Quality of groundwater

ACWADAM
Plot no.4, Lenyadri Co-op Hsg. Society, Sus Road, Pashan
Pune
Phone:020-25871539
Email: acwadam@vsnl.net

Water quality

- Safe drinking water is a right of every human being.
- According to UN, safe means water with adequate **Quality, Quantity, Continuity, Coverage and Cost.**
- In India, priority list will be **availability**, **quantity**, **feasibility** and then **quality.**

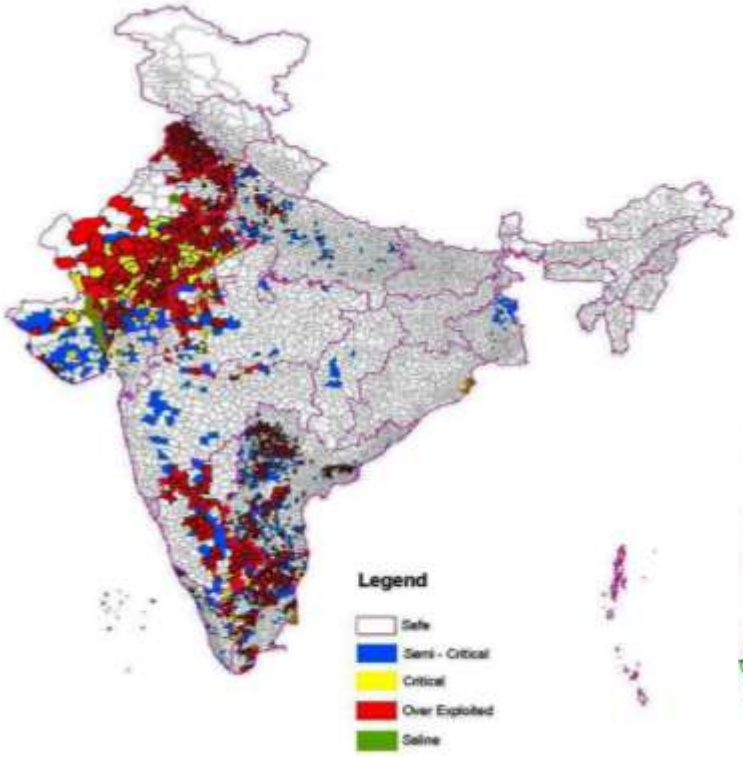
Groundwater is the largest source of accessible freshwater

ACWADAM

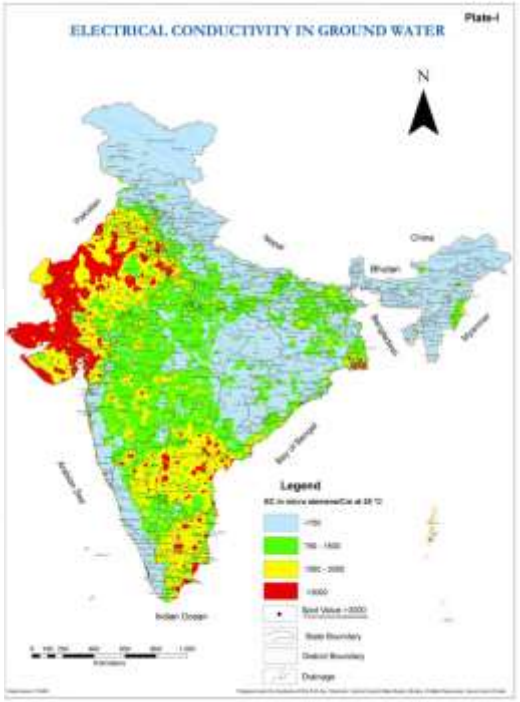
Importance of quality in groundwater

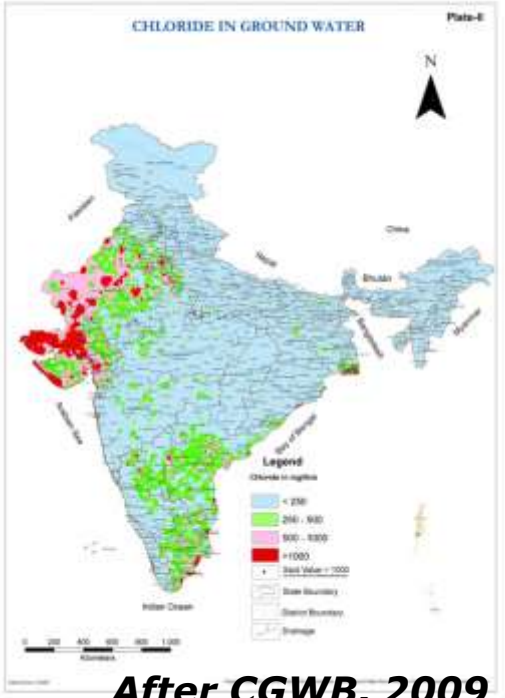
- 90% of the rural water supply is sourced from groundwater.
- More than 45% of urban water supply is dependent on GW.
- Development of groundwater has affected the quality of GW.
- Statutory obligation to maintain quality in many countries & some states of India

