GW·MATE THE WORLD BANK GLOBAL WATER PARTNERSHIP

THE GLOBAL BOOM IN GROUNDWATER IRRIGATION
experience of trying to reconcile resource use and sustainability

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WATER PARTNERSHIP PROGRAM

DFID Department for International Development

GLOBAL BOOM IN GROUNDWATER IRRIGATION
benefits and concerns

- massive growth of waterwells for irrigation in developing world (especially SE Asia but not Africa)
- mainly private investment stimulated by government grants, soft loans, subsidies, guarantee prices, etc
- led widely to major improvements in rural livelihoods often with economic benefits at national level
- groundwater 'popular' with farmers (despite energy cost – if energy-supply reliable) drought resilient, access under direct control, close to point-of-use, well-suited to pressurised irrigation technology
- BUT widespread and serious concerns about sustainability

SCOPE OF PRESENTATION
and some acknowledgements

- focused on our experience in providing advice to public administrations concerned about the impacts of intensive groundwater exploitation
- mainly in zones of 'physical water scarcity' in the developing world
- groundwater pollution not considered here (only quality issues directly related to resource abstraction)

special thank you to :
Jake Burke (UN-FAO), Karin Kemper, Doug Olson, Javier Zuleta & Sanjay Pahuja (World Bank) and numerous country counterparts

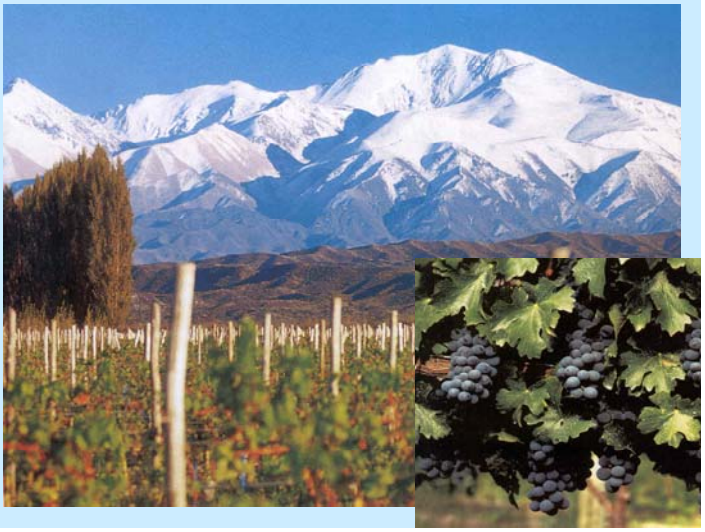
Groundwater Management Advisory Team (GW•MATE)

THE WORLD BANK

What is GW•MATE?

The Groundwater Management Advisory Team:

- is a multi-disciplinary expert team
- Works as an advisory group to the World Bank and the Global Water Partnership
- Provides support globally for development of capacity in groundwater resource management and groundwater quality protection
- Disseminates best-practice elements internationally through provision of Guides & Books, a Briefing Notes Series and a Case Profile Collection, together with the organization of short courses and study tours



EXCESSIVE GROUNDWATER ABSTRACTION
fantasy of a simple panacea or 'quick fix'

- first reaction of governments to propose major stand-alone investments in :
  - aquifer recharge enhancement and/or
  - 'efficient' irrigation technology
- rather than focusing on the 'underlying core issue' of reducing consumptive water-use (preferably 'non-beneficial' but sometimes even beneficial) and concomitant need to raise water-use productivity to maintain/increase farmer incomes
- and confronting the harsh reality of weakly-recharged aquifers trying to support inappropriate agricultural economies

UNSUSTAINABLE GROUNDWATER USE
role of government

- first – appropriate to ask 'is it necessary for public administration to intervene' or perhaps simpler *' to allow nature to take its course with gradual user adaptation to hard resource realities'*
- *questionable whether this is acceptable* where :
  - social inequity aggravated by eliminating access to groundwater of poorer villagers for drinking water-supply/subsistence farming
  - downstream users and ecological interests unacceptably impacted by baseflow reduction
  - non-renewable resource use without identifiable and implementable 'exit strategy' for user
  - aquifer system susceptible to irreversible degradation under short-term overexploitation

