GROUNDWATER BASED RICE FARMING IN GANGA BASIN- A SUSTAINABILITY STUDY

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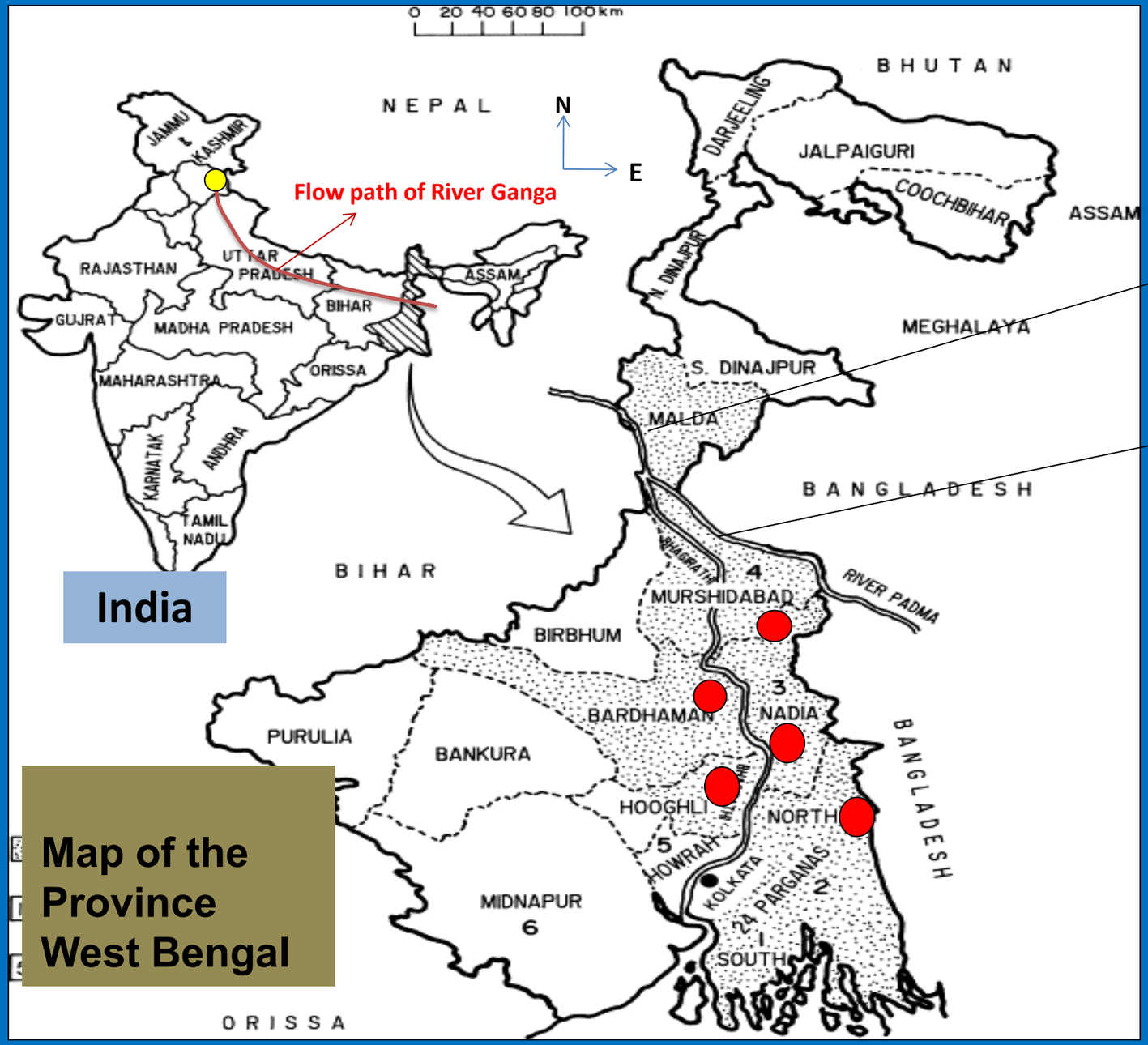


