Global Water Partnership

GLOBAL WATER SECURITY
the role and status of groundwater

SEGURIDAD MUNDIAL DEL AGUA
el Papel y Estado de los Recursos Subterraneos

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IAH–Past President 2004-08
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THE CONCEPT OF 'WATER SECURITY'
definition and implications

- < the availability of an acceptable quantity and quality of water for health, livelihoods, ecosystems and production, coupled with an acceptable level of water-related risks to people, environments and economies> (Grey & Sadoff, 2007)

- GWP-OECD macro-economists estimate that water insecurity costs the global economy more than US$ 500 billion/a (North Africa is region most exposed to water scarcity)

- more political than operational – from water resource perspective only rational if applied at scale of specific city, river sub-basin or aquifer – and if specific to drought, flood and pollution risks

- groundwater storage plays a critical role in improving drought water security but to ensure this resource aquifers must be managed and protected against pollution (not considered here)

GROUNDWATER – GLOBAL DEPENDENCY
(Siebert et al, 2010 / UN-FAO commissioned)

REGION	*GROUNDWATER IRRIGATION AREA*		*GROUNDWATER VOLUME USED*	
	Mha	*total*	*km3/a*	*propn*
GLOBAL TOTAL	**112.9**	**38%**	**545**	**43%**
South Asia	**48.3**	**57%**	**262**	**57%**
East Asia	**19.3**	**29%**	**57**	**34%**
South-East Asia	**1.0**	**5%**	**3**	**6%**
Mid East & North Africa	**12.9**	**43%**	**87**	**44%**
Latin America	**2.5**	**18%**	**8**	**19%**
Sub-Saharan Africa	**0.4**	**6%**	**2**	**7%**

no comprehensive data on URBAN groundwater dependence –
major use in EU, Nigeria, Bangladesh, Pakistan, Zambia, Peru for example

GROUNDWATER RESOURCES

- Strategic Reserve – Characteristics & Risks
- Management Challenges from Irrigated Agriculture
- Urban Water Use Policy
- Basis for Integrated & Adaptive Management

LOS RECURSOS HIDRICOS SUBTERRANEOS

- Reserva Estrategica – Caracteristicas y Riesgos
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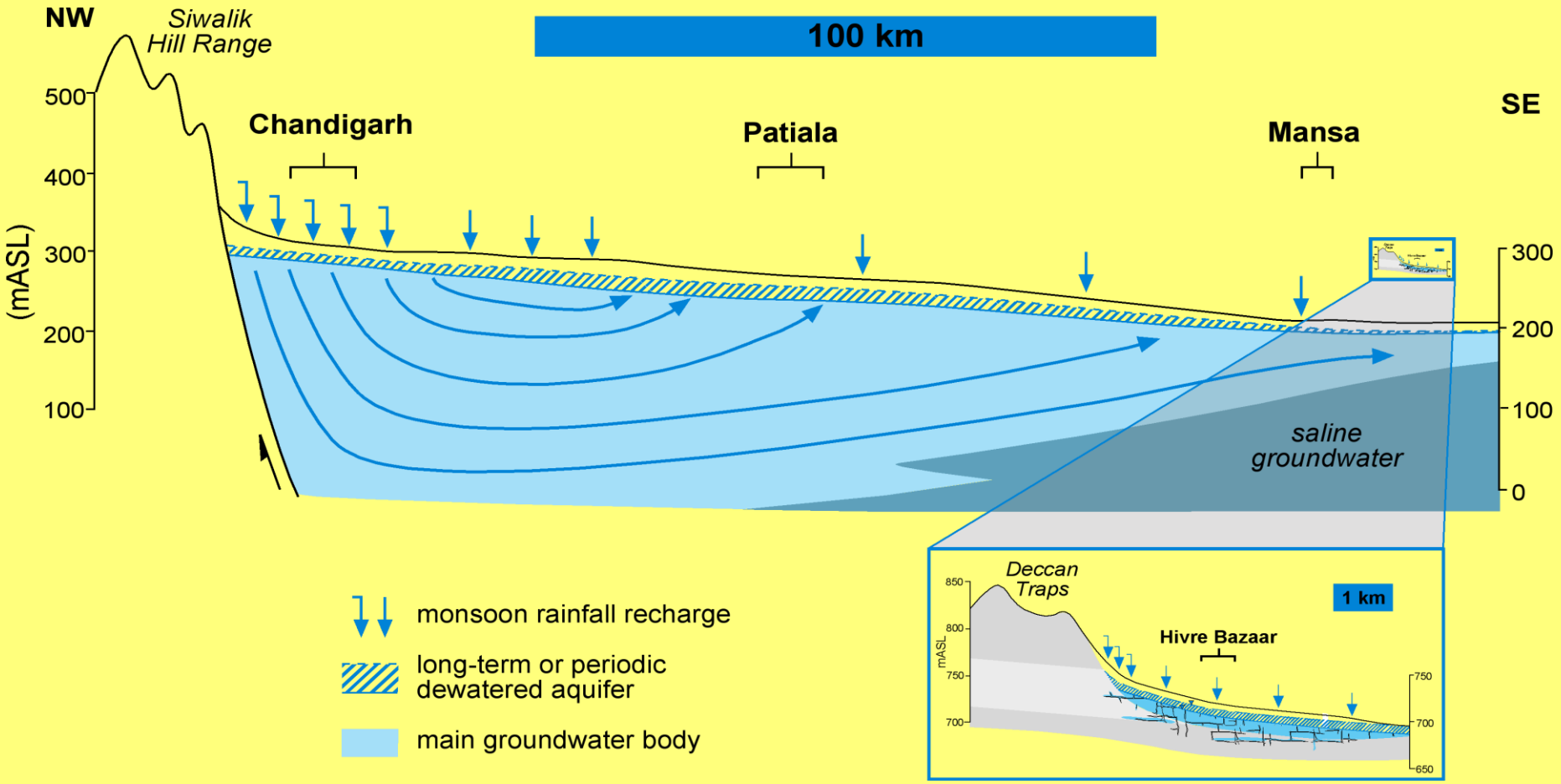
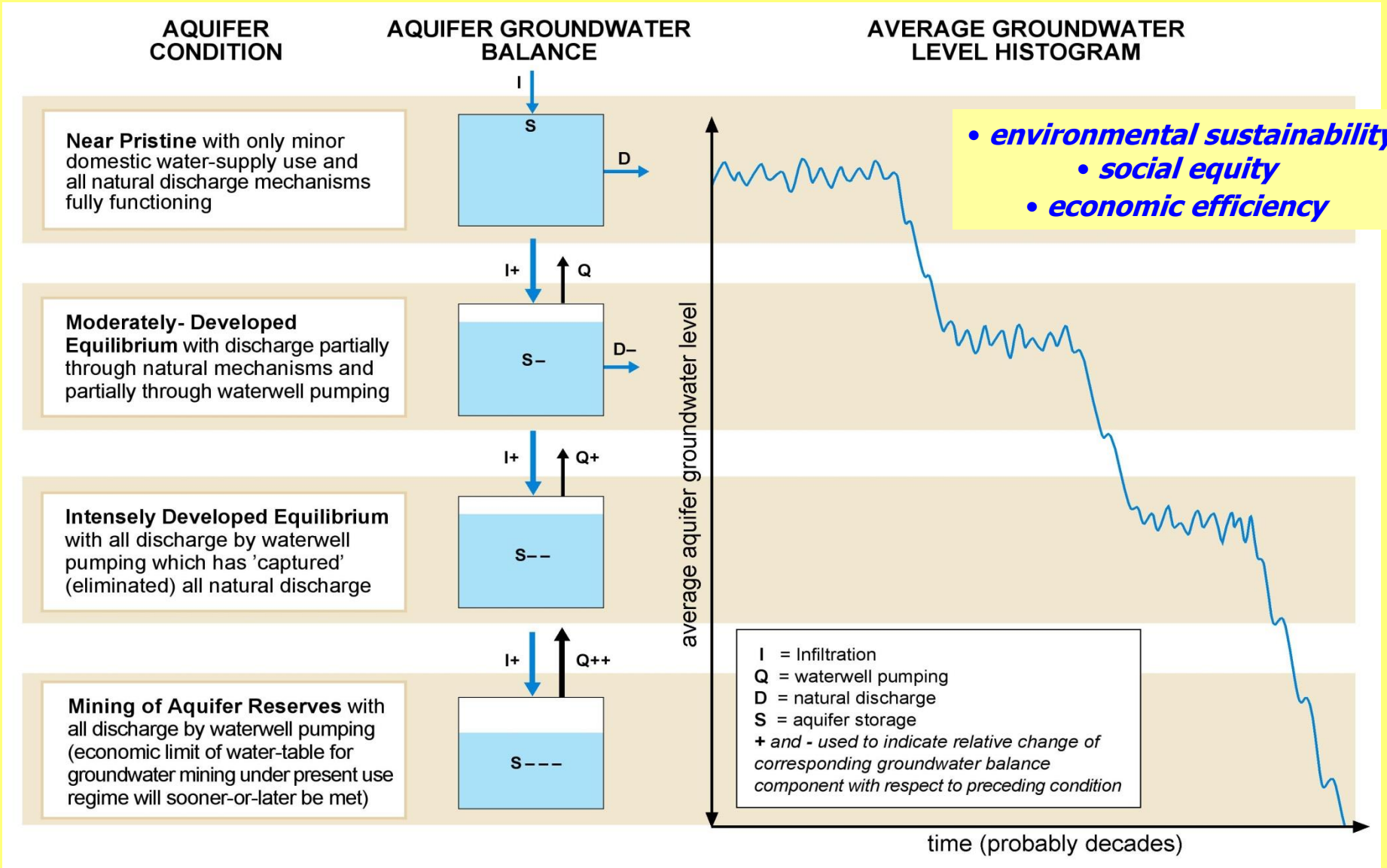
GROUNDWATER STORAGE
makes major contribution to water-supply security



- **existence of aquifer highly significant – since groundwater storage plays a fundamental role in shaping water security in drought**
- **groundwater system resilience – related concept quantified through assessment of aquifer storage, productive capacity and pollution vulnerability**

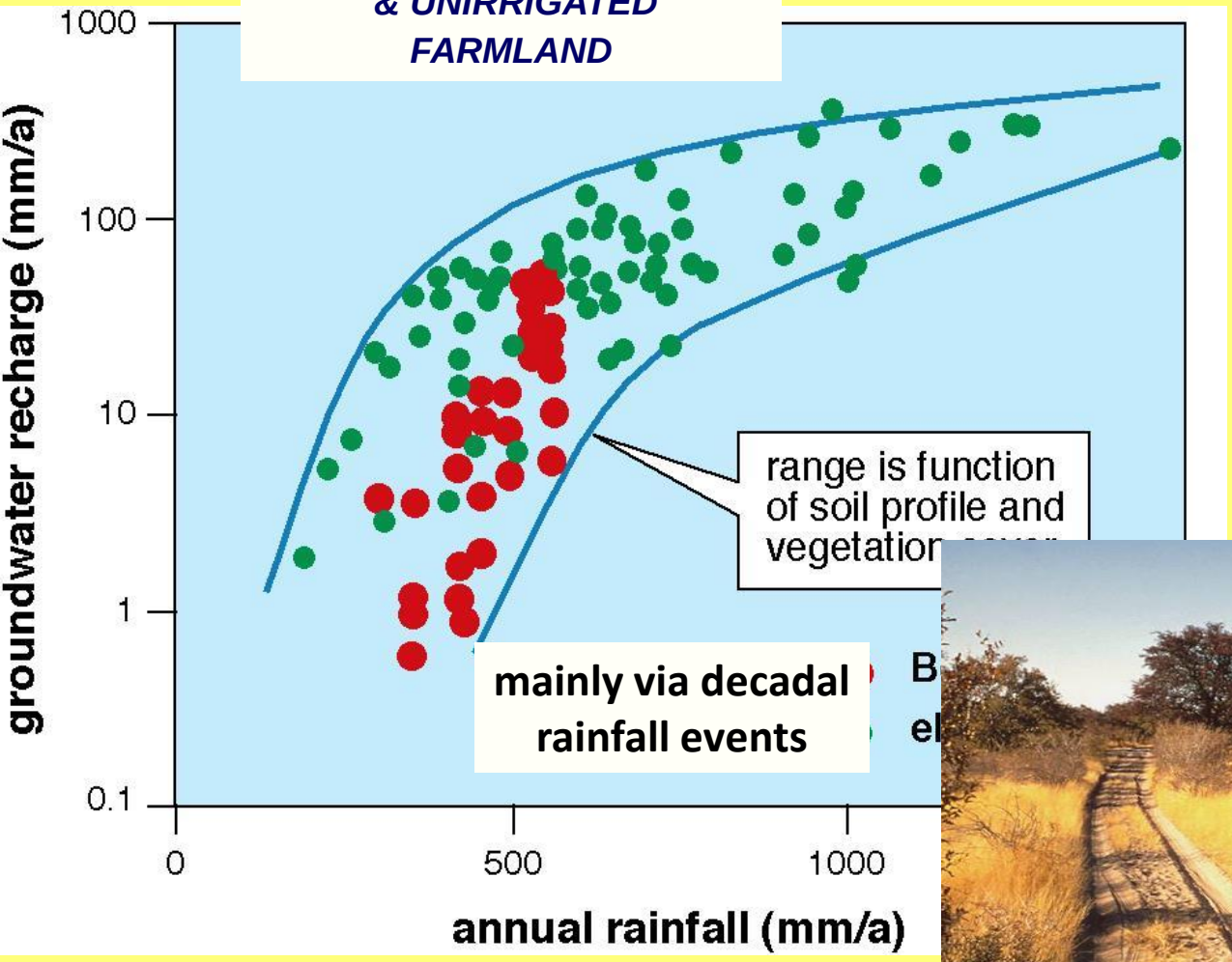
STAGES OF GROUNDWATER DEVELOPMENT
and their consequences

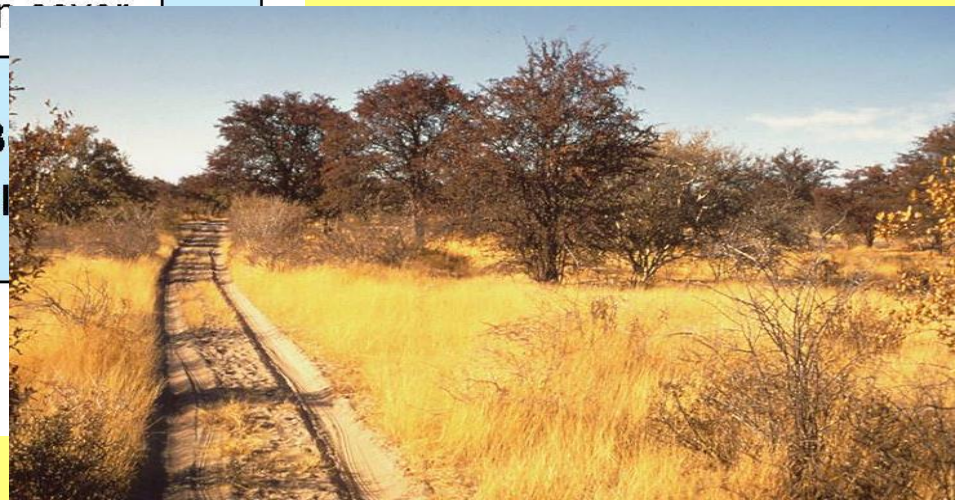


GROUNDWATER RECHARGE – RAINFALL CORRELATION
less predictable in more arid climates