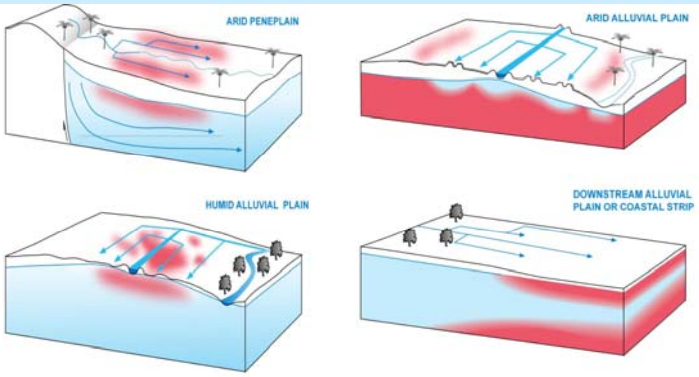
WORLD BANK GW-MATE PROJECT EXPERIENCE
positive and negative

LOCATION	AQUIFER	FARMING
Peninsular India–AP & MH States	hard-rock	mixed
North China Plain–Hebei Province	extensive alluvial deposits	national staple crops #
Indo-Gangetic Plain–UP & PJ States		
Sana'a Basin of Yemen	local alluvial deposits	mixed
Ica Valley & Pampa of Peru		high-value national/ export market crops
Mendoza Oases of Argentina		
Apodi Plateau of NE Brasil	sediment and/or volcanic basins	
Sousse Basin of Morocco		
Guanajuato Plateau of Mexico		mixed #

areas where groundwater salinity is an actual/potential problem

including fodder crops for livestock rearing

GROUNDWATER USE IN IRRIGATED AGRICULTURE
the threat of groundwater salinisation



UNSUSTAINABLE GROUNDWATER USE
developing a 'government strategy'

- important for 'public administration' to :
  - evaluate consequences of non-intervention in terms of socioeconomic impact and resource degradation risk
  - assess practicability of introducing different controls given current regulatory/fiscal powers and existing institutional/community capacity
- GW-MATe has evolved a 'pragmatic framework' to guide selection of a balanced approach – recognising hydrogeologic and socioeconomic setting defines problem and constrains solution

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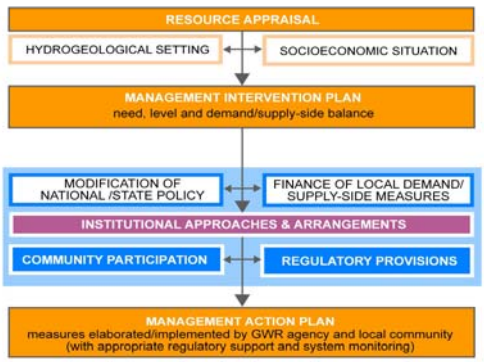
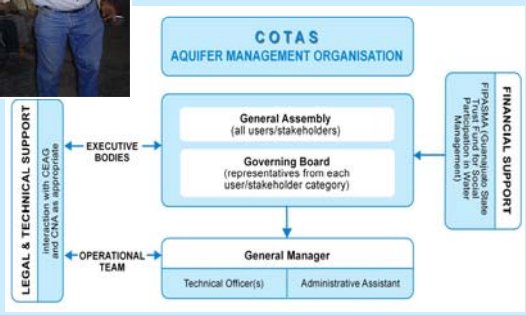
PRAGMATIC FRAMEWORK FOR GROUNDWATER RESOURCE MANAGEMENT IN EXCESSIVELY-EXPLOITED AQUIFERS



MEXICO – CONFRONTING AQUIFER DEPLETION
the COTAS experience



GROUNDWATER RESOURCE MANAGEMENT
harmonising 'bottom-up' and 'top-down'

GENERIC LESSONS ON GROUNDWATER MANAGEMENT POLICY IN DEVELOPING NATIONS

- no 'simple blueprint' – management strategy must be tailored to 'resource setting' – need understanding of 'use dynamics' as well as 'resource characteristics'
- best based on consistent groundwater bodies with understanding risks of irreversible degradation, continuous depletion and downstream derogation
- management by users alone almost always questionable – but without user participation almost always impossible
- local government agency having legal mandate and political backing as 'groundwater guardian' is critical
- progress requires the 'push' of groundwater body champions and the 'glue' of effective coordination

APPROACHES TO GROUNDWATER MANAGEMENT

- Community-Based Action
- Use Regulation & Charging
- Agriculture & Energy Policy Modifications
- Irrigation Technology Investments

COROLLARY

- Conjunctive Use with Surface Water Sources

IMPLEMENTING GROUNDWATER REGULATIONS
mobilising user participation

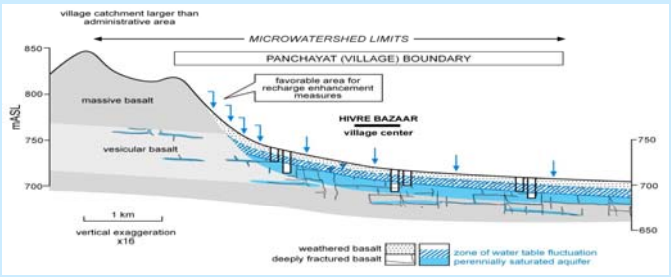
- 'representative structured participation' essential to promote effective resource management – should be facilitated/nutured by public administration
  (helps to confront harsh realities, implement difficult decisions, reduce inspection and monitoring costs
  – but requires user awareness, establishment/operational support and complementary investments/incentives)