River Ganga

River Bhagirathi (distributary of river Ganges)

Study areas in 5 districts of West Bengal in Lower Ganga Basin

The study areas in West Bengal under Lower Ganga Basin

Farming major source of livelihoods

(91% small farmers)

Pre-dominance of rice farming

(Staple food)

Groundwater based irrigated farming

(84% irrigated land)

Farming characters of the study areas

IRRIGTED RICE FARMING

Arsenic pollution of aquifer

Depletion of groundwater table

Flood irrigation system

(30,000 m^3 water per hectare cultivation)

Highest water consumer

(3000-5000 lit water / kg rice production)

Flood irrigation in rice field

Challenges ahead……

Objectives

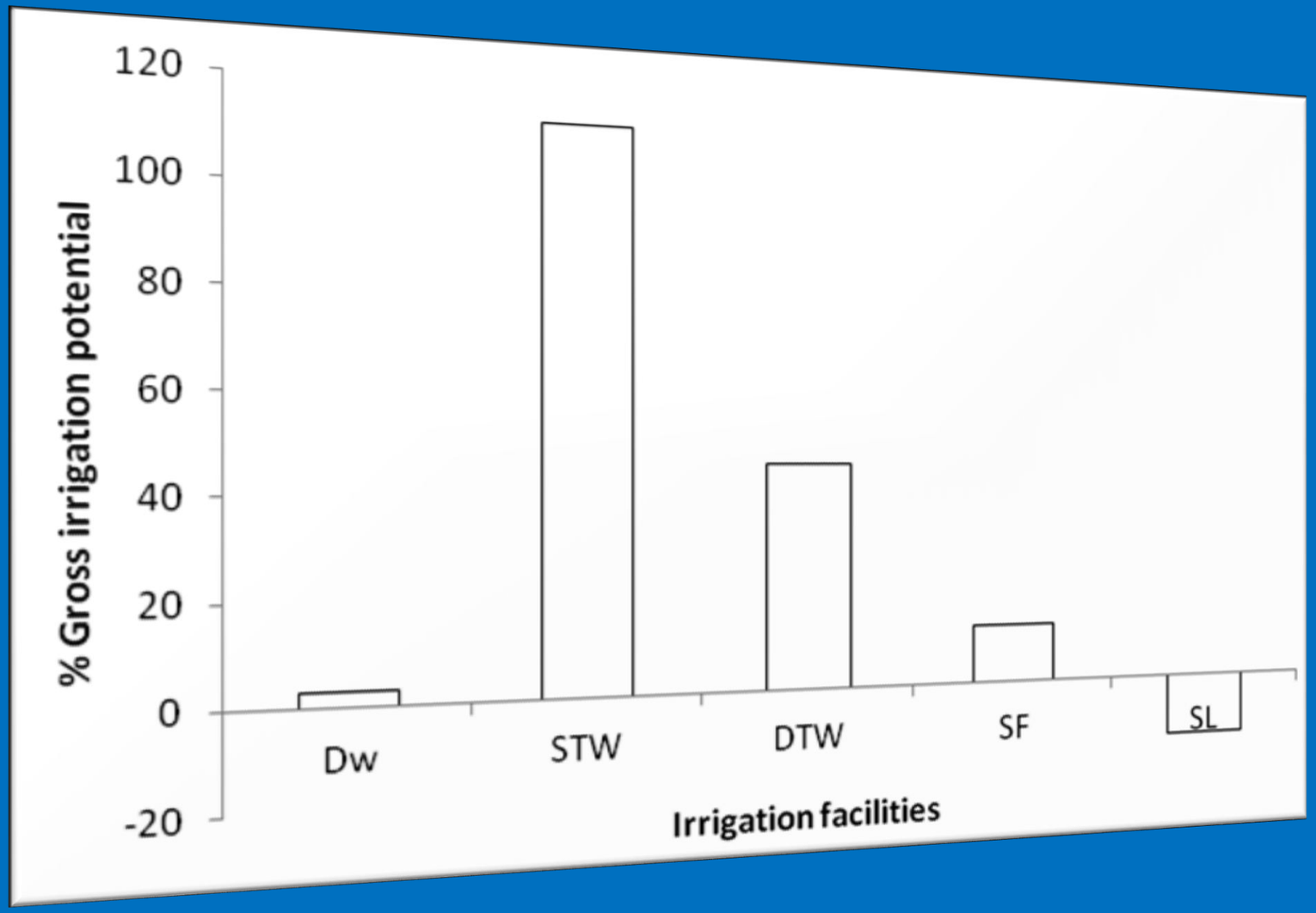
1. **To analyze the trends of groundwater development *vis-a-vis* rice farming**
2. **To study environmental consequences**
3. **To address the issues towards sustainable management of water resources in lower Ganga basin of India**

