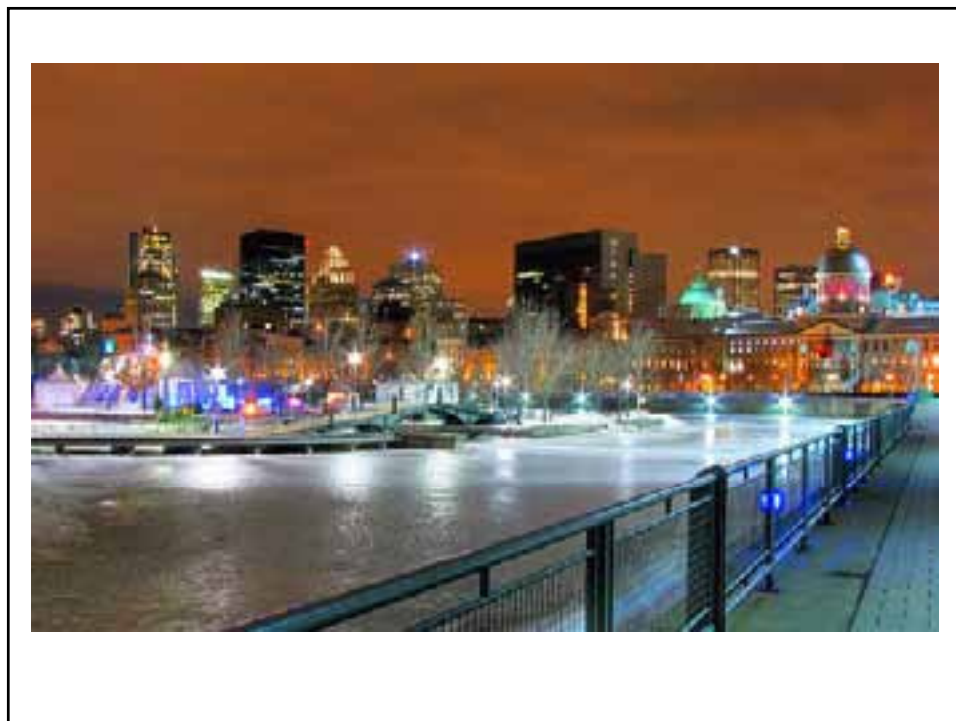




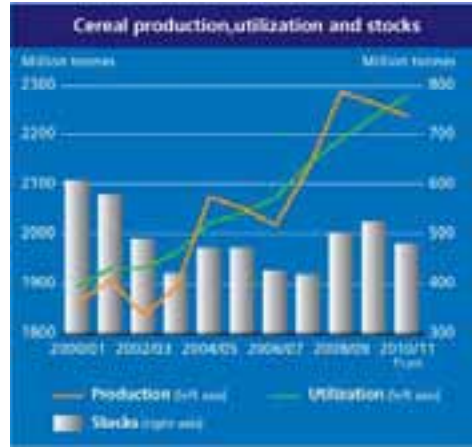
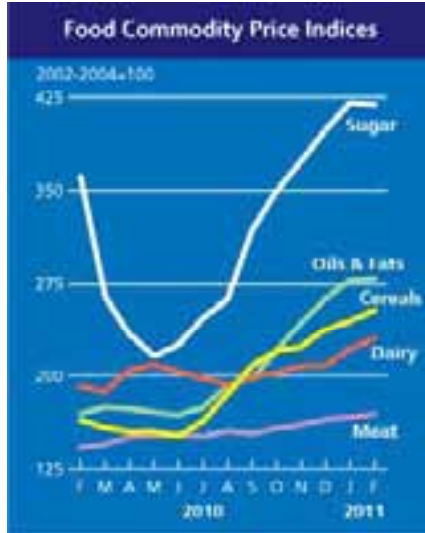
**ICID-CID**

**CANCID CNCID**  
Canadian National Committee on Irrigation and Drainage  
Comité National Canadien de l'Irrigation et du Drainage

