

Climate Change Adaptation with GROUNDWATER

Development Issues with a Focus on Asia

Karen G. Villholth

Groundwater Specialist

GEUS, Geological Survey
of Denmark and Greenland
Copenhagen, Denmark



Holland Water House side events:
Groundwater – Key to Adaptation

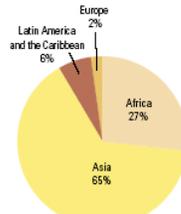
UN Climate Change Conference, Copenhagen, Denmark, Dec. 10, 2009



Water is the victim of climate change & extremes

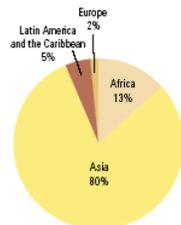


Water supply:



Total unserved: 1.1 billion

Sanitation:



Total unserved: 2.4 billion

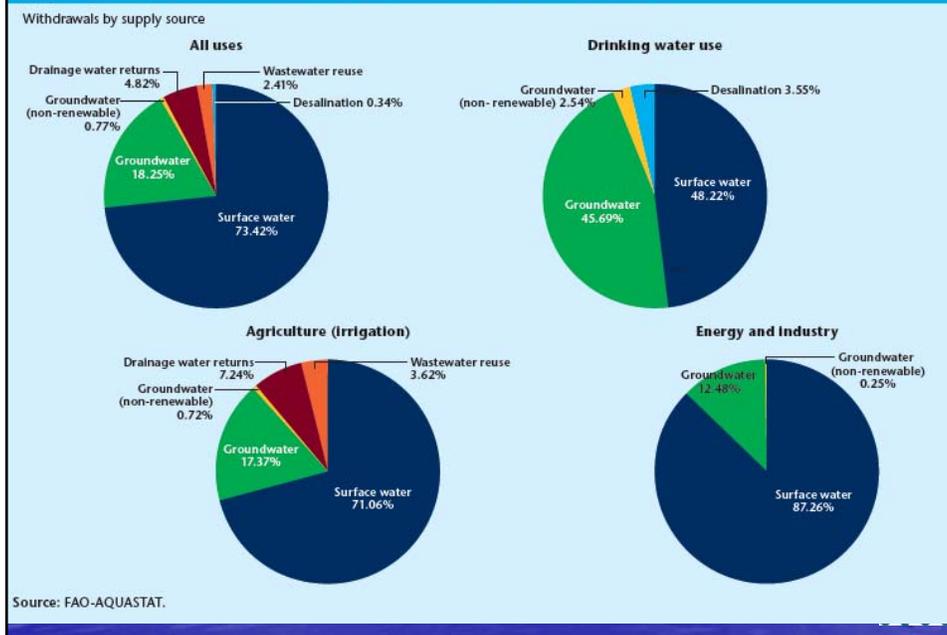
3 mill. humans (mostly children) die every year from water related diseases