Methodology

Primary Data Generation		
Field study area	75 Villages from 5 districts of West Bengal	Purposive selection from Lower Ganga Basin
Farm household survey	1500 respondents	Random selection & questionnaire method
Water-table monitoring	45 hydrological points	‘Steel tape and chalk’ method
Arsenic analysis	3000 tube-well drinking water samples	Standard methods (AAS-FIAS 400-HG)
Secondary Data Source		
Government literatures	Minor Irrigation Reports, Central Ground Water Board Reports and Field Crops Statistical Abstracts	Compilation of data

Findings

Development of irrigation facilities during 1986 -2010



- ✓ **80% growth in STW & DTW ground water irrigation**
- ✓ **Declining trends in surface irrigation (SL)**

DW (Dug-well), STW (Shallow tube-well) & DTW (Deep tube-well) are groundwater irrigation sources

SF (Surface flow) & SL (Surface lift) are surface water irrigation sources

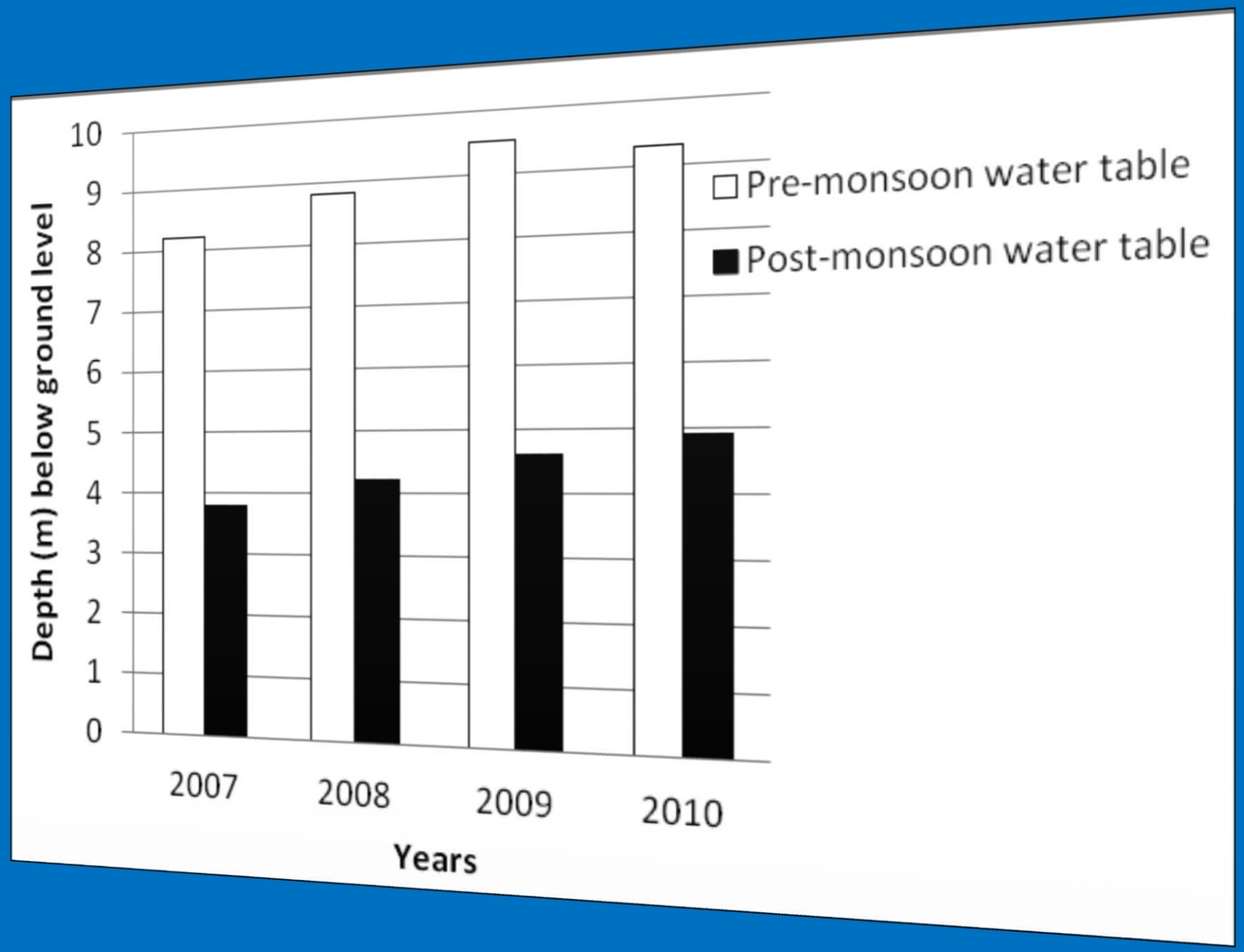
Groundwater irrigation development triggers summer rice cultivation (January to May)

