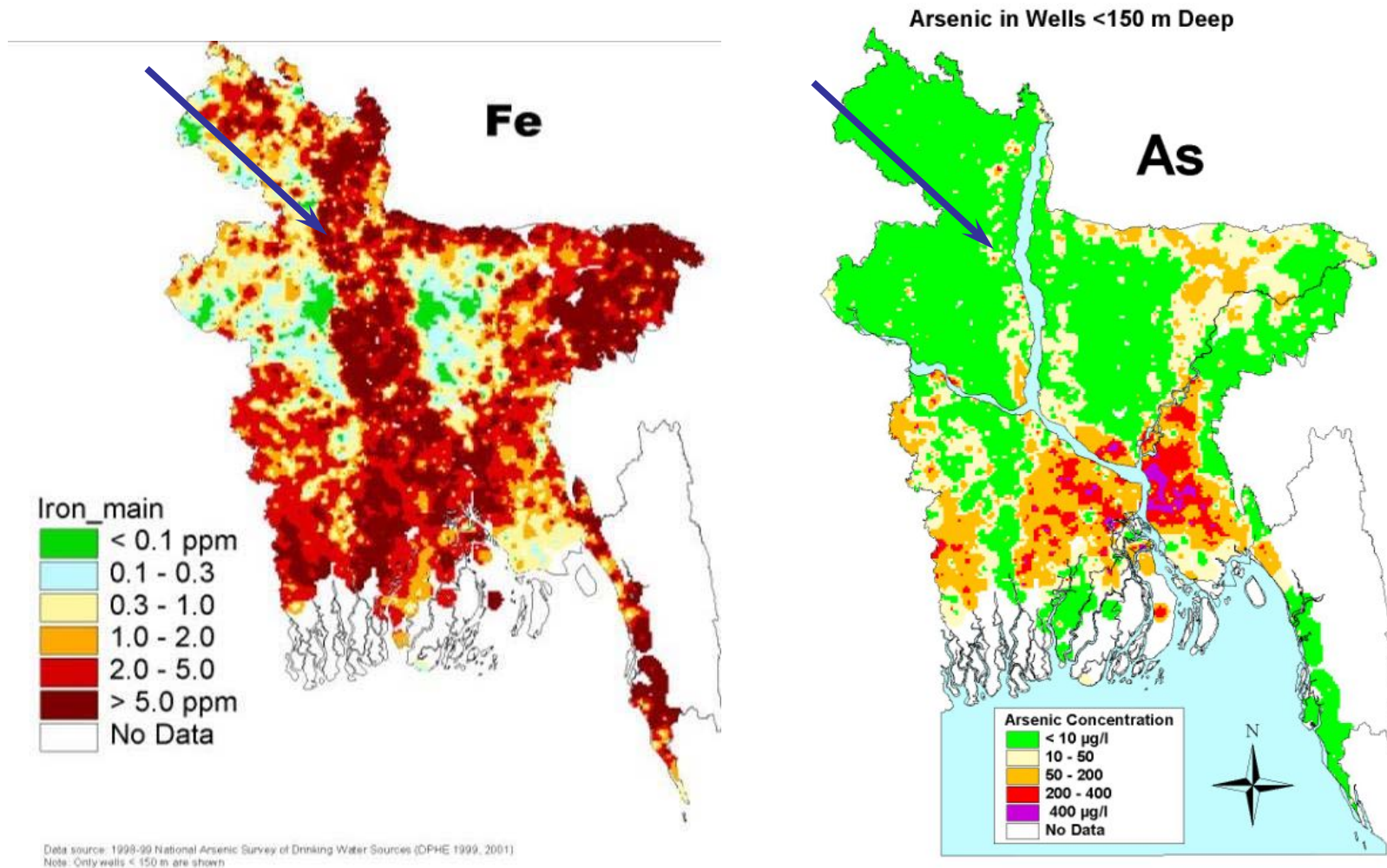
75% of Dry Season Irrigation from Groundwater*