GW quality is seriously affected by many industries

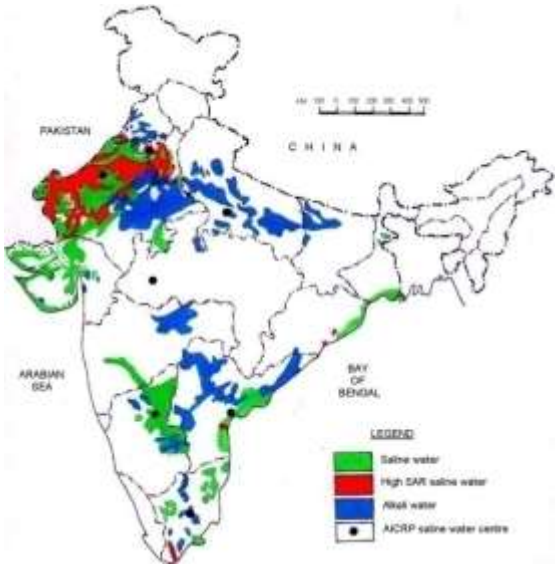


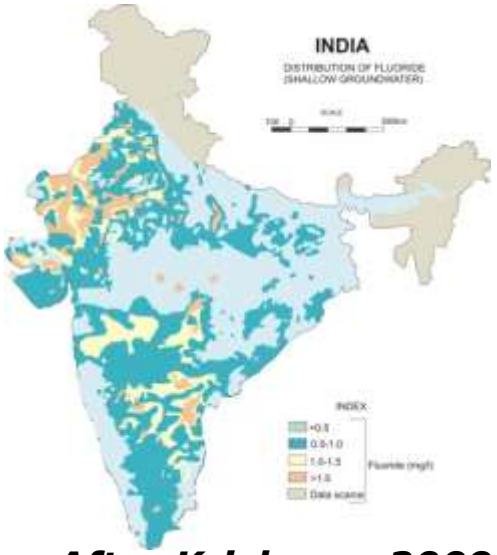
Overexploited blocks of India





After CGWB, 2009



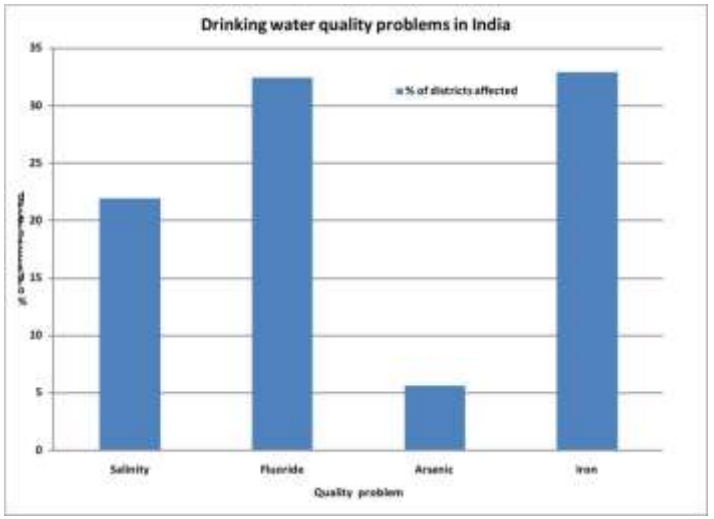


After Krishnan, 2009

Water quality indicators

- 37.7 million Indians are affected by Water bourn diseases every year.
- 1.5 million children are estimated to die of diarrhea alone.
- 66 million Indians are at risk due to higher amount of Fluoride in drinking water.
- 10 million Indians are at risk due to higher amount of Arsenic in groundwater.

Source: Water Aid, India



Out of 593 surveyed districts of India, more than 35% districts have problems like high F, As, Ni, Fe etc. (*DDWS, 2009*)

ACWADAM

Physical and chemical properties of water

Physical & chemical properties of water

- Universal solvent
- High specific heat
- High surface tension
- Neutral pH
- Total dissolved solids
- Hardness

Groundwater origin and evolution

Groundwater origin

- Rainfall and infiltration
- Chemical composition of water changes after interaction with rock
- GW quality can vary from one rock type to another
- Time for chemical interaction between rock and groundwater

inorganic constituents are found dissolved in water:

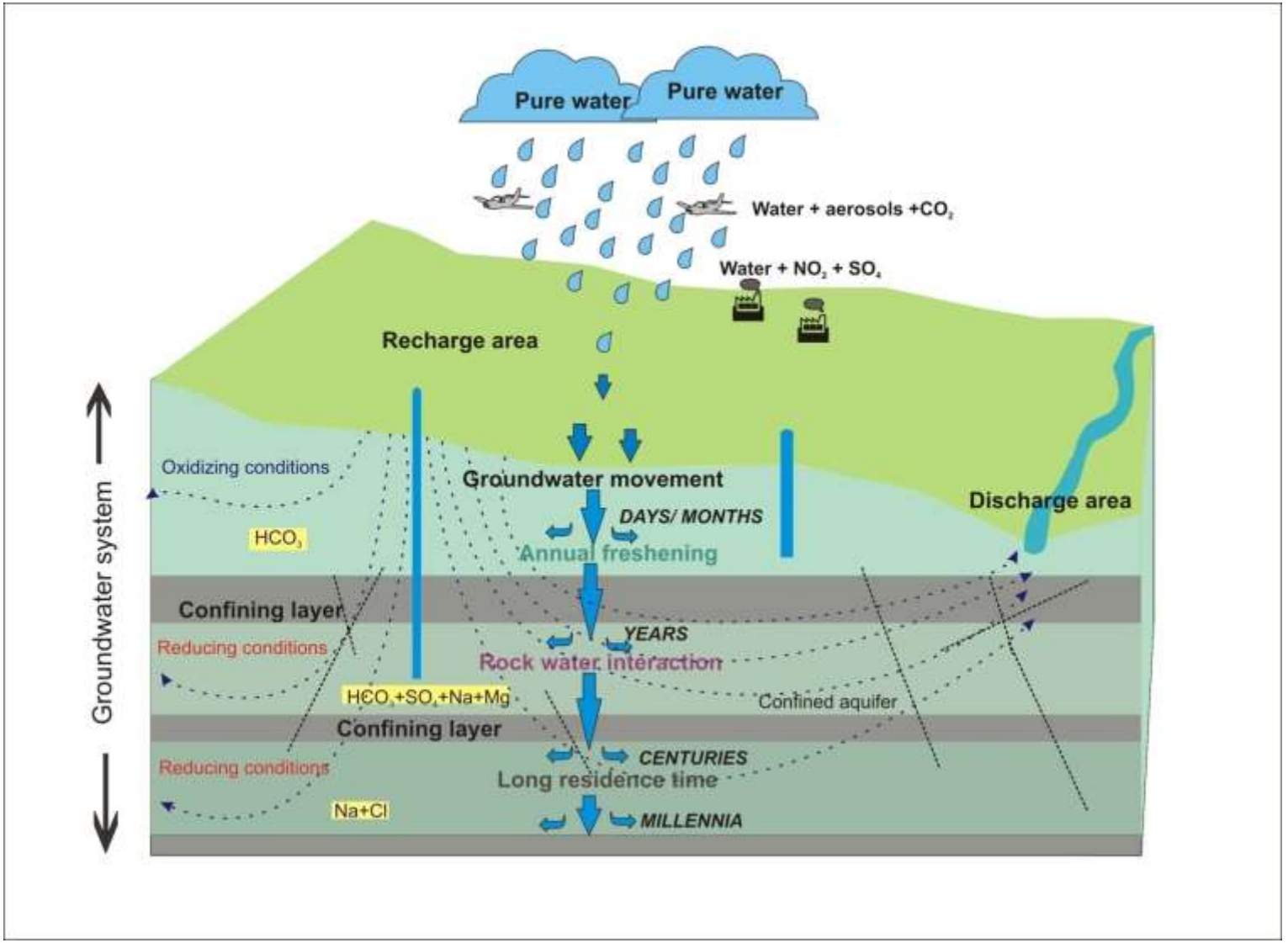
Major constituents (5mg>): bicarbonate, silicon, Ca, Na,Cl, SO_4,Mg

Minor constituents(0.01-0.1mg): Boron, Ni, Cobalt, K, F, Fe and Strontium

Trace constituents (0.01mg<): Alumunium, Cadmium, Lead, Cerium etc.

ACWADAM

Movement of water from the atmosphere to great depths…



Anion change: $HCO_3 \rightarrow SO_4 \rightarrow Cl$

Cation change: Ca → Mg → Na

Factors affecting quality

Amount of chemical interaction may vary in different areas

Temperate-humid area: aquifer is low in overall chemical content.

Arid and semiarid area: high level of natural mineralization

Desert areas: maximum salinity

Rock origin may affect the level of mineralisation

Igneous rock has less dissolved material than sedimentary rocks.

Less mineralization in igneous and metamorphic than in sedimentary

ACWADAM

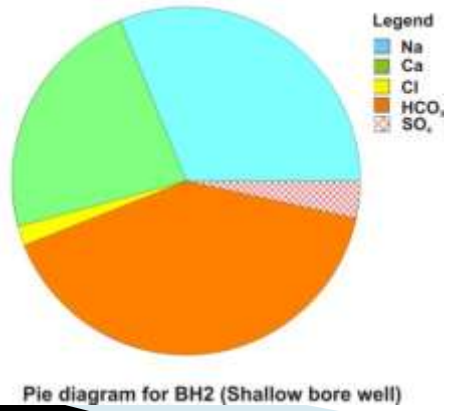
Temperature and depth affect groundwater quality

- The temperature gradually increases with the depth
- An increase in water temperature increases the solubility of most minerals
- The water found in greater depths is more mineralised
- So, the TDS (total dissolved solids = salinity) of the deep groundwater is sometimes more than 10000 mg/l

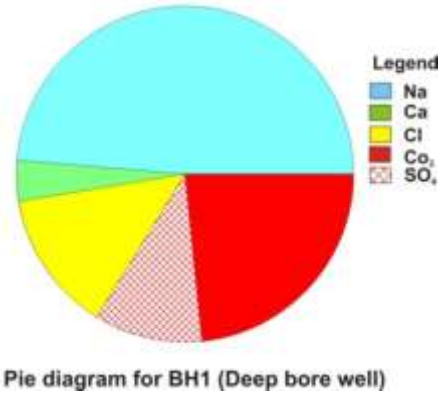
Shallow and deep groundwater

Properties	Unconfined aquifer	Confined aquifer
Recharge	Usually immediate recharge	Receives late recharge due to more travel time for water
Mineralization	Less mineralized	More mineralized
Water type	HCO_3 type	CO3-SO4-Cl-Na-Mg type
Dissolved solids	Low TDS	High TDS
Contaminants	More biological contamination	More chemical contamination

Chemical composition



Pie diagram for BH2 (Shallow bore well)



Pie diagram for BH1 (Deep bore well)

Groundwater quality problems

Why groundwater quality deteriorates?