Area expansion rate of summer rice about 300% during last two and half decades

Reduction of cultivated area of other low-water requiring crops, specially wheat and pulse crops

Environmental consequences

Periodical depletion of groundwater table



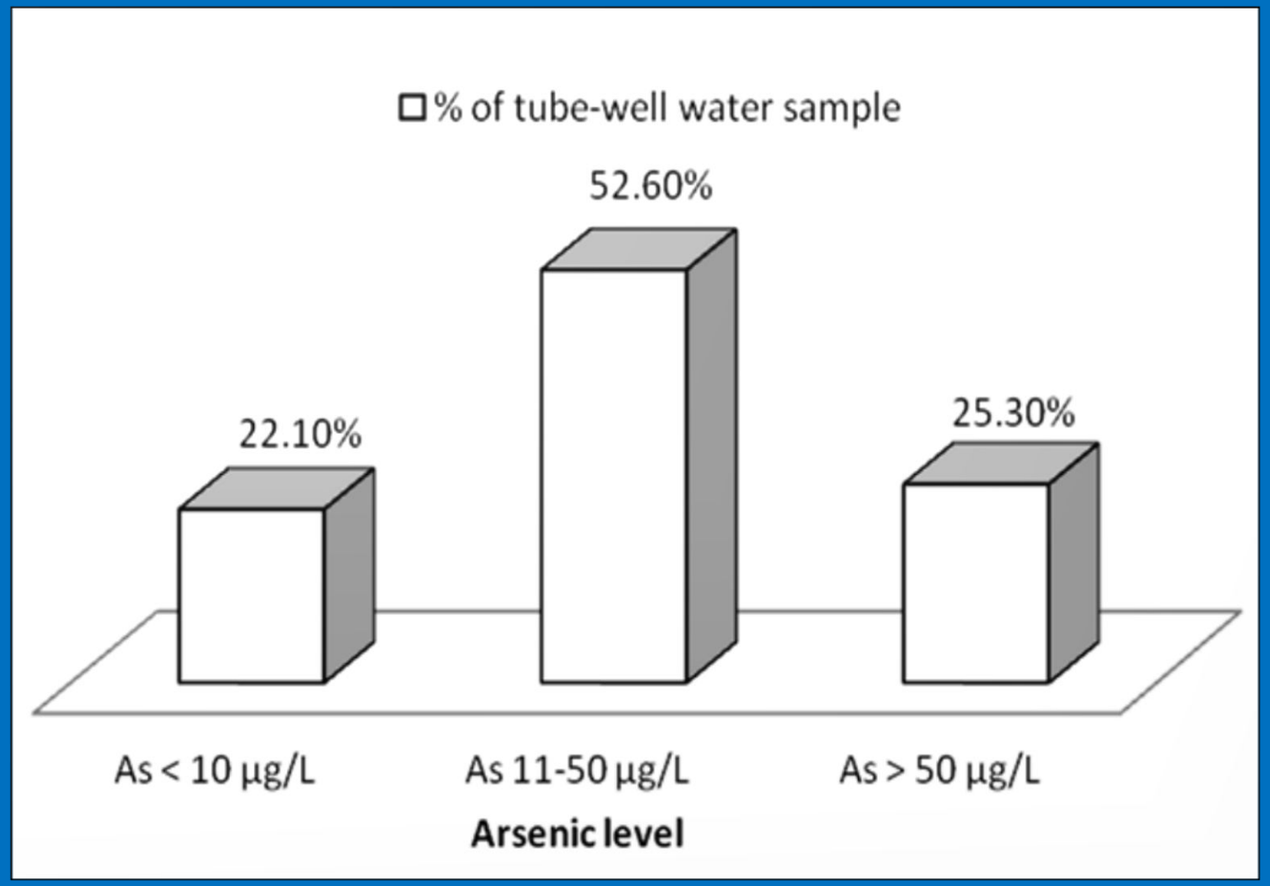
✓ **Water-table is more or less declining due to exhaustive pumping without any efficient recharging system**