APPROACHES TO GROUNDWATER MANAGEMENT
Community-Based Action

- 'self-regulation' via community-based resource management is much 'a bigger step'
  – but may be only feasible approach where :
  - large number of small heterogeneous users
  - local and robust groundwater system
- shift social behaviour from *'destructive competition for dwindling storage reserves'* (with few 'winners') to *'constructive dialogue on productive use of available average recharge'* (with many beneficiaries)
- important for local government to play permanent 'lighthouse function' in support and for up-scaling of positive outcomes)

COMMUNITY-BASED GROUNDWATER MANAGEMENT
the Hivre Bazaar (Maharashtra) - India experience

- Deccan Traps Basalt area with ~450 mm/a rainfall, long history of drought devastion, land degradation and outward migration
- from 1994 charismatic leader has promoted community-action on groundwater management (as foundation for sustainable social development) – with aims of stabilising water-table, domestic water-supply security and increased crop/water productivity



COMMUNITY-BASED GROUNDWATER MANAGEMENT
the Hivre Bazaar (Maharashtra) - India experience

- successful recharge enhancement in favourable hill-foot setting (with complimentary soil-erosion control)
- inspired community decision to allow only dugwell use for irrigation – eliminating divisive competition for limited groundwater storage and focusing farmers' attention on 'irrigation water productivity'
- introduction of crop-water budgeting based on antecedent conditions, ban on sugar-cane cultivation and intelligent crop diversification

OUTCOMES

YEAR	1992	2003#
Summer/Jayaad Irrigated Area (ha)	7	72
Land in Horticultural Production (ha)	7	54
Pulse Cultivation (ha)	54	188
No. of Milk-Producing Livestock	19	476
Household Income (1 rpa/a)	830	11,900
Families below Poverty Line (%)	92	1

+ eliminated reliance on domestic water-supply tankers

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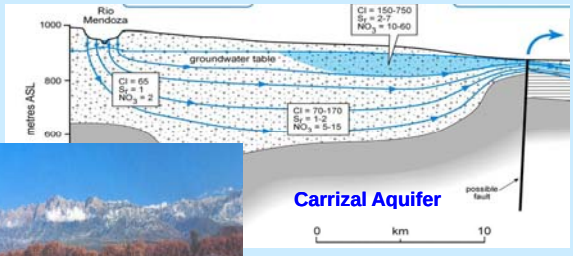
APPROACHES TO GROUNDWATER MANAGEMENT
Use Regulation & Charging

- simple regulations (waterwell drilling bans or minm. spacing) effective if supported by stakeholders
- use (not ownership) rights desirable :
  - where moderate number of high-value users and community small-users aggregated
  - must be realistically based and issue of non-renewable resources addressed
  - should be subject to use/transferability constraints and periodic revision

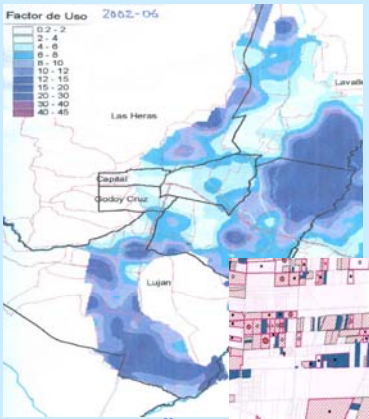
- improved use measurement needed :
  - for acceptable resource-fee levying (can best be combined with electricity charging)
  - improved estimates of consumptive use and refinement of groundwater resource balance

GROUNDWATER MANAGEMENT – REGULATORY APPROACH
experience from Mendoza-Argentina



- *declared 'area of waterwell drilling restriction'*
- constrained spatial transfer of groundwater use rights
- intensified groundwater level use and salinity monitoring
-

Mendoza-Argentina
WATERWELL USE FROM ELECTRICITY SUPPLY & CONSUMPTION DATA



GIS-based inventory of irrigation wells and irrigated land

average waterwell use factor 2002-06

caution about increasing consumptive use (even if licensed abstraction fixed)

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APPROACHES TO GROUNDWATER MANAGEMENT
Agriculture & Energy Policy Modifications