**Presentation at New Delhi Associate Centre of WWC  
by  
Professor Dr. Chandra Madramootoo, ing.  
President, ICID**

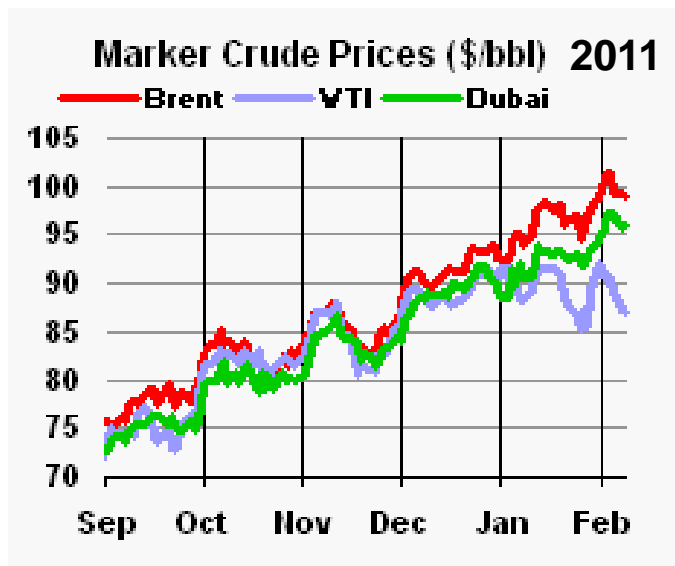


## The On-Going World Food Crisis



(Source: FAO, 2011)

## Linked to rising energy prices



**Linked to political turmoil and instability**



**Linked to increasing water scarcity**



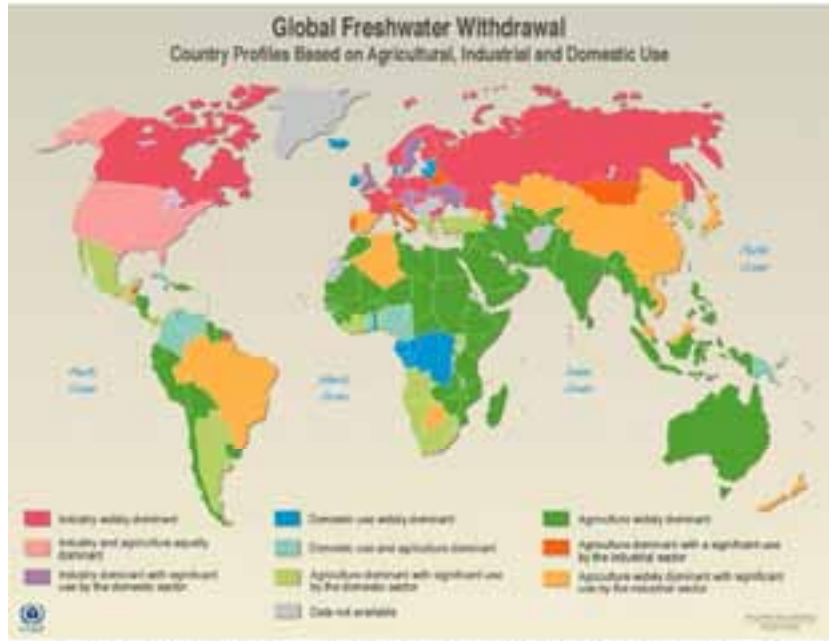
**FOOD PRODUCTION  
NEEDS TO DOUBLE OVER  
THE NEXT 25 YEARS TO  
MEET POPULATION  
DEMANDS**