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

***(Rahman & Ravenscroft 2003)**

BGS Groundwater Study



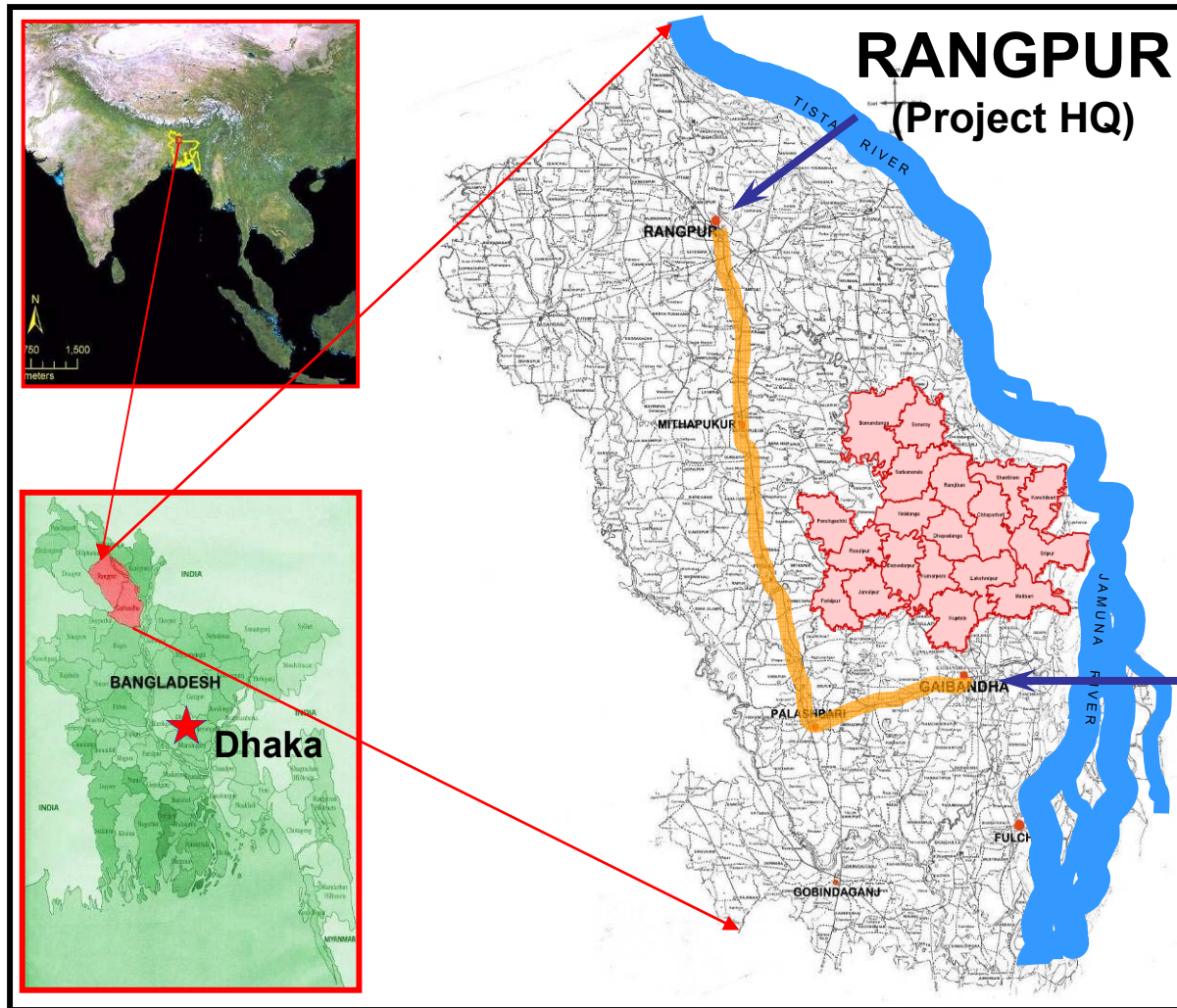
Rangpur/Gaibanda Area

- **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**

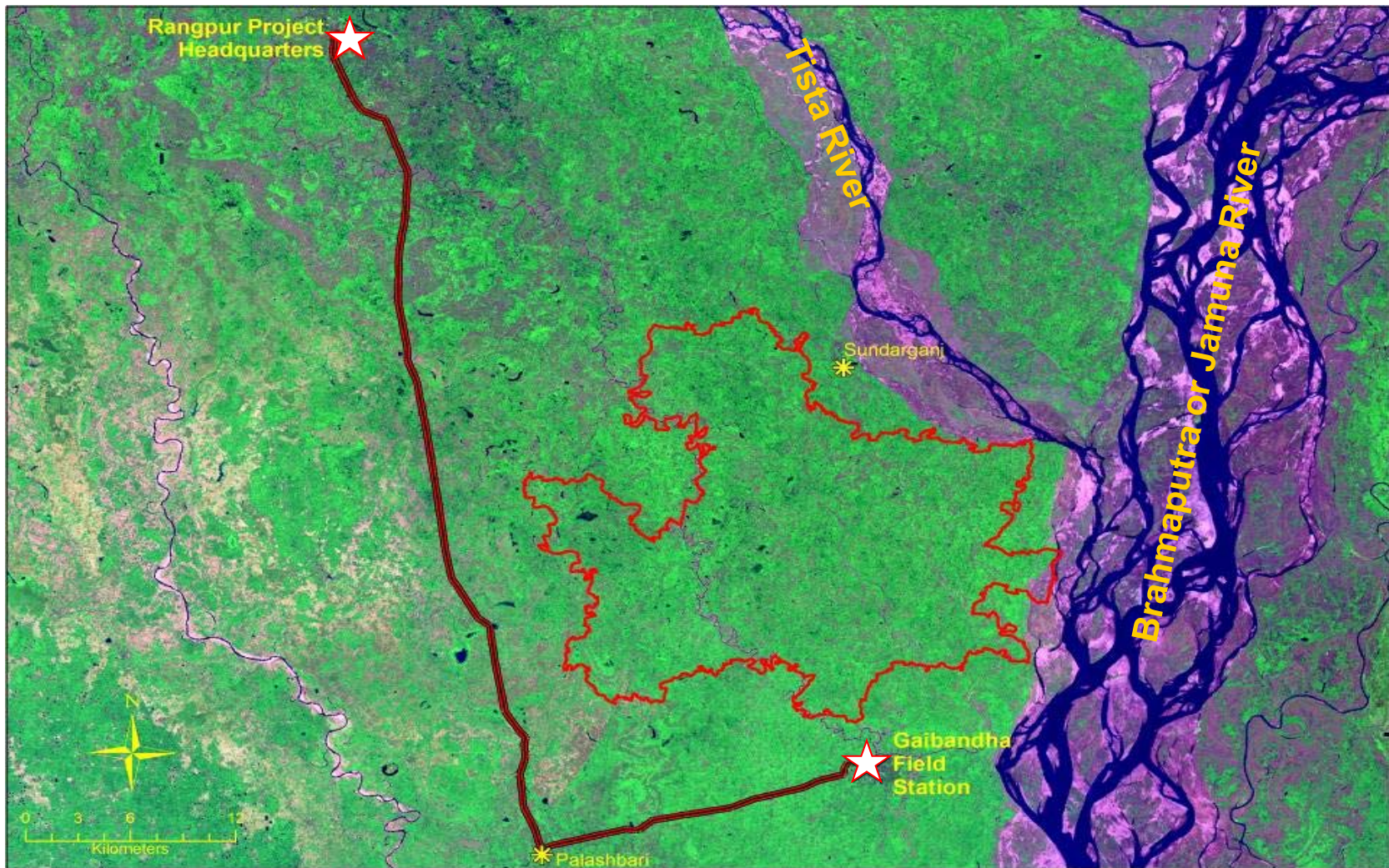
JiVitA Project Area



Overview
Area: 435 km²
Population: 650,000
Density: 1150 persons/km²
70 JiVitA Field Offices
850 + Field Staff