- **modifications to agricultural policy can exert a powerful influence on groundwater use for irrigation :**
  - adjusting guarantee prices for highly water-consuming crops
  - discouraging alfalfa irrigation for arid-zone livestock farming
  - geographic bans on sugar-cane cultivation
  - statutory deferral of rice planting date to reduce NBET
- **unravelling groundwater-energy nexus is complex :**
  - socio-political rationale for subsidies is 'much lower comparative cost of canal-water' – but not primary cause of overexploitation since also occurs in areas using diesel-engine power
  - but flat-rate tariffs (by pump HP or connection potential) need t to be phased-out since bankrupting electricity boards
  - water-table recovery through groundwater management measures will reap large benefits (via reduced pump head-losses) – widespread need for closer audit/control of rural electricity use (including mapping kW/hr/ha/crop)

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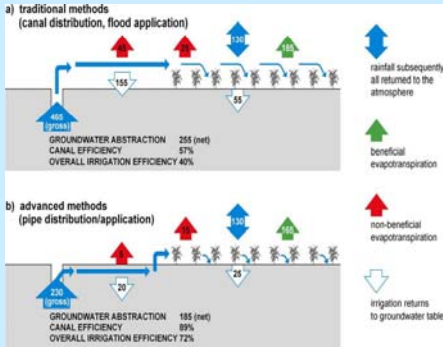
IRRIGATION TECHNIQUES

- intimate relation with shallow groundwater with irrigation returns exerting major influence on aquifer recharge or net waterwell abstraction (depending on source of irrigation water)

IRRIGATION TECHNOLOGY INVESTMENTS
much needed but may not 'save' water resources

- improved irrigation technology is very effective for energy saving and enhancing water productivity – ***BUT*** improving irrigation efficiency alone does not necessarily mean real groundwater resource saving (and often results in the reverse)
- for ***'real water saving'*** it is necessary also to : (a) ensure that water-saving measures are targeted at reducing non-recoverable losses (b) constrain irrigated area and reduce use groundwater rights



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GENERIC LESSONS ON GROUNDWATER MANAGEMENT PRACTICE IN DEVELOPING NATIONS

- use sensitive to agro/energy-policy adjustments – 'bottom-up measures' need facilitation by 'top-down incentives'
- improving 'irrigation water-use efficiency' alone does not equate to 'real water savings' (often the reverse)
- groundwater use rights at individual/communal level (subject to periodic revision) are a very useful tool to mobilise users
- piecemeal regulatory action, economic intervention or technical innovation unlikely to be successful

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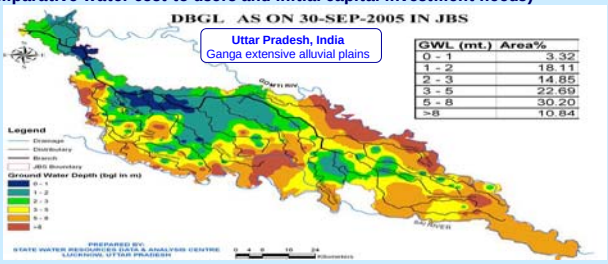
CONJUNCTIVE USE WITH SURFACE-WATER SOURCES
with shallow water-table – management needs

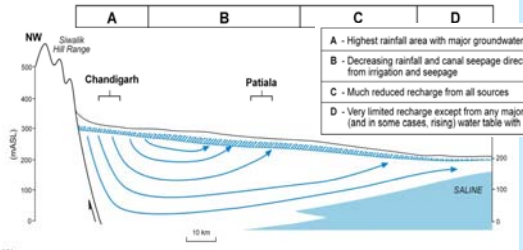
- spontaneous conjunctive use widely practised as 'coping strategy' for inadequate canal-water service levels – but often causes water-table depletion in tail-end zones and accompanied by waterlogging/salinisation in head-canal zones
- integrated modelling suggests average cropping intensity could be increased from < 150% to >220% with 'planned conjunctive use' if social/economic obstacles can be overcome

(power of head-canal land owners, split institutional responsibility, comparative water cost to users and initial capital investment needs)



CONJUNCTIVE USE WITH SURFACE-WATER SOURCES
with deep water-table – management needs

- in deeper water-table settings (eg. pre-montane outwash plains) major complication for conjunctive use is inadequate resource assessment (failure to recognise strong interdependence of groundwater and surface water) and consequent 'double water-resource accounting' and 'over allocation'
- Indian Punjab : 70% of irrigation supply is obtained from waterwells but about 40% of groundwater recharge derives from irrigation-canal seepage (many canals are presently more artificial recharge structures than conventional irrigation infrastructure)



INDIAN PUNJAB

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