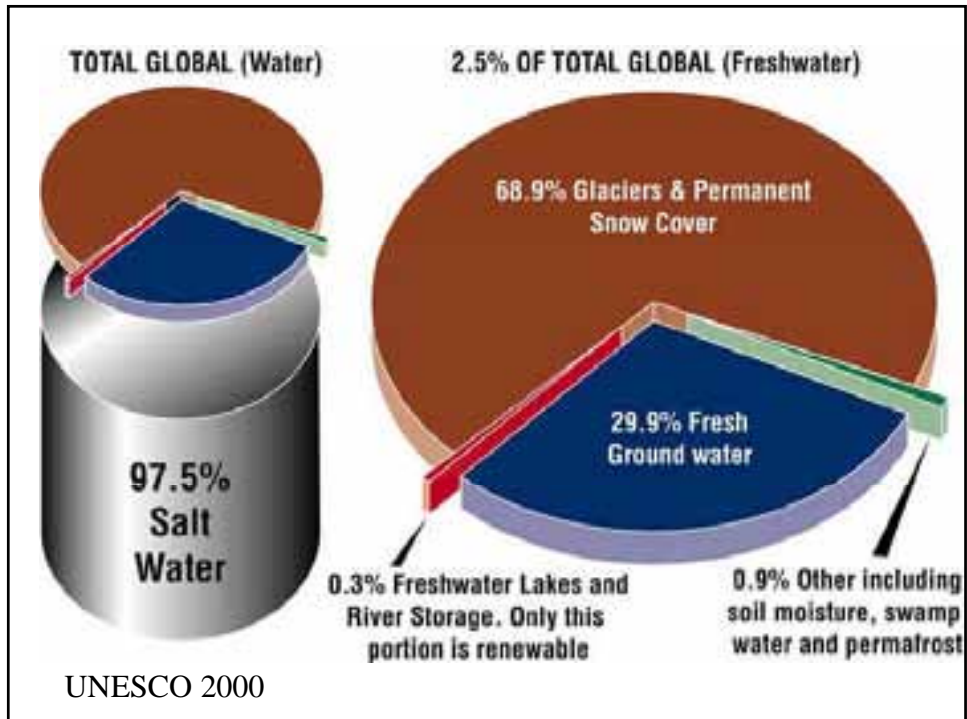
Irrigation will play a major role



10 b



## Role of ground water systems

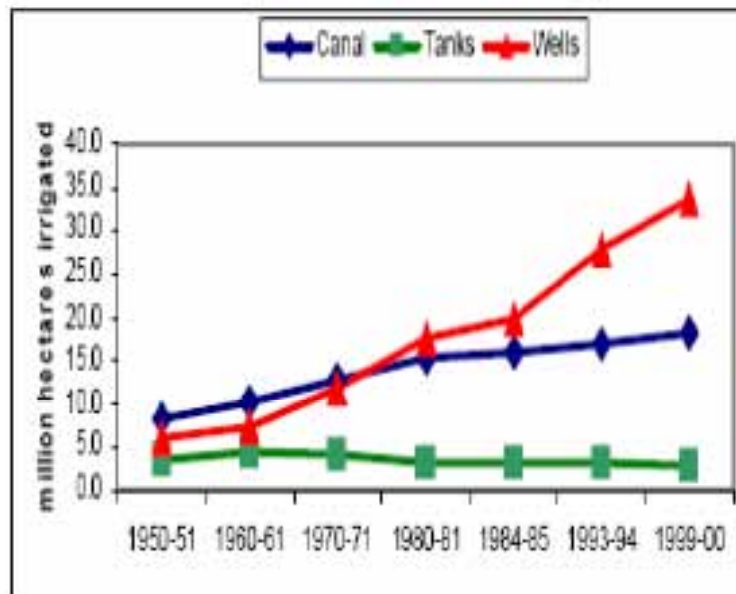


### Ground Water Exploitation

- Has expanded irrigation
- Boosted local food production
- Increased small holder production systems
- Contributed to inadequate management of the resource



### Evolution of irrigation in India (Bhatia, 2005)



- Global irrigated area is approximately 300 Mha
- 38% equipped for groundwater irrigation
- Total irrigation water consumptive use is 1277 km<sup>3</sup>/a
- 43% or 545 km<sup>3</sup>/a is consumptive ground water use

#### Groundwater irrigated areas:

- India – 39 Mha
- China – 19 Mha
- US – 17Mha

Siebert et al., 2010 – Groundwater use for irrigation – a global inventory

Table 1: Contribution of groundwater used for irrigation for countries where data are available (source: FAO Aquastat)