- Contamination due to naturally existing sources in rocks that host GW.
- Ex: Arsenic, Fe
- **Geogenic sources**

- Contamination as a consequence of human activities.
- Ex: Nitrate, Phosphates, Bacterial contamination
- **Anthropogenic sources**

Fluoride

Salinity

Problem of excessive fluoride

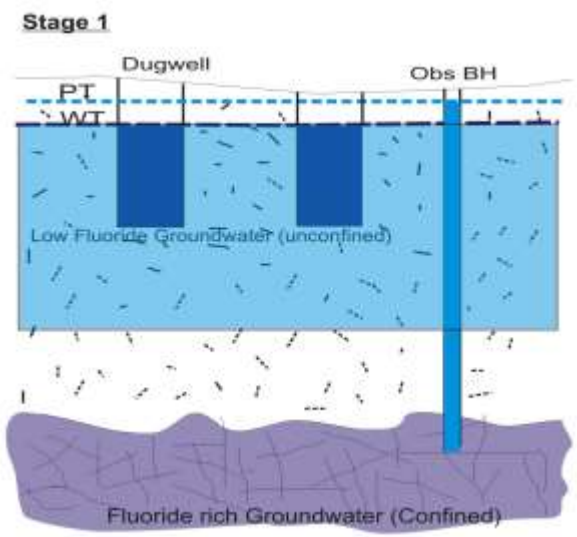
- Essential for human health.
- Excess or deficient intake may cause problems.
- Fluoride problems dominant in arid (low recharge) areas.
- Problems related to Fluoride are not life threatening but affect quality of life and livelihoods.

Fluoride concentration	Health impaacts
<1 mg/l	Safe
About 1.5 mg/l	Dental fluorosis
About 4mg/l	Skeletal fluorosis
Above 10 mg/l	Crippling fluorosis

Defluoridation processes: Artificial recharge, RWH, Adsorption method,RO filter etc.

Diet rich in Protein, Ca, Mg & vitamin C

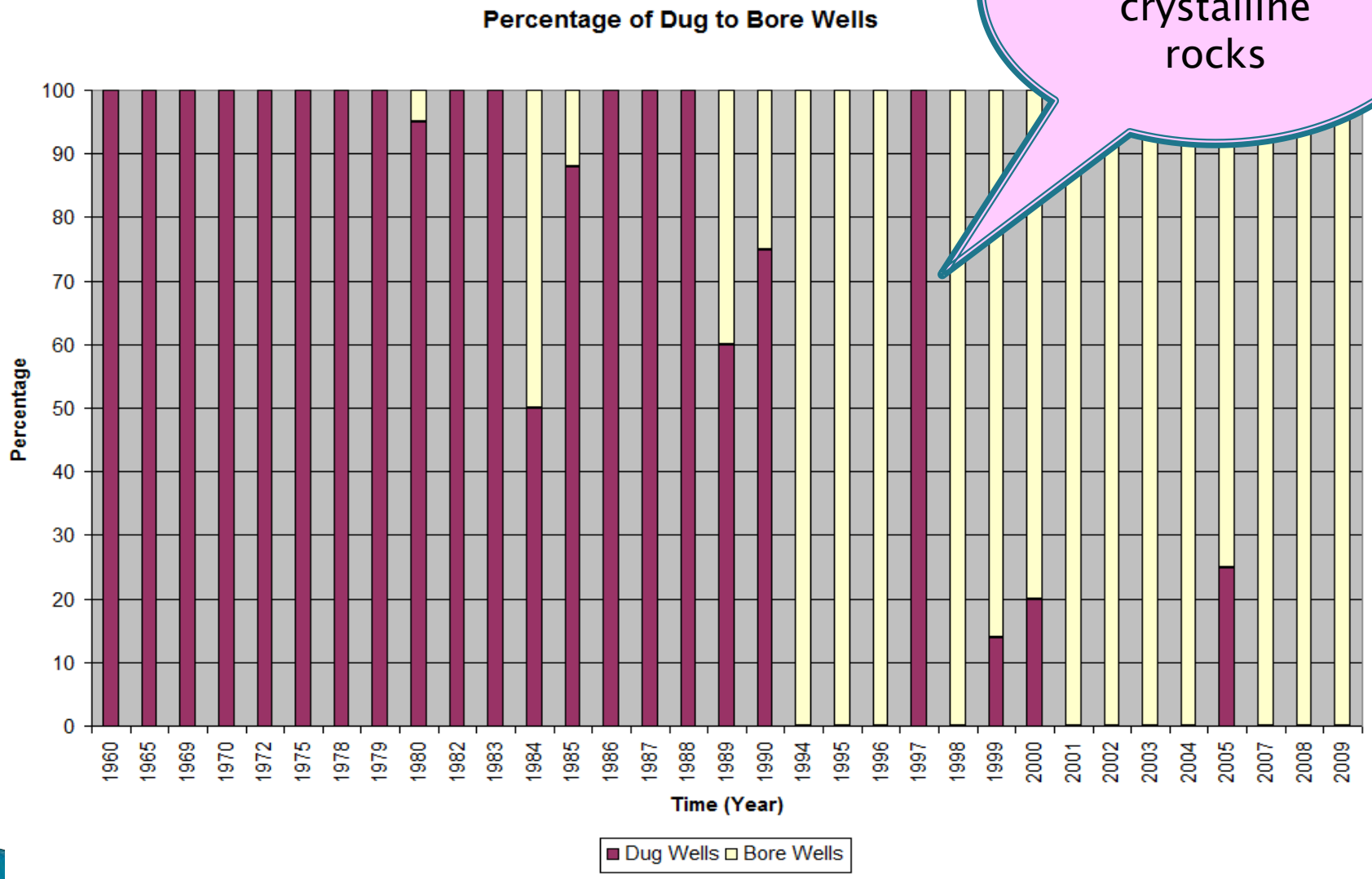
ACWADAM



: the fluoride
s not simply a
of fluoride
ing rocks…

Fig. 11: History of Fluoride Mobilization in the Study Area

The classical "well-story" in crystalline rocks

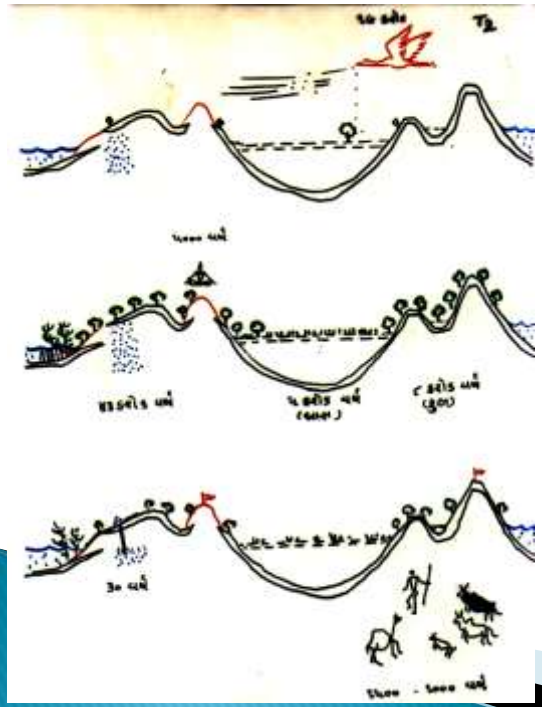


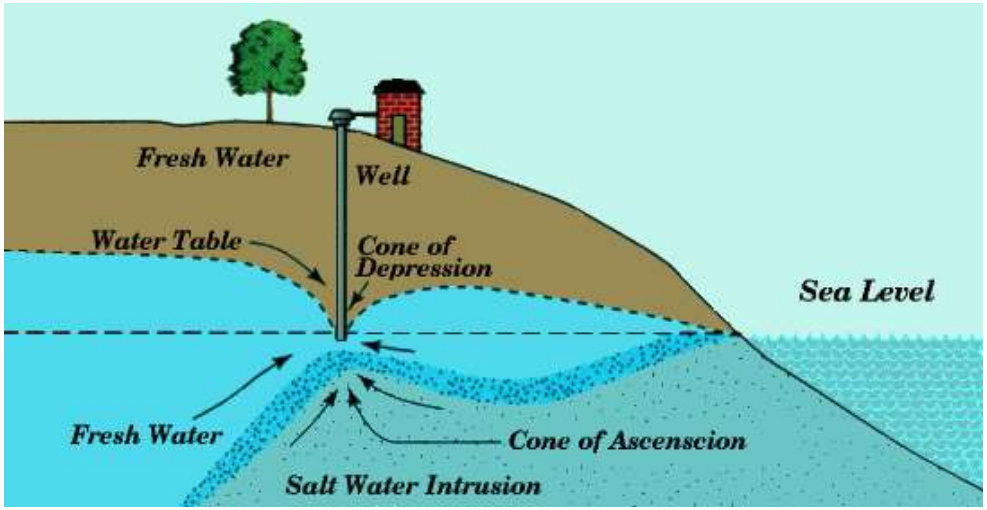
Kaushal (2010), WASSAN (2010)

Problem related to Salinity

Inherent salinity

- Due to saline formations like Katchch area of Gujarat





Human interventions

Due to overexploitation of groundwater in the coastal areas

Problem of excessive Arsenic

- Major areas affected by Arsenic are Parts of W.Bengal, Bihar and Zharkhand.
- The source of Arsenic is geological
- GW more susceptible than surface water
- Arsenic is recognized as a toxin and carcinogen.

After School of Environmental Studies, Kolkata

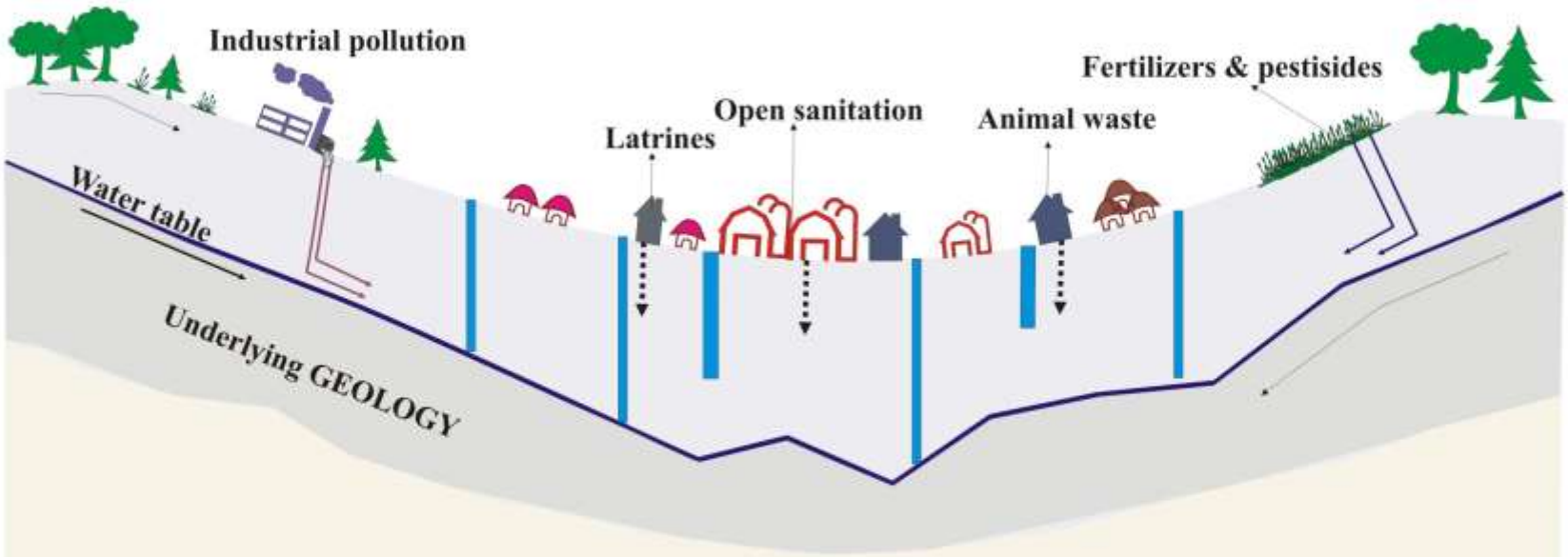
More than 3000 villages in India are affected by problem of excessive As in GW

Problem of other excessive chemical components

Chemical component	Effects
Iron	Unpleasant taste. Leaves stains , may cause Homochromatosis
Nitrate	Harmful to infants, " Blue baby syndrome", Carcinogenic
Heavy metals like Cadmium, lead, nickel, Copper etc	Cadmium: high renal toxicity, Lead: neurotoxic for unborn, Nickel; High allergenic

ACWADAM

Groundwater pollution by different means.....



Human activities: Improper sanitation methods. Urban pollution etc.

Aquifer vulnerability: Underlying rock strata, Degree of confinement

Bacterial contamination

Groundwater sampling and analysis

Need to study water quality


Chlorination test


H_2S test

- Groundwater quality can affect people's health.
- It can also cause problems like salinization of lands affecting agriculture.
- Water sampling can help in understanding the properties of water and temporal changes in the quality.
- Sampling can be done in situ or from laboratory.

Field tool kits

- Field tool kits are available for:
  - Chlorine test
  - Bacteriological field kit
  - Turbidity kit
  - Nitrate field kit
  - Fluoride test kit
  - H2S kit
  - 14 parameter field test kit

  - LABORATORY ANALYSIS

INDIAN STANDARD SPECIFICATIONS FOR DRINKING WATER
IS: 10500

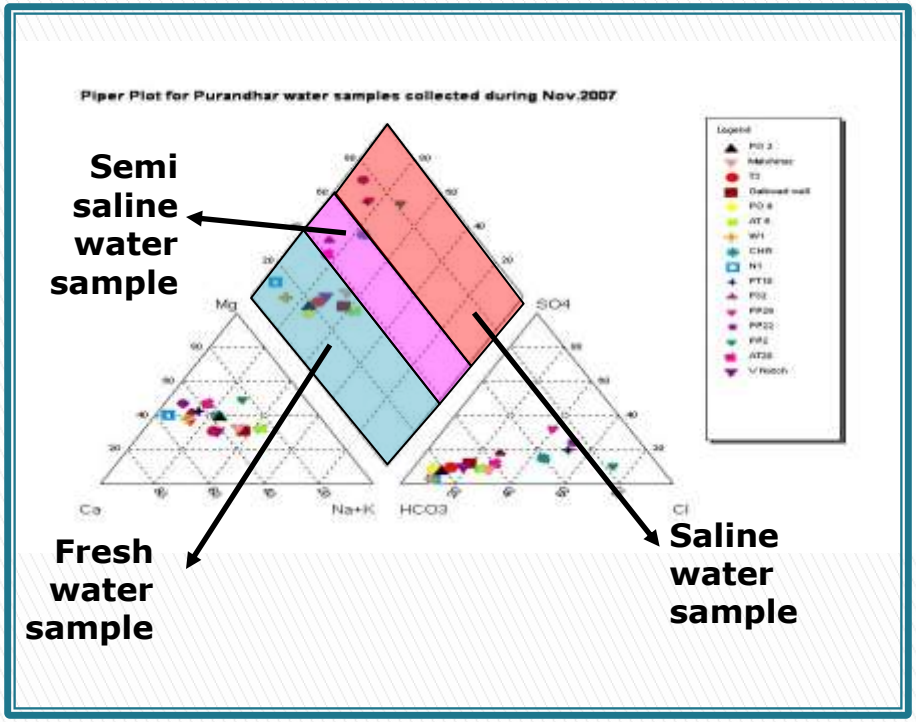
Parameter	Required desirable limit
pH	6.5 to 8.5
TDS	500 ppm or less
Ca	75 mg/l (Can be extended up to 200 mg/l)
Mg	30 mg/l (May be extended up to 100 mg/l)
Cl	250 mg/l
SO4	150 mg/l
NO3	45 mg/l
F	1.5 mg/l
As	0.05 mg/l

Sampling frequency

- The dug well samples can be sampled at east twice a year;
  - Once in summer i.e April-May
  - Once in post monsoon period i.e. Mid November
- For deep bore well samples can be sampled once a year as there is a lesser chance of contamination and mixing.

Sampling & Analysis

The sampling should be done once or twice a year



Anions	Cations
Bicarbonate (HCO3)	Sodium (Na)
Carbonates (CO3)	Potatssium (K)
Chlorides (Cl)	Calcium (Ca)
Fluoride (F)	Magnesium (Mg)
Nitrates (NO3)	Iron (Fe)
Sulphates (SO4)	Mangenese (Mn)
	Arsenic (As)

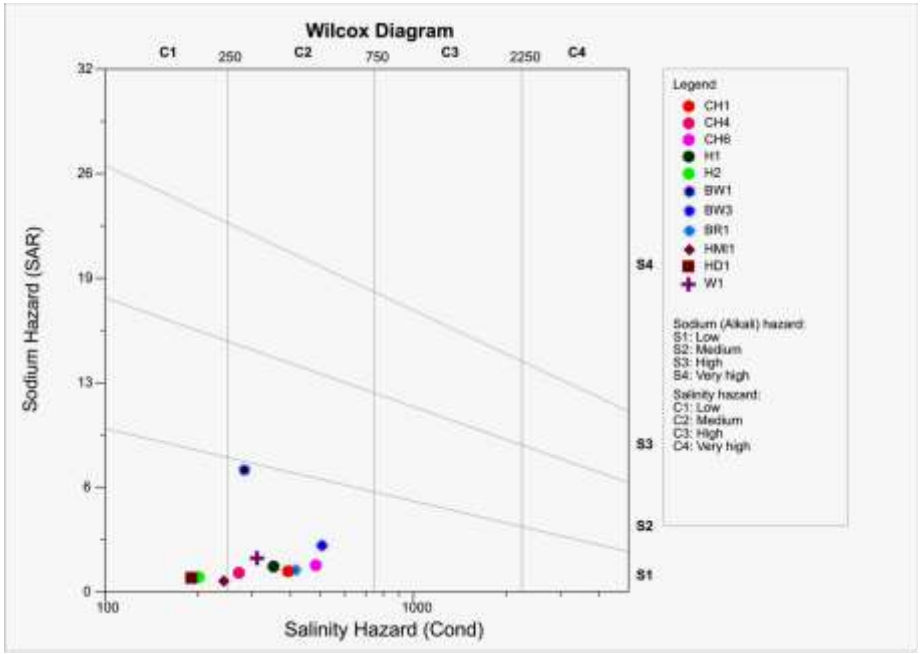
Piper diagram are most commonly used to understand the water type and behaviour spatially and **temporally**.