GW is water underground



Figure 7.1 Sources of water use globally and for major sectors, 2000

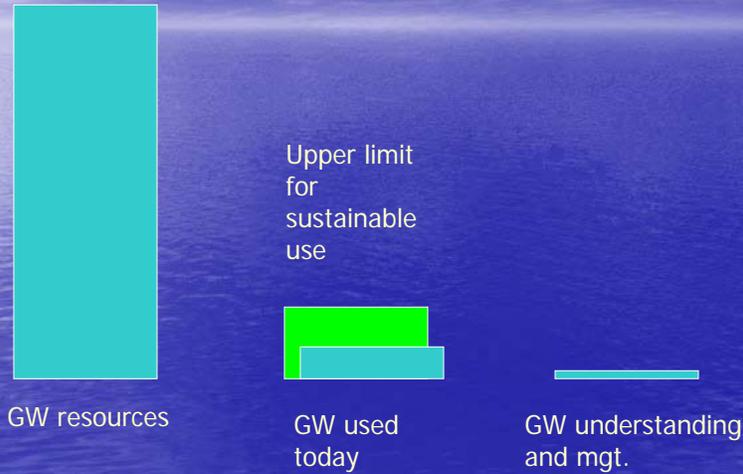


Global figures for GW use

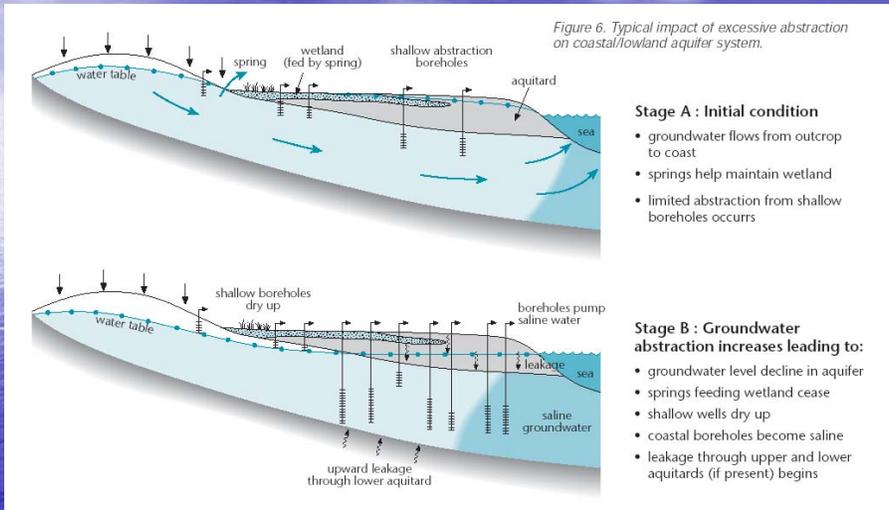
- Total annual GW abstraction: 1000 km³
 - ❖ ~ 20% of global water abstraction
 - ❖ ~ 8% of renewable GW reserves
 - ❖ ~ 0.0001% of global GW reserves



Groundwater use



Groundwater not inexhaustible



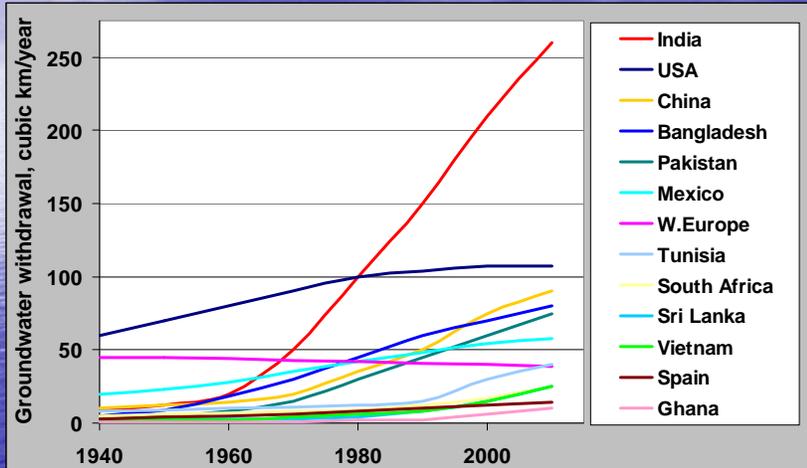
GW provides potable water to 45% of the global population



GW is often the only alternative for water supply in arid and semi-arid areas



Groundwater development is on the rise



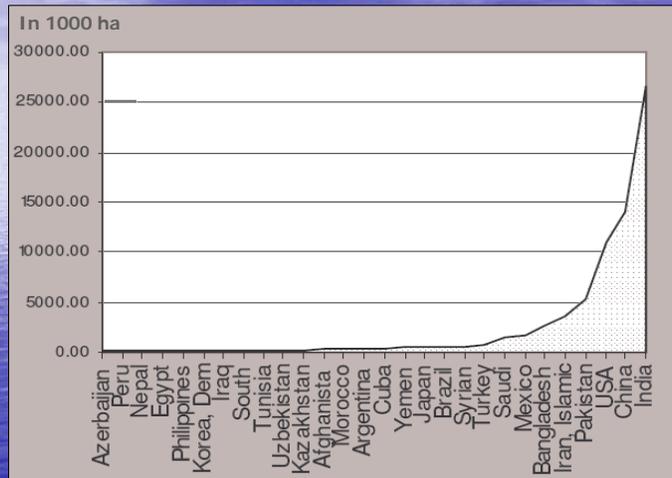
Ref: Shah, 2004



The majority of groundwater is used in agriculture, ~ 70 %



Groundwater irrigated area



Ref:
FAO Aquastat
2003 and other
sources



40 % of global food production is produced by groundwater irrigation



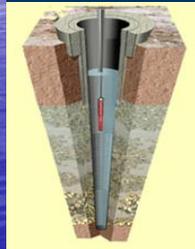
In India, China, Bangladesh and Pakistan
one billion people depend on GW for
agriculture