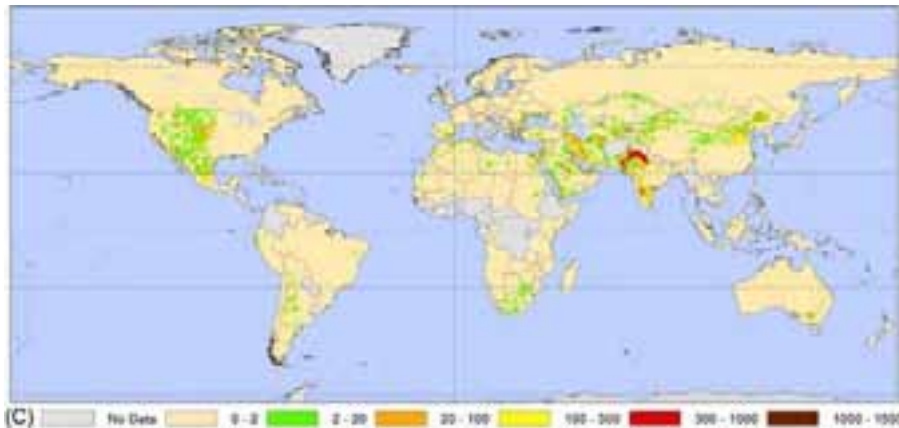
Country	Percent of groundwater as part of water resource used	Total irrigation water use (million m <sup>3</sup> /year)
Saudi Arabia	96	15 310
Bangladesh	89	12 600
Yunna	61	2 730
Jordan	55	748
India	53	460 000
Iran	50	64 988
Pakistan	34	150 600
Morocco	31	10 180
Mexico	27	61 200
China	18	467 600
South Africa	18	9 580
Nepal	12	28 700
Peru	11	16 300
Malaysia	8	9 700
Egypt	4	45 400
Mali	3	1 320
Indonesia	1	68 200

### Ground water irrigation:

- on demand
- individual use and not constrained by institutional management and variability in supply
- user flexibility in irrigation scheduling and water management
- overcomes temporal variability in soil moisture in order to stabilize crop production
- drought proofing in times of climate change

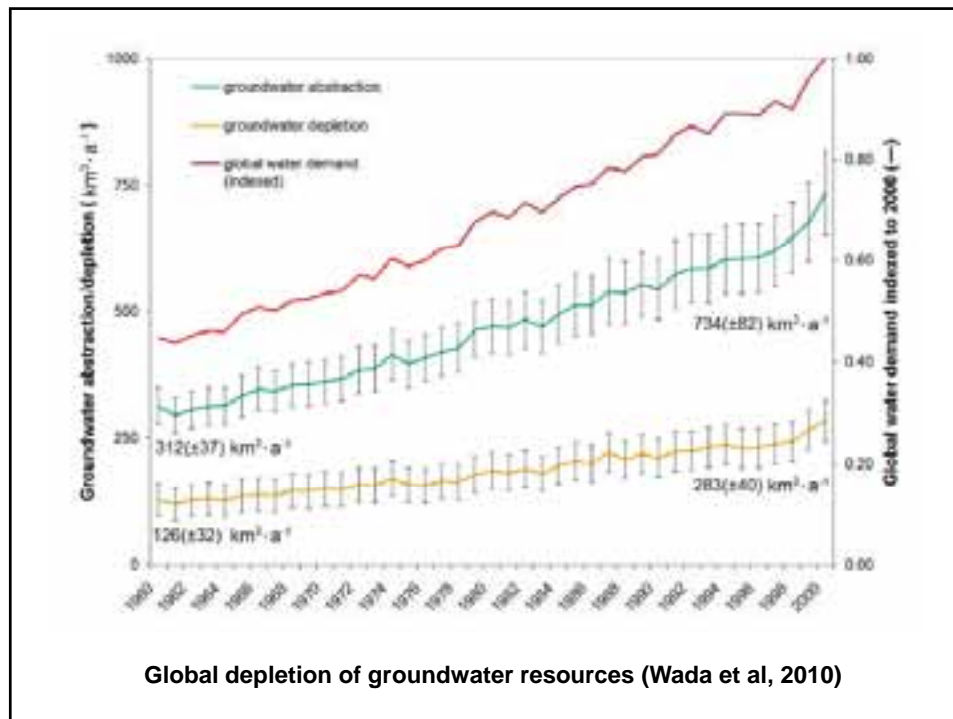
### An invisible and diminishing resource

- when abstraction exceeds recharge
- depletion
- multiple pumping points – difficult to manage without legal framework
- lack of monitoring and permits
- energy costs – used to be cheap/subsidized