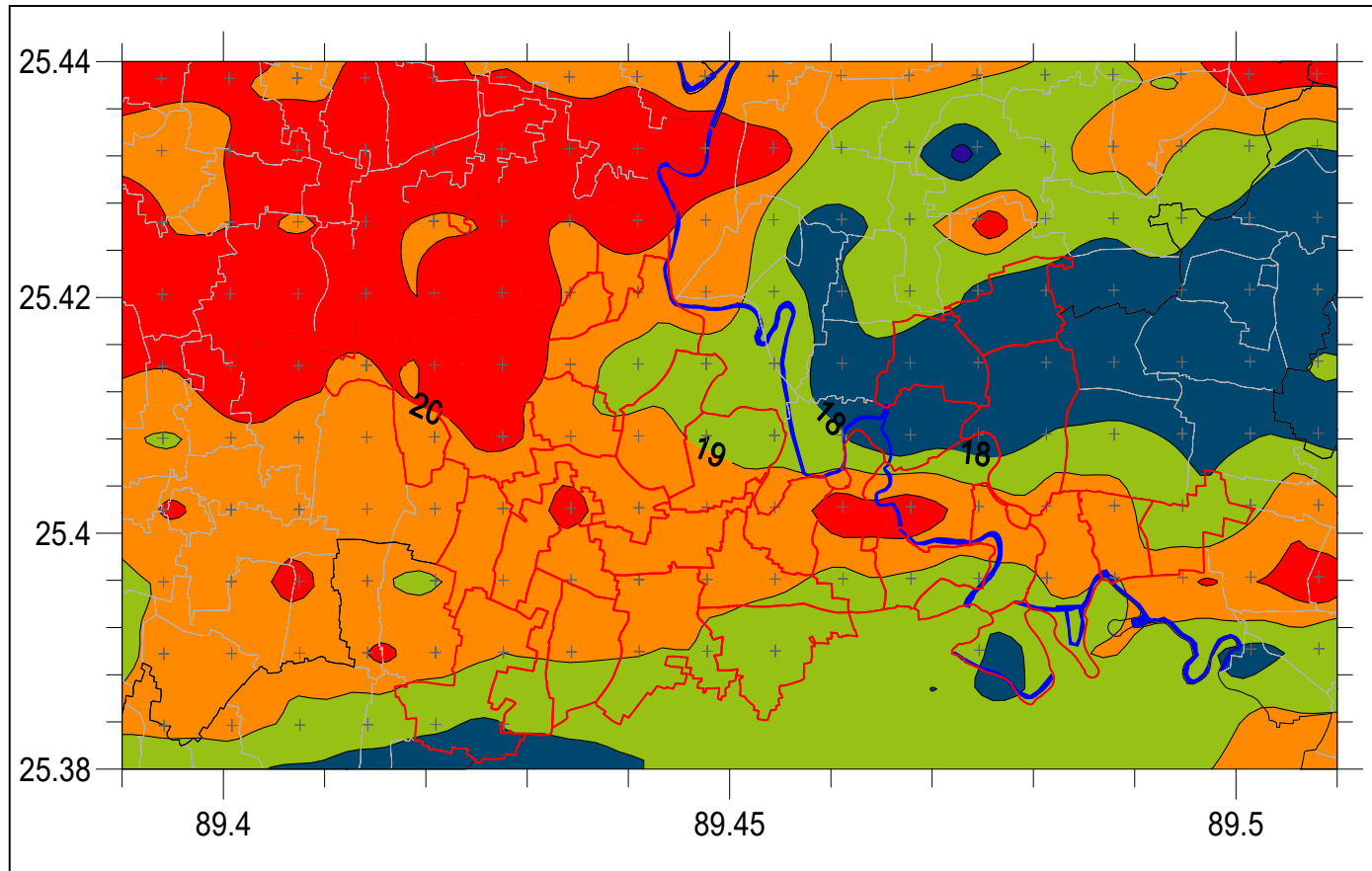
GAIBANDHA
(Field Station)