*** Pre and post monsoons studies conduct in May and November months respectively**

Effects of groundwater depletion and people awareness

Effects in pre-moon period	Total observations	Number showing the effects	% showing the effects
Difficult to pump hand tube-wells for drinking water	900	576	64
Non-functioning of tube-wells	900	153	17
Shallow tube-wells replaced by deep submersible pumps	350	245	70
Drying up of dug-wells	80	25	31
People aware of environmental consequences	1500	270	18

Arsenic contamination in groundwater



- ✓ **Exhaustive pumping of groundwater for summer rice cultivation aggravates arsenic pollution in the basin region**
- ✓ **11 blocks out of 15 surveyed are exposed to arsenic toxicity beyond WHO permissible limit for drinking water 10µg/L**
- ✓ **53% of tube-well drinking water contains arsenic above 10 µg/L and 25% above 50 µg/L**

- ❑ **3000 tube-wells drinking water samples tested**

Mechanisms of Arsenic contamination in groundwater

Arsenopyrites (Non-toxic form) → **Oxidation** → **Arsenite [As (III)] & Arsenate [As (V) (Toxic forms)** → **Arsenic leached to groundwater**

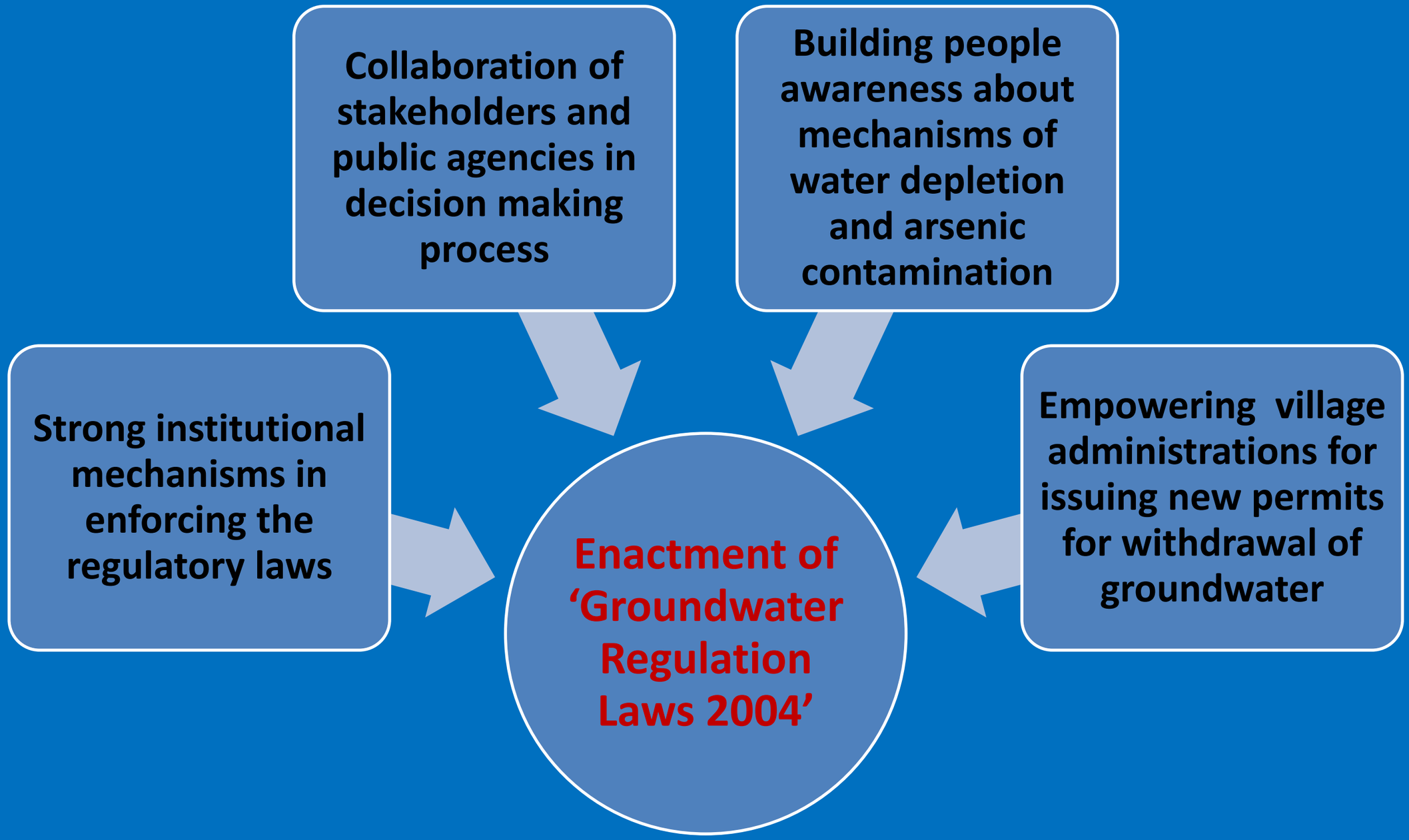
- **Arsenopyrites – a geogenic formation from the underground rocks along the Ganga basin and it is present in soils (aquifer sediments in non-toxic forms)**
- **Excessive pumping of groundwater creats a vacuum by lowering water-table and causes entering of atmospheric oxygen into the underground aquifers**
- **Then oxidation of arsenopyrites to form toxic arsenite and arsenate , which are water soluble and leaching to groundwater**
- **Arsenite is more toxic than arsenate**