Simulated groundwater depletion, mm/a

**Global depletion of groundwater resources (Wada et al, 2010)**

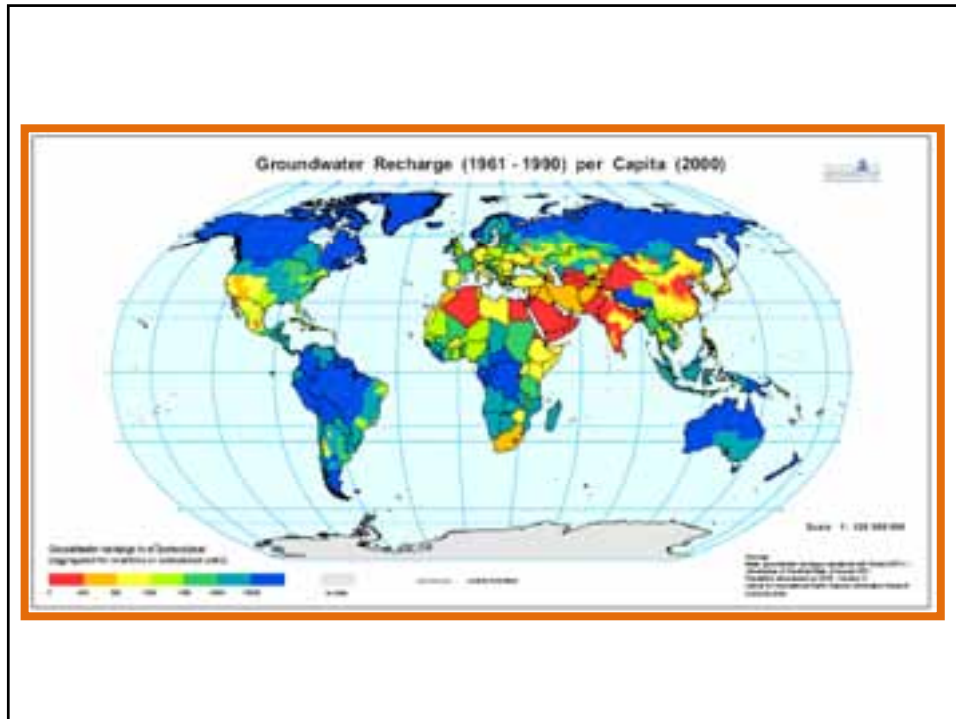


## Groundwater Depletion Raises Likelihood of Global Food Crises

National Geographic Freshwater Initiative  
Sandra Postel  
September, 2010

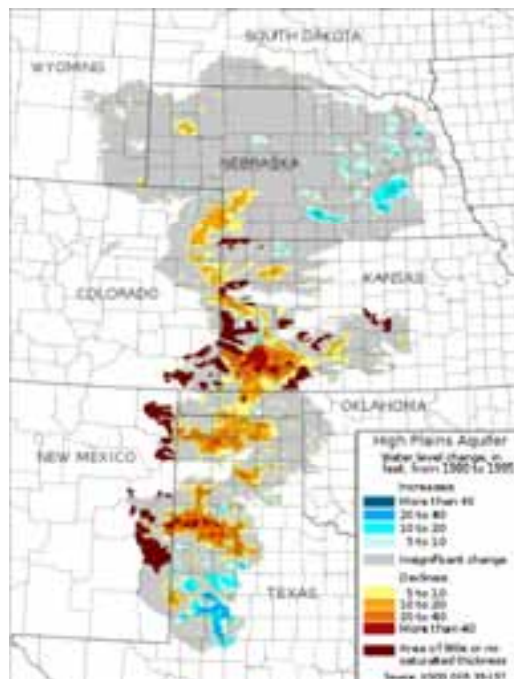
- Water budgets are badly out of balance, throwing many regions into water debt.
- The water depleted annually could feed 940 million people for a year.