Proximal to BhramaPutra River



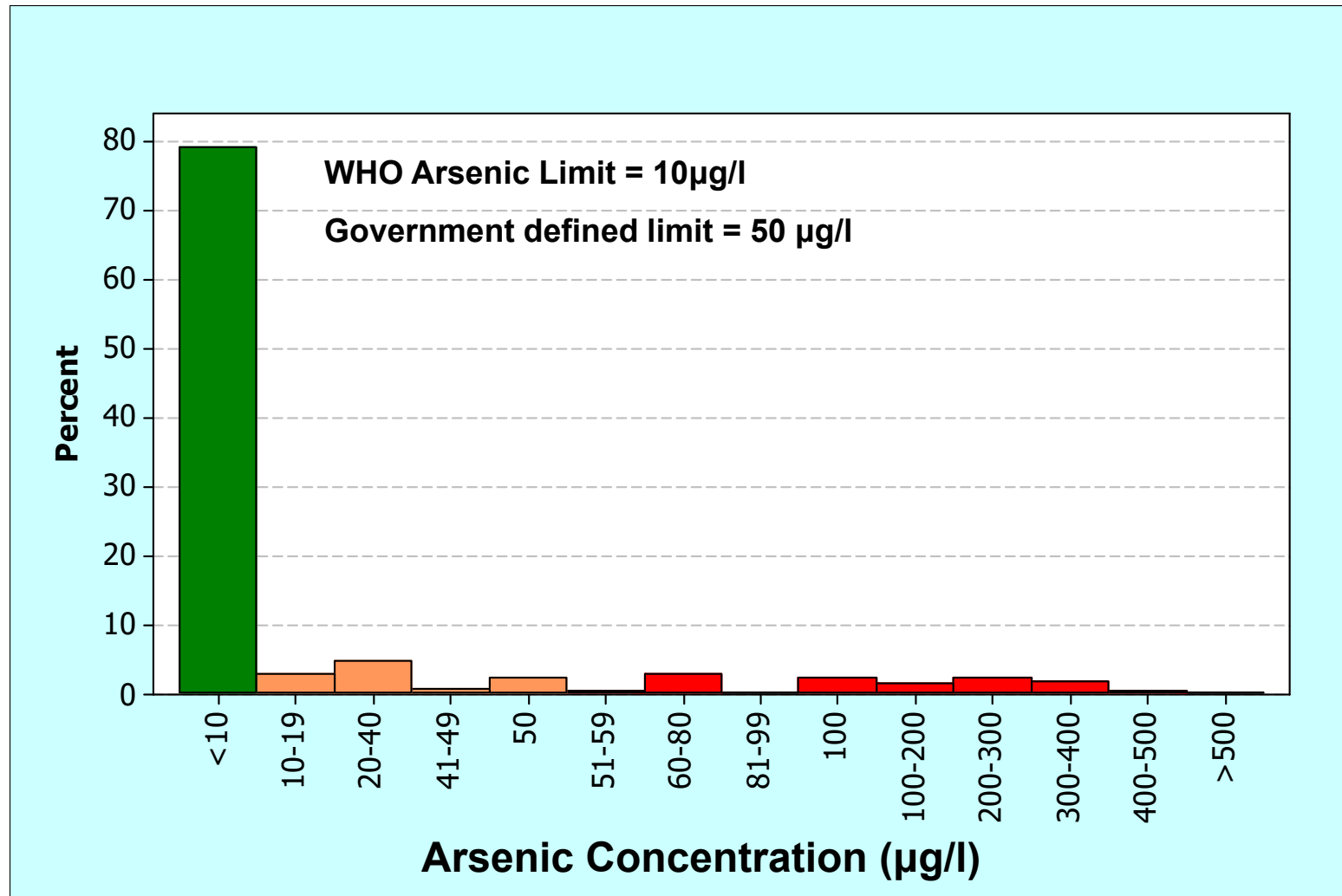
Elevation (m)