Cost of chemical sampling is Rs. 2800/- per sample

Groundwater quality and water use

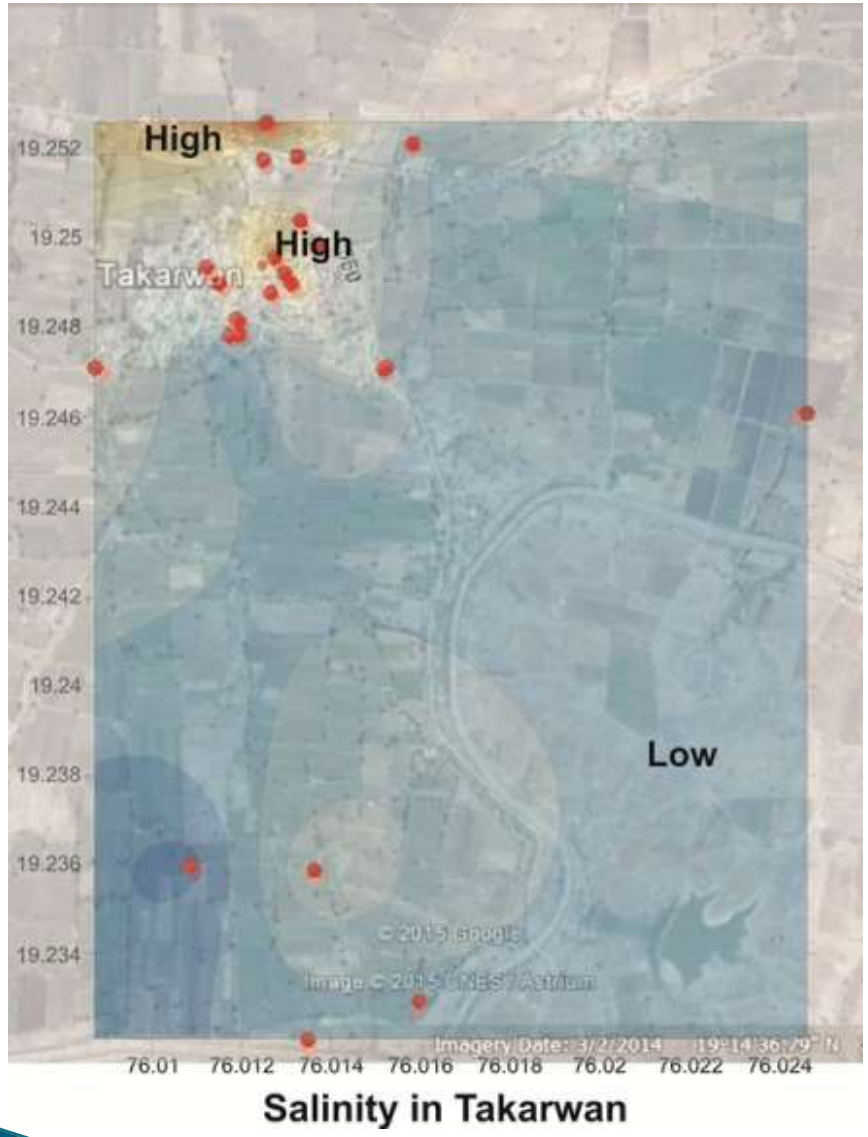
Agriculture

- Use depends on concentration of TDS Specific ions that are toxic for plants and SAR.
- Depends on crops, type, drainability of soil and climate.
- Water using mechanism may be determined by the quality.



Livestock

TDS less than 3000mg/l is suitable for farm animals (except poultry)



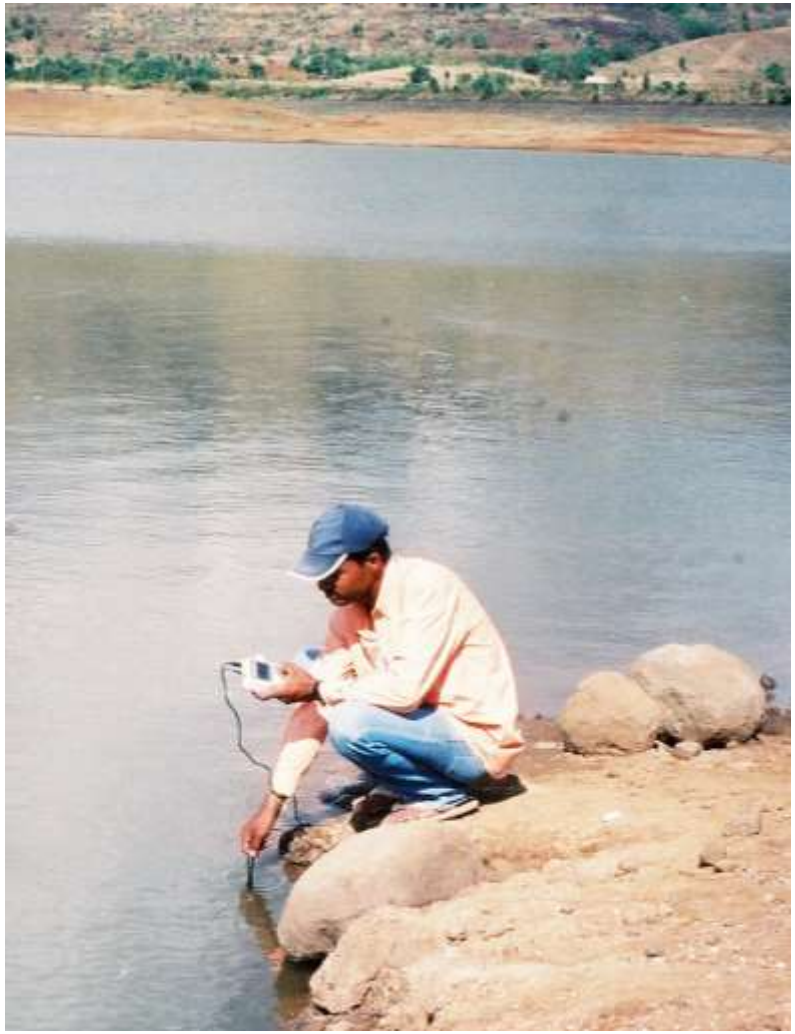
Salinity in Takarwan

To improve water quality:

- Awareness generation and sensitization
- Capacity building of the community
- Monitoring
- Use of alternate methods of water harvesting
- Promotion of traditional methods of water purification .
  - Matka filters
  - Copper/brass vessels

Groundwater quality protection strategy

- Understanding of geology..
- Studying underlying rock strata..
- Chemical and biological analysis of water samples…
- Improved awareness among the citizens about general health and hygiene.
- Groundwater management



Thank you!