**Can we learn lessons from the Ogallala Aquifer project?**

- Monitoring
- Management
- Mitigation

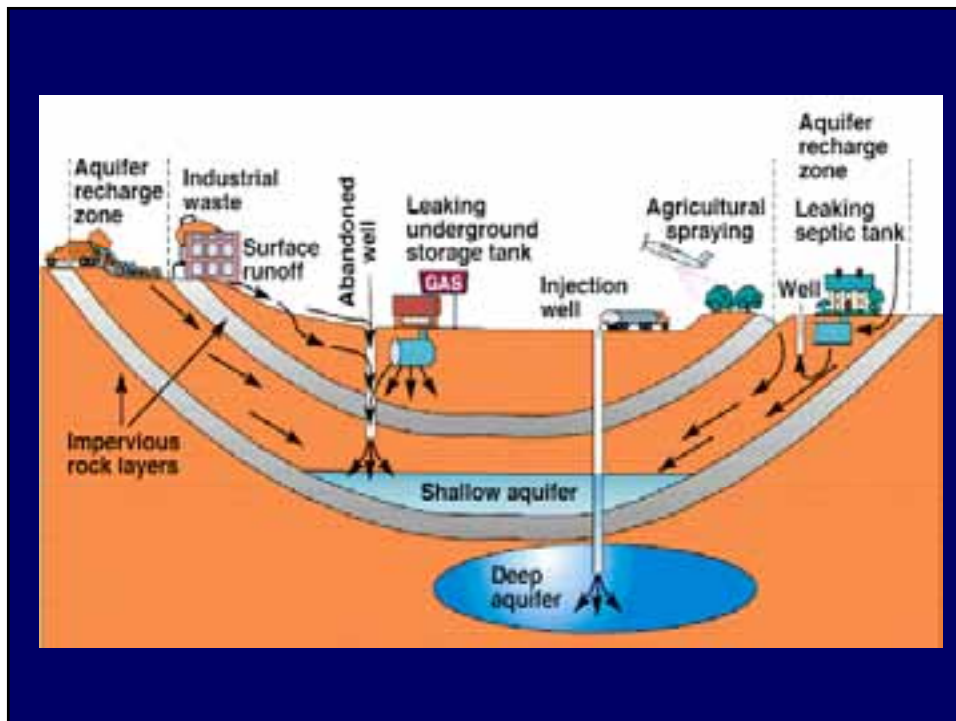
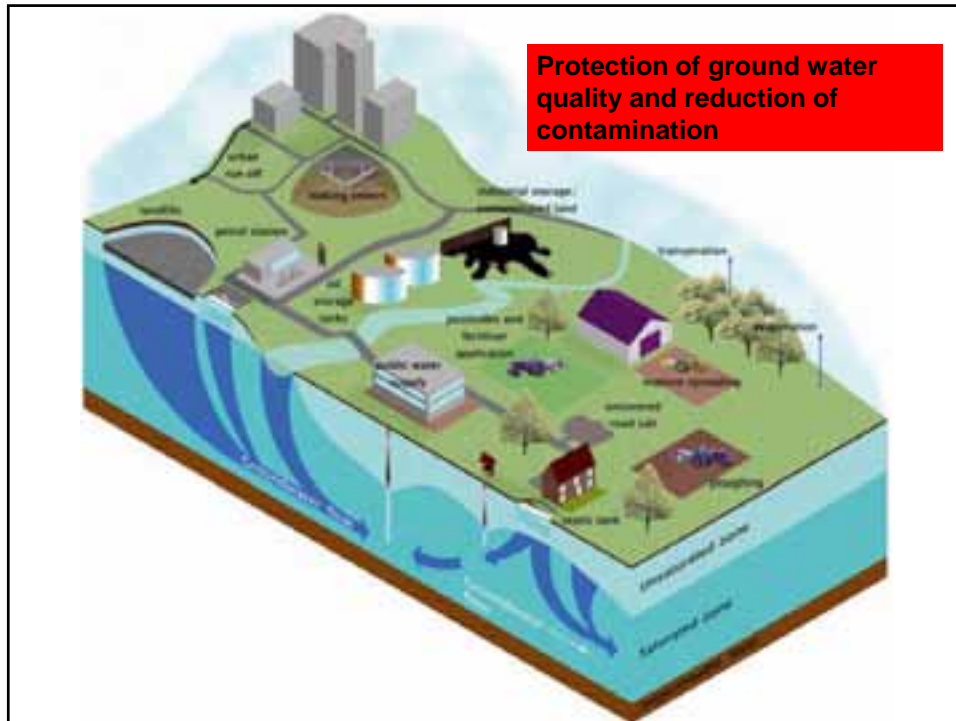