Development of technology



From the dug well to
the deep borehole



From the waterwheel to the
submersible pump



From the water witches to
hydrogeology



Groundwater as a strategic resource

- MDGs: *Water supply*

g15



Food production



- Drought proofing, climate change adaptation



GW for agriculture, Africa

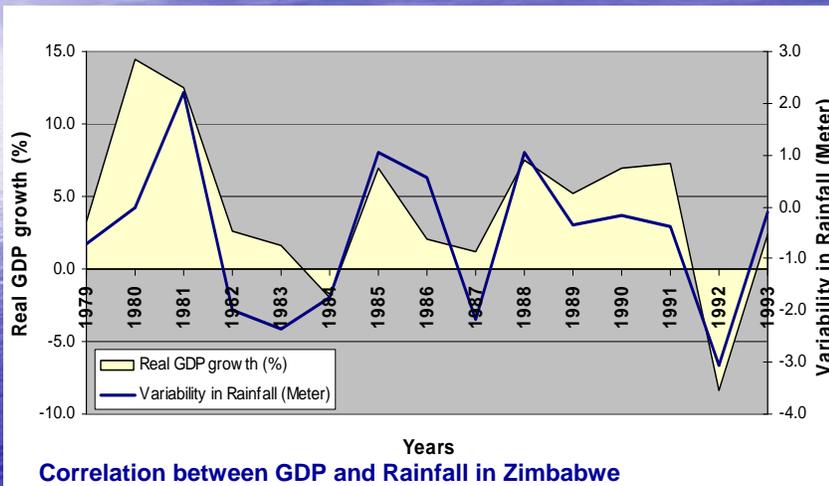
- Not developed significantly
- <5% of cropland in Africa is irrigated, comp. to one third in Asia



Slide 17

g15 It is a matter of access, more than availability
geus, 27-5-2009

The vulnerability to rainfall deficits



Groundwater – Resources and Management

BGR Bundesanstalt für Geowissenschaften und Rohstoffe
GEOZENTRUM HANNOVER



GEOCENTER
DENVATE

Groundwater and Climate Change: Challenges and Possibilities



Commissioned by:
Ministry
of Economic Co-operation
and Development

“Despite the critical importance of groundwater resources in many parts of the world, there have been very few direct studies of the effect(s) of global warming on groundwater recharge.” (IPCC 1996, p. 336)

“Although the effects ... on groundwater resources are not adequately understood at present, they cannot be ignored.” (IPCC 1998, p.122)

“Groundwater is the major source of water across much of the world, particularly in rural areas in arid and semi-arid regions, but there has been very little research on the potential effects of climate change.” (IPCC 2001, p. 199)

“There is a need to improve understanding and modelling of climate changes related to the hydrological cycle at scales relevant to decision making. Information about the water-related impacts of climate change is inadequate - especially with respect to water quality, aquatic ecosystems and groundwater - including their socio-economic dimensions.” (IPCC 2008, p. 4)



Climate change on GW

- In arid areas, recharge impacts of CC difficult to predict
- GW can be a drought prevention strategy but only to a certain extent
- Energy intricately linked to GW exploitation
- CC exacerbates existing water problems (variability, uneven distribution)