JiVitA 1 Substudy Area

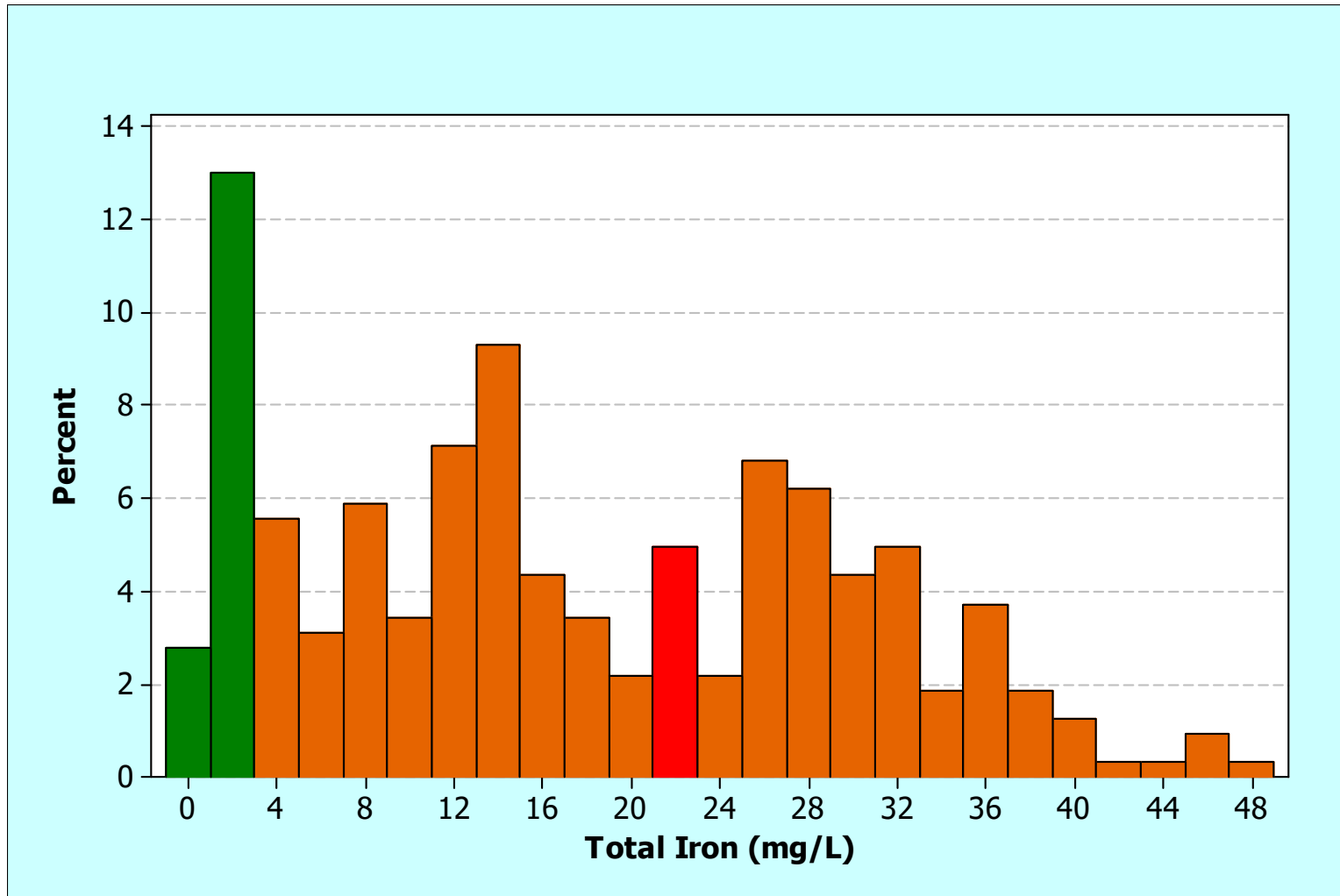


Contour Interval 1m

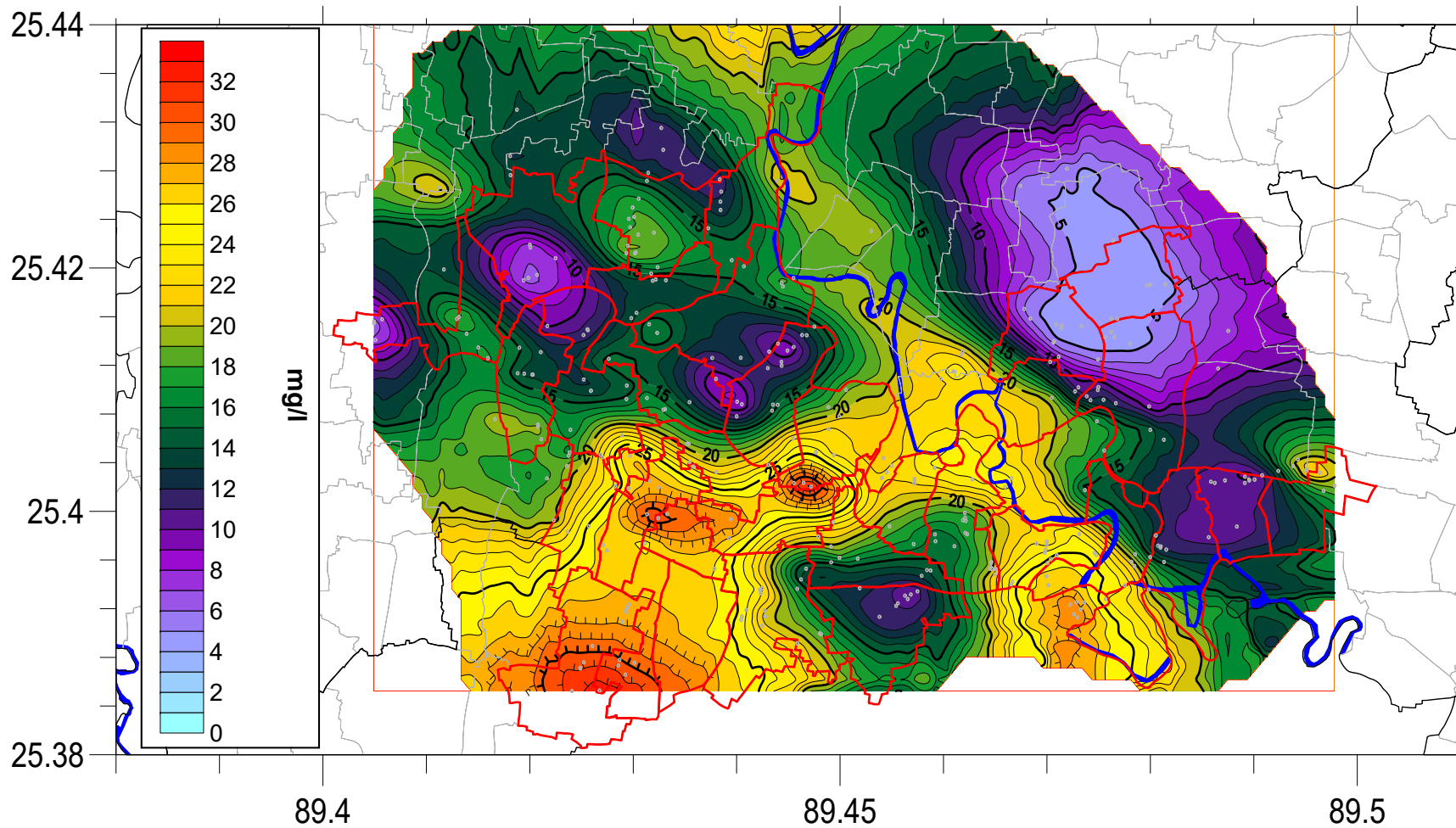
Arsenic in PANI 5 Area



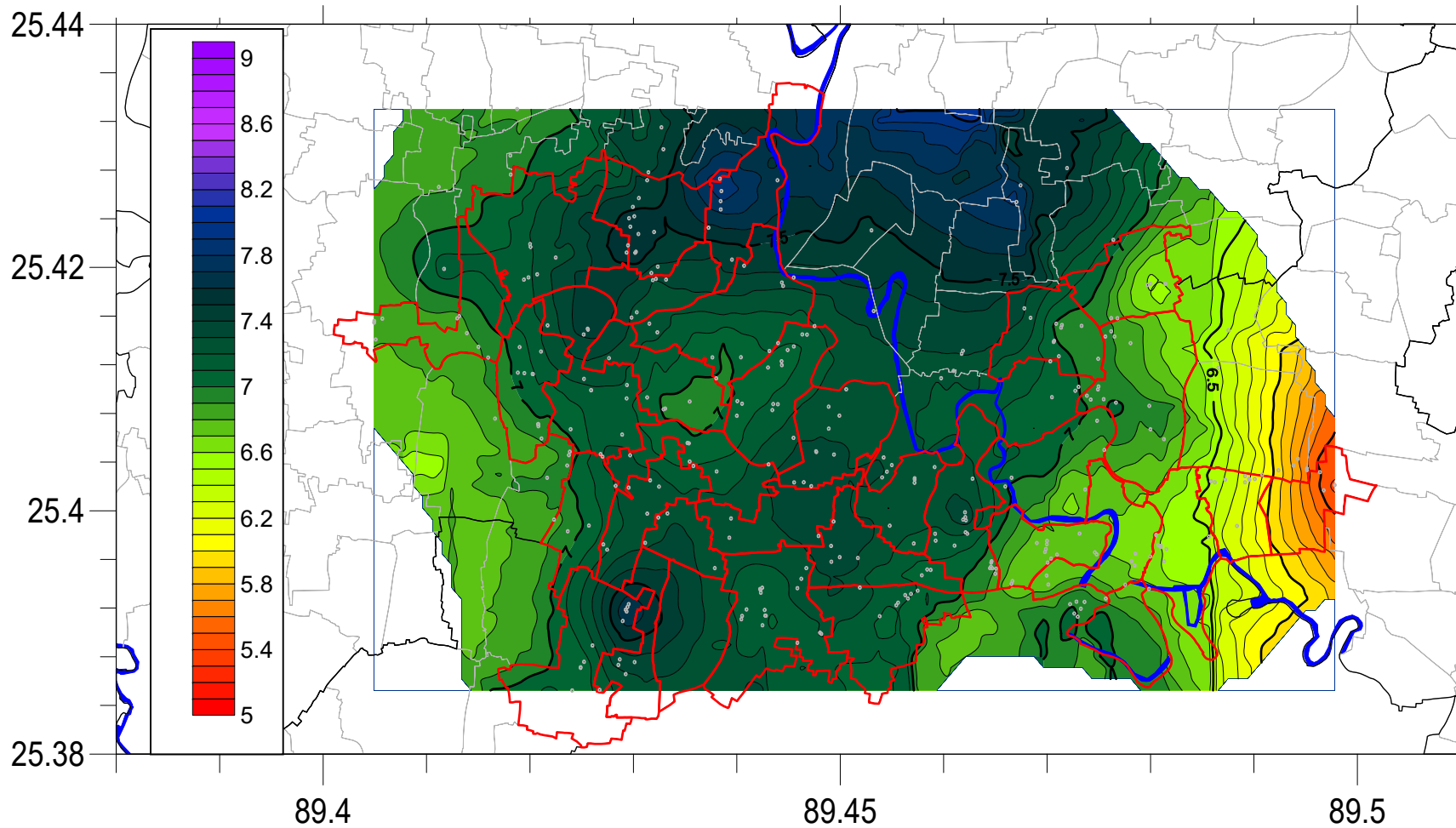
PANI 5 Area Total Iron (mg/l)



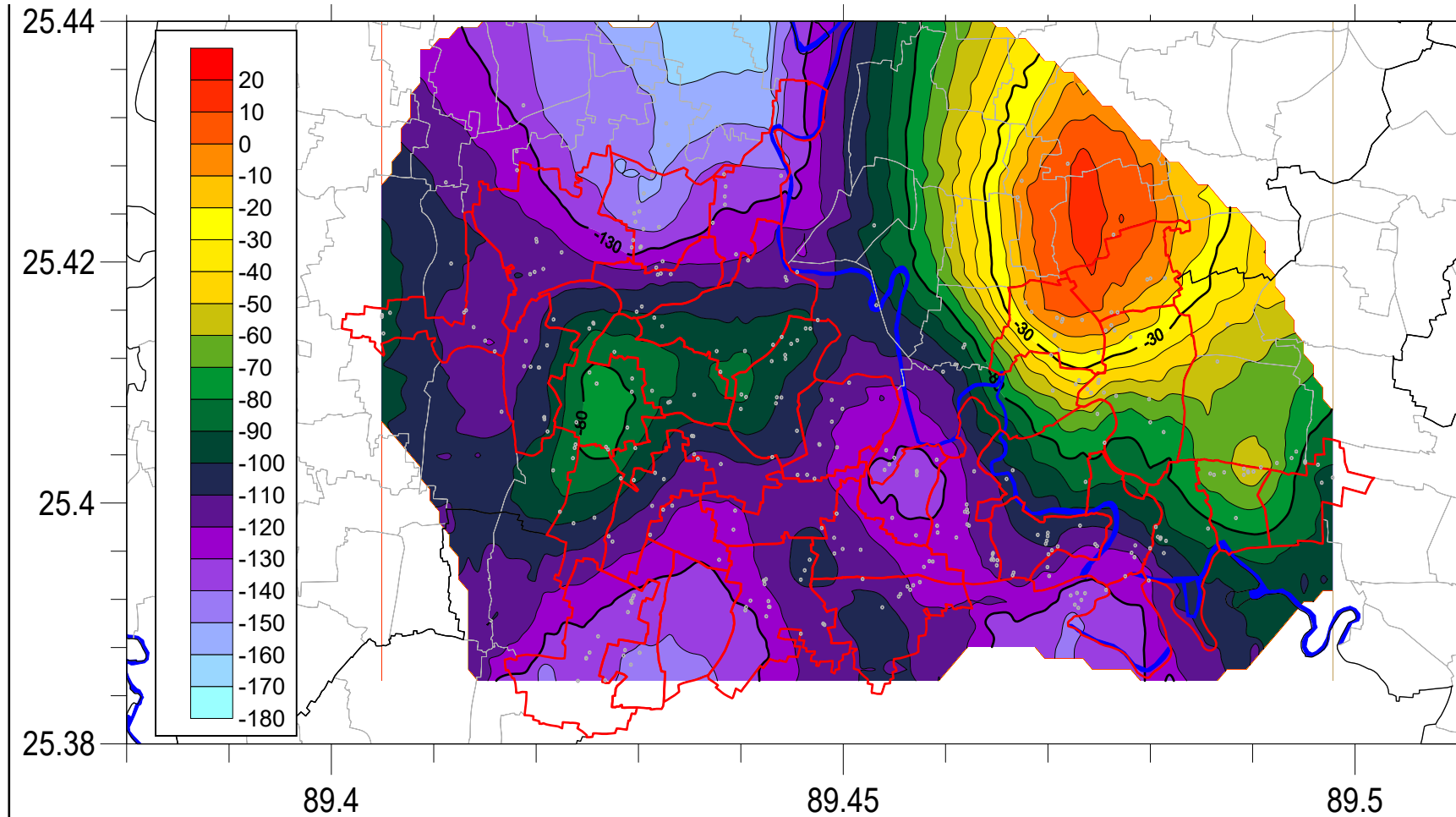
Iron Concentration (mg/l) JiVitA 1 Substudy Area



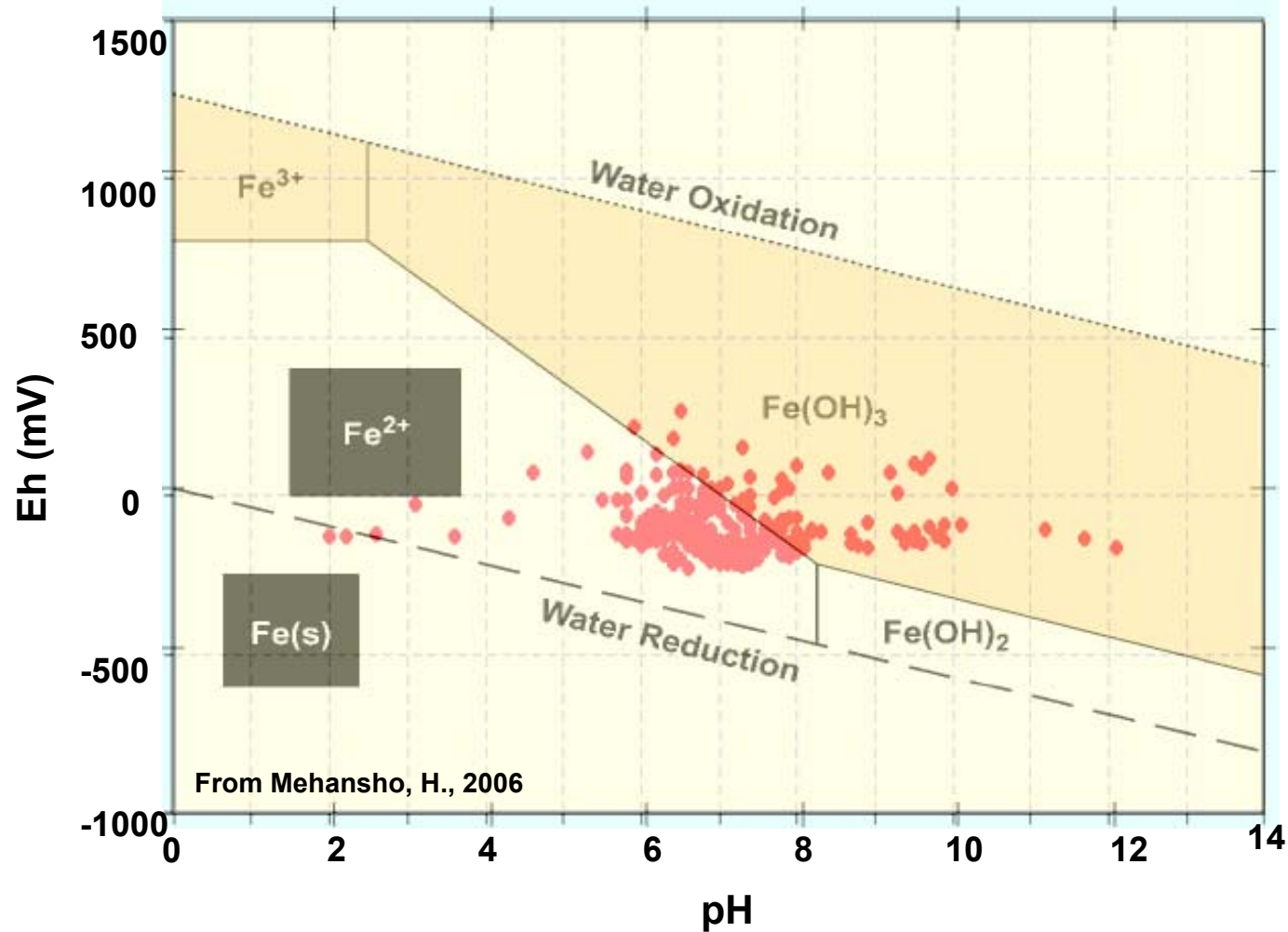
pH – JiVitA 1 Substudy Area



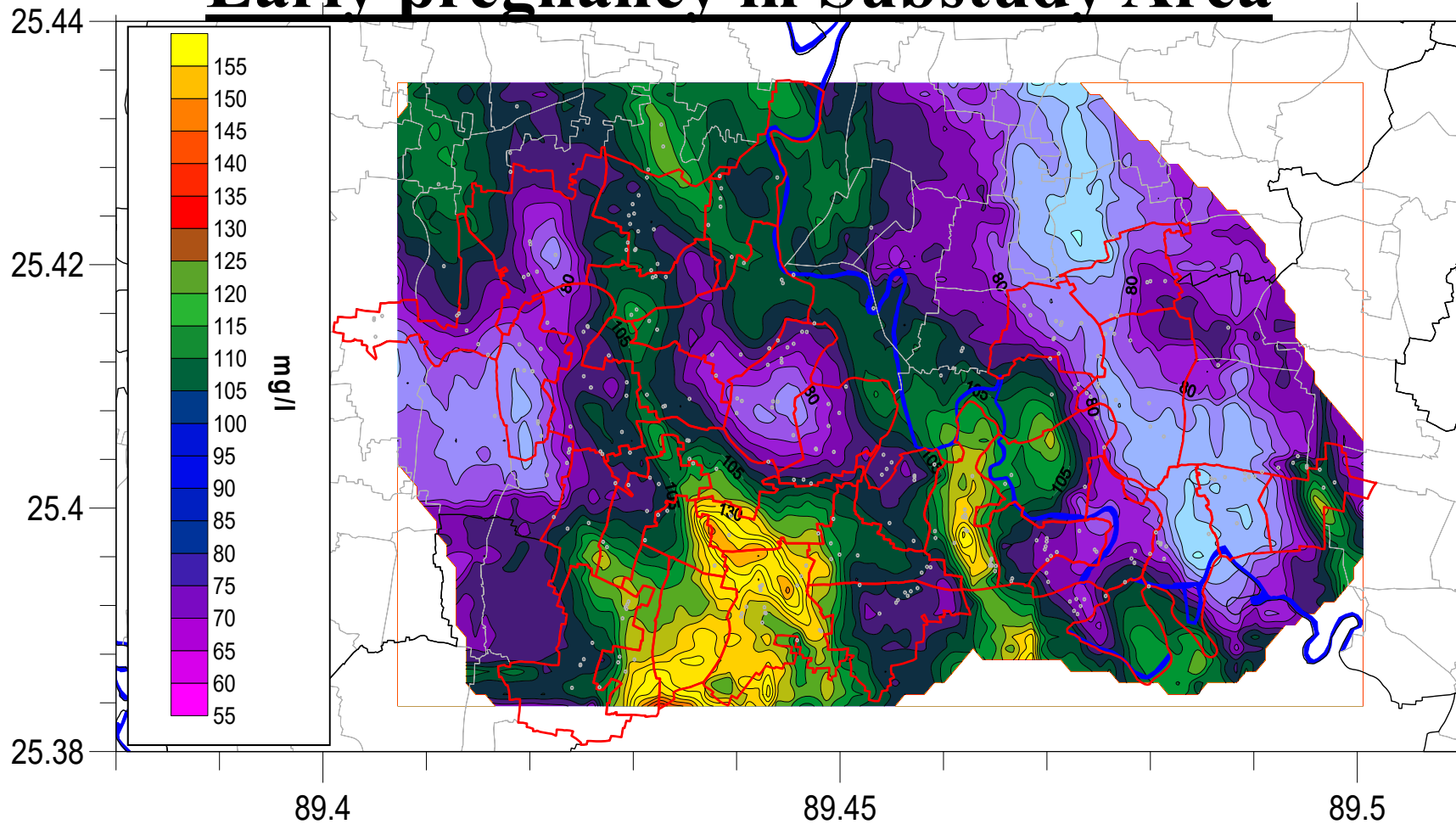
Eh – JiVitA 1 Substudy Area



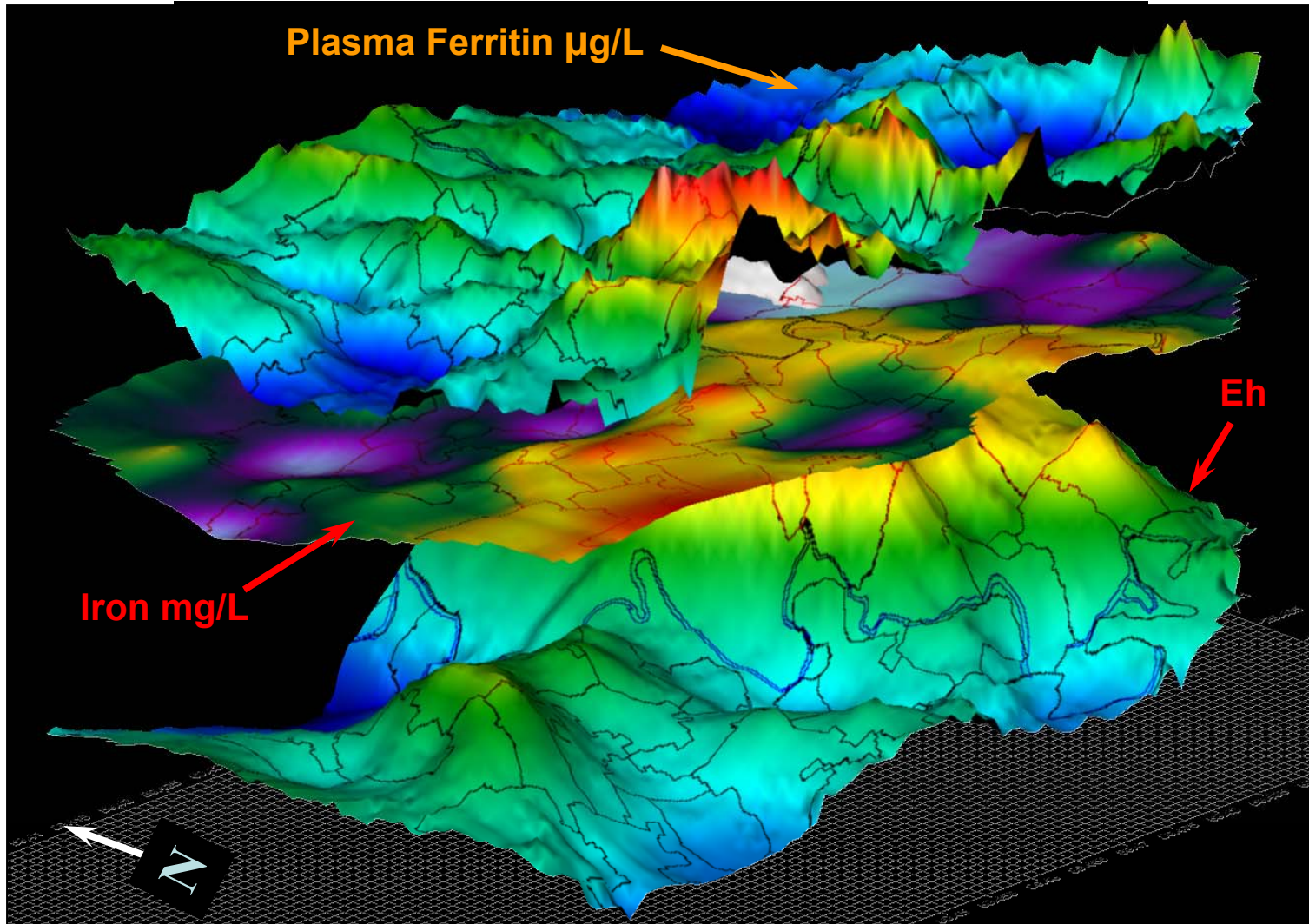
Ferrous Iron Dominant in Groundwater



Plasma Ferritin ($\mu\text{g/l}$) 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