## Ogallala Aquifer

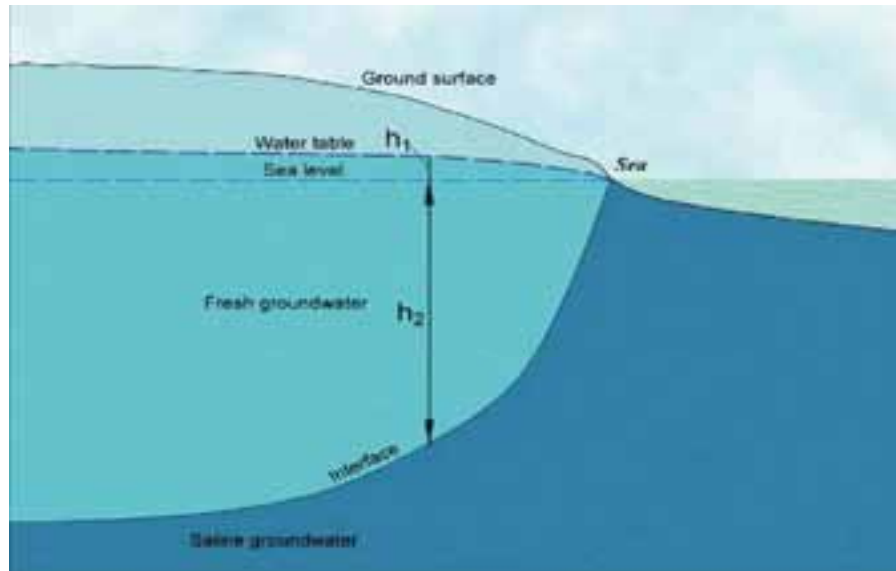
- Covers 450,000 km<sup>2</sup>
- Covers 27% of US irrigated land
- Withdrawals for irrigation - 26 km<sup>3</sup>
- Total withdrawals since development – 312 km<sup>3</sup>
- 9% decline in storage since development



- If spread across the U.S. the aquifer would cover all 50 states with 45 cm of water;
- If drained, it would take more than 6,000 years to refill naturally;
- More than 90% of the water pumped is used to irrigate crops;
- \$20 billion a year in food and fiber depend on the aquifer;



## Over pumping and ground water salinization




## A Highly Complex Interaction Irrigation – Drainage – Groundwater - Salinity

### Box no. 5: Groundwater development in Pakistan

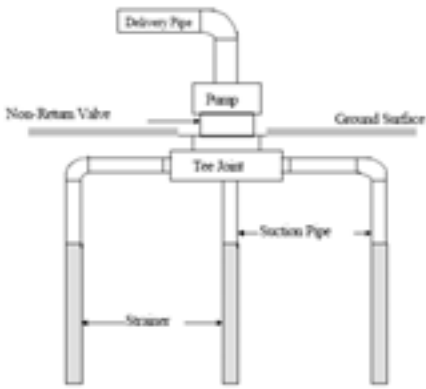
Over the past 30 years, more than 12 500 public deep tubewells were installed in Pakistan with the primary objective to combat waterlogging and associated salinity. Groundwater development through private tubewells has grown exponentially, especially in Punjab. According to the latest estimates, Pakistan has more than 300 000 tubewells.

According to a 1991 survey, about  $46 \times 10^6$  cubic meters of groundwater are used for irrigation in the Indus basin, of which 85 percent comes from private tubewells. Because of groundwater extraction, water tables have declined beyond the range over which salinization can be expected. However, salinity continues to present a threat to the sustainability of irrigated agriculture in Punjab because of recycling of large quantities of poor quality groundwater from the top of underlying aquifers. Farmers reduce the risks of crop failures and improve yields by smoothing operational fluctuations in water supplies from the main canals. According to a 1978 study, average yields of wheat from farmers using canal water only (1.7 tonnes per hectare) were 25 percent lower than those from farmers owning wells (2.2 tonnes per hectare). Rice farmers using wells with yields of 2.2 tonnes per hectare are also doing better compared to those using canal water only.



Complexity of the soil-water-plant environment

## Skimming well technologies – Pakistan



### Establishing a Framework for Groundwater Management and Protection

- Protection of ecosystem viability
- Proper governance systems to reduce depletion and pollution
- Establish institutional, monitoring, permitting and pricing mechanisms
- Assessment of the resource
- Enhancing recharge
- Use of surface water control systems to replenish ground water
- Sustainable management to achieve economic and social well being

## Impact of rising energy prices A Ground Water Conservation Benefit?



McGill Institute for  
Global Food Security

Institut pour la sécurité  
alimentaire mondiale  
de McGill



Thank you