Symptoms of chronic arsenic poisoning

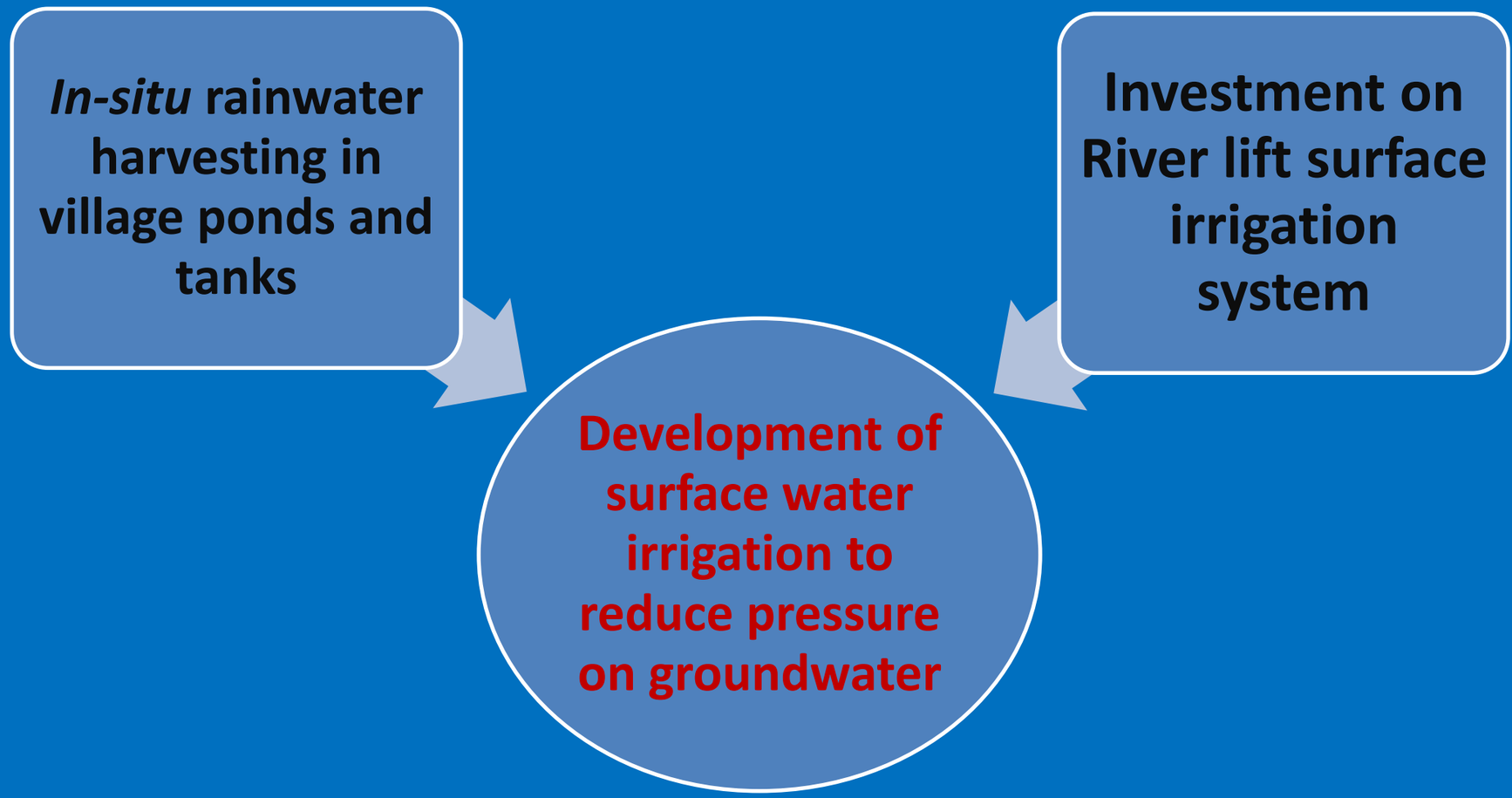
Arsenicosis (Skin lesions and cancers)

Resources management for sustainability

Supply-side management strategies:



Supply-side management strategies:



Demand side management strategies

- Grow rice with less water
  - Adoption of water-saving SRI rice technology through training and incentives of farmers
  - Research on aerobic rice cultivation
- Switching over to low water requiring cropping pattern
  - Promote wheat, pulses and oilseeds crops by replacing summer rice

Conclusions

Considering the deleterious effects of groundwater based rice farming on environment of the river basin, the study calls for a paradigm shift in policy from further groundwater development to sustainable water resources management. The sustainability of water resources of the region will largely remain a function of the working of this integrated supply and demand side management regimes.

Thank you