g14

Groundwater is invisible



Slide 22

g14

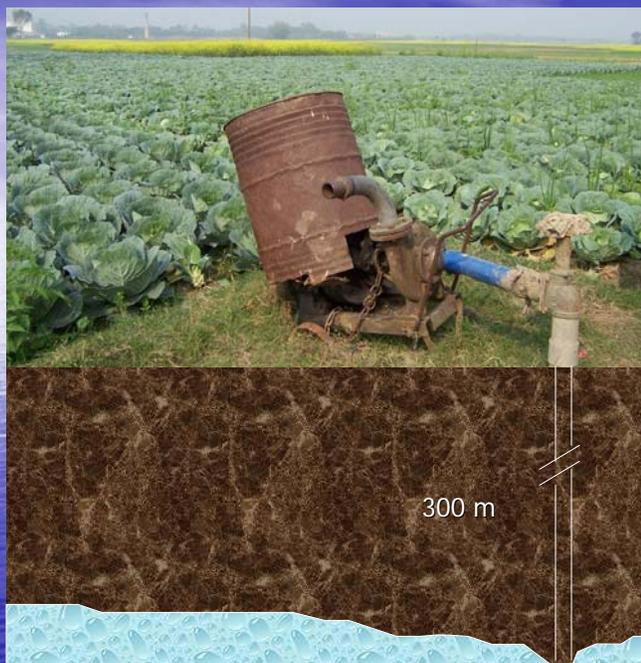
GW is invisible. This means that to understand it and its behaviour, we have to do a lot of sampling which is generally costly and relatively cumbersome.

It also means that GW contamination may go unnoticed for many years, and often it is only apparent when it reaches an exit to open water, e.g a well or a surface water body, and then it may be late to do anything about it.

geus, 8-5-2009

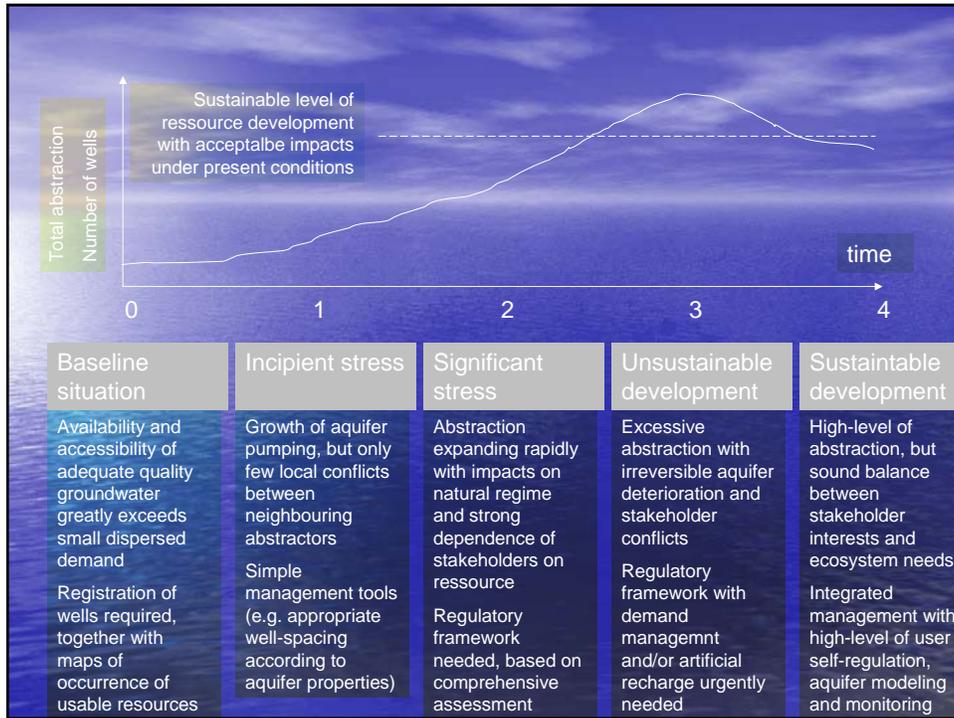
GW is invisible =>

- For the **users**:
 - They think it is an infinite and separate resource
- For the **policy makers**:
 - No attention
- For the **researchers**:
 - They have to do a lot of sampling which is generally costly and relatively cumbersome
 - GW contamination may go unnoticed for many years, and often it is only apparent when it reaches e.g. a well or a surface water body, and then it may be late to remediate



The
hidden
drought





911

GW use is often underestimated and disregarded

PUNJABI LOGIC

FROM THE LAND OF FIGHT RIVERS



g11

Other examples:

- Europe: GW was not considered specifically (in a separate supplemental directive) in the WFD until 2006, 6 years after the overall framework was agreed upon
- FAO statistics
- GW chapter in in book

geus, 8-5-2009

Groundwater increasingly acknowledged

- Europe: Groundwater Directive g12
- River basin mgt. <-> aquifer mgt. (TWRM) k13
- FAO statistics of GW irrigation k15
- GW into laws (national & international) k14
g13
- African Groundwater Commission under AMCOW
- GW data, maps and knowledge



GW development -> towards GW management



Environmental protection



Protecting GW from flooding disasters and preserving it for disaster water supply



Livestock-human link to GW



GW mgt in cities

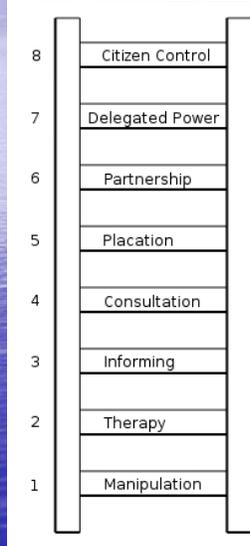


Waste handling

Slide 27

- g12** GW was not considered specifically (in a separate supplemental directive) in the WFD until 2006, 6 years after the overall framework was agreed upon
geus, 8-5-2009
- g13** AGWC is being established under the AMCOW, African Ministers' Council on Water, which was established between all African countries in 2002 to promote cooperation, security, social and economic development and poverty eradication among member states through the management of water resources and provision of water supply services.
geus, 8-5-2009
- k13** GW previously an ad-on to river basin mgt. plans and agreements on international water sharing, now it is being explicitly considered, e.g through the ISARM projec and draft international law
kgv, 10-12-2009
- k14** 'Principles of Water Law and Administration' from 1992, ammended in 2007 with a specific chapter on GW.
kgv, 10-5-2009
- k15** FAO admits in a report on CC that ther statistics on irrigation is underestimating the contribution from GW.
kgv, 10-5-2009

Ladder of participation



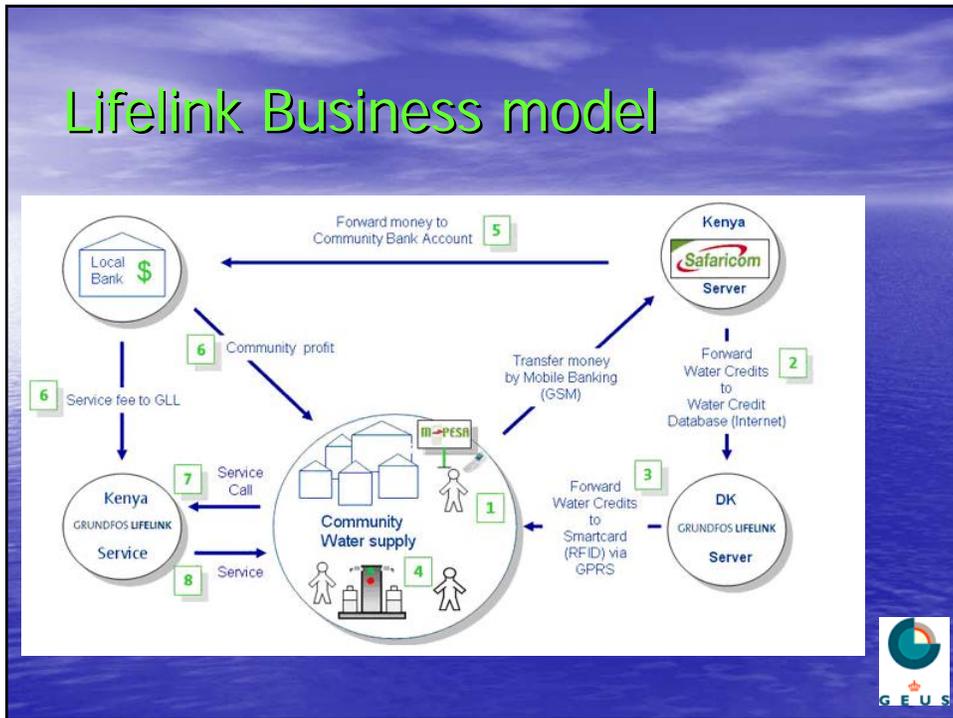
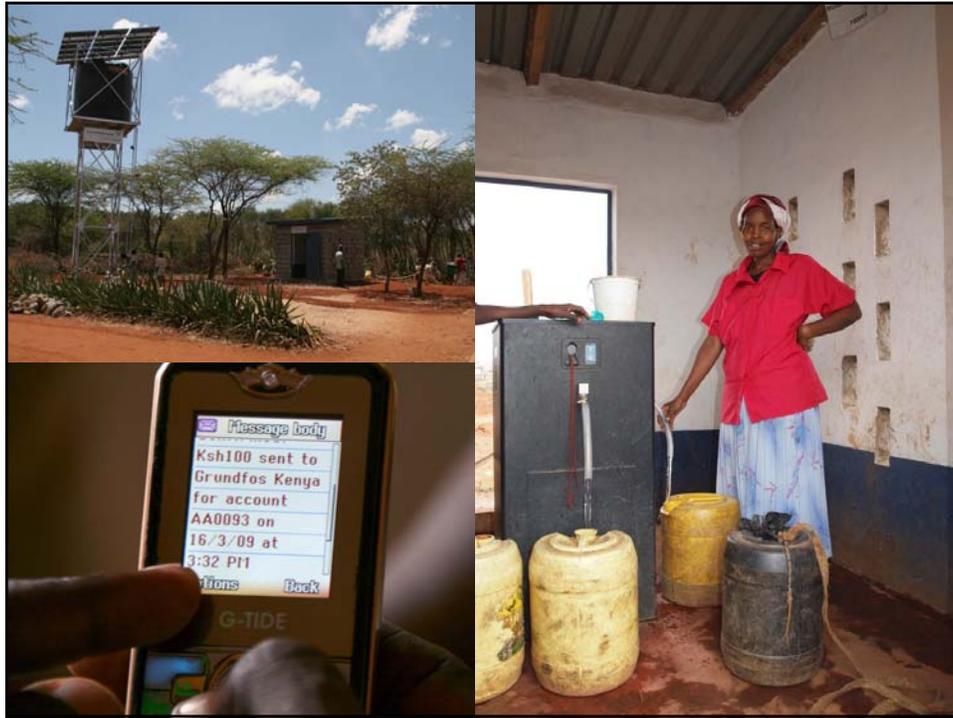
Grundfos Lifelink



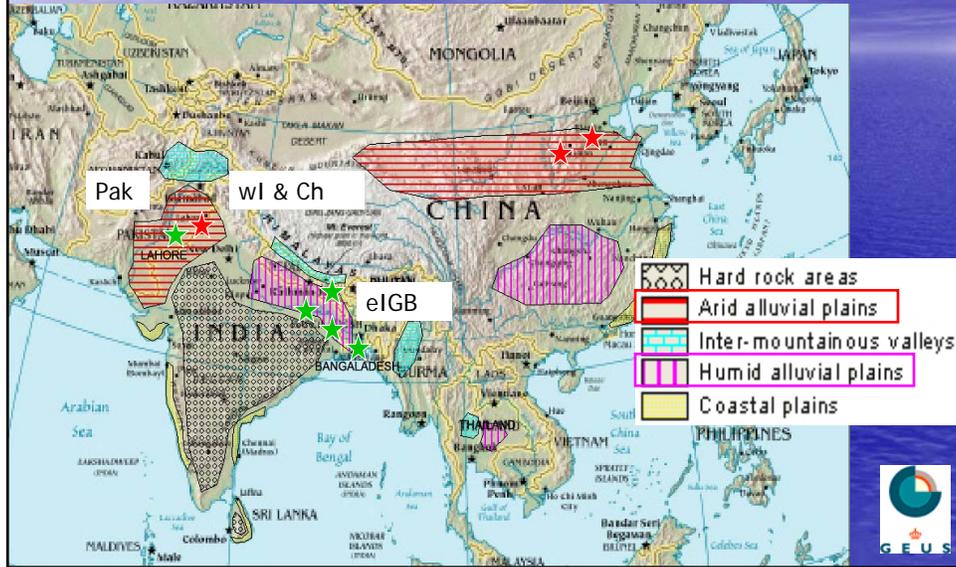
Grundfos LIFELINK

UN's Millennium Development Goal :
 "reducing by half the proportion of
 people without sustainable access to
 safe drinking water by the year 2015 "

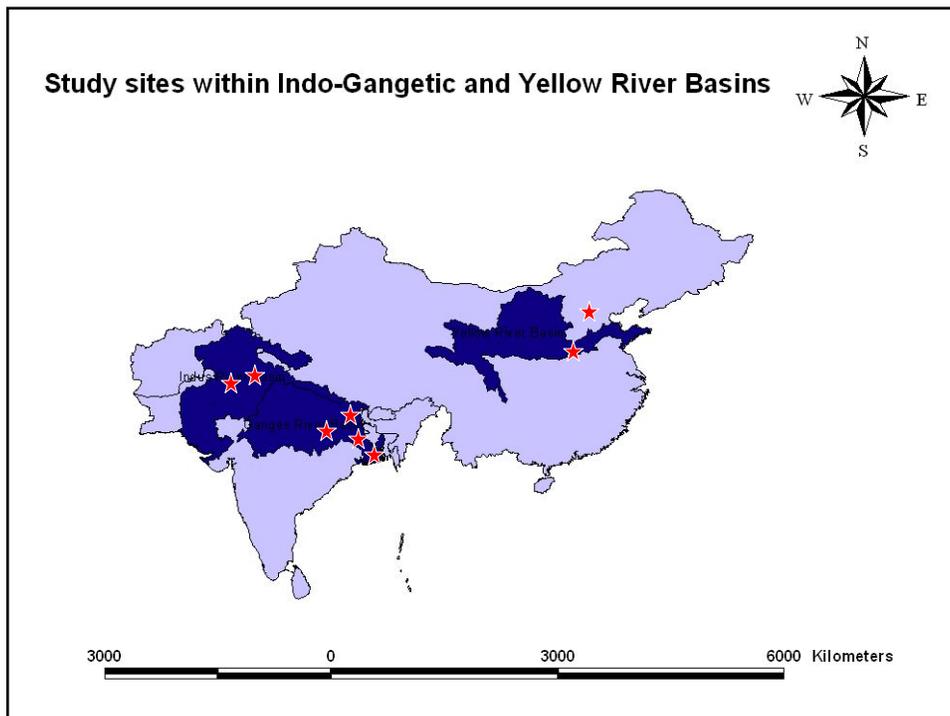




Groundwater zones of Asia



Study sites within Indo-Gangetic and Yellow River Basins



Coping strategies

wI & Ch	eIGB	Pak
<ul style="list-style-type: none"> • Crop diversification • Install deeper wells • Efficient pumps • Simple water saving techniques • Income diversification • Migration 	<ul style="list-style-type: none"> • Rain-fed farming • Leasing out land to tube-well owners • Use of kerosene to replace diesel • Rental market for pumps • Use of fuel-efficient Honda pumps • Use of plastic pipelines for conveyance • Diversify livelihoods and work for larger farmers 	<ul style="list-style-type: none"> • Conjunctive use of GW and surface water • Farmers crop intensively and grow more water saving crops or cash crops



INTERNATIONAL ASSOCIATION OF HYDROGEOLOGISTS SELECTED PAPERS



15

Groundwater Governance in the Indo-Gangetic and Yellow River Basins

Realities and Challenges

Editors: Aditi Mukherji
Karen G. Villholth
Bharat R. Sharma
Jinxia Wang

Taylor & Francis
Engineering, Water and Earth Sciences

CRC Press
Taylor & Francis Group
A BALKEMA BOOK

www.taylorandfrancis.com
www.crcpress.com
www.balkema.nl

Slide 35

g16 Percentage of irrigation water from GW: 68_100
geus, 8-3-2009

Key messages

- Groundwater inevitably will play an even greater role in the future, due to population and economic development
- Irrespective of reasons for climatic changes and possibilities for mitigating the effect of climate change, groundwater will be a key resource for adapting to climate change and extreme events
- Policy makers, researchers, managers, and developers involved in water and climate change adaptation have to come together to drive an agenda towards more focus on and better and innovative approaches to groundwater development and management



Thank you!



Contact:

Karen Villholth

kgv@geus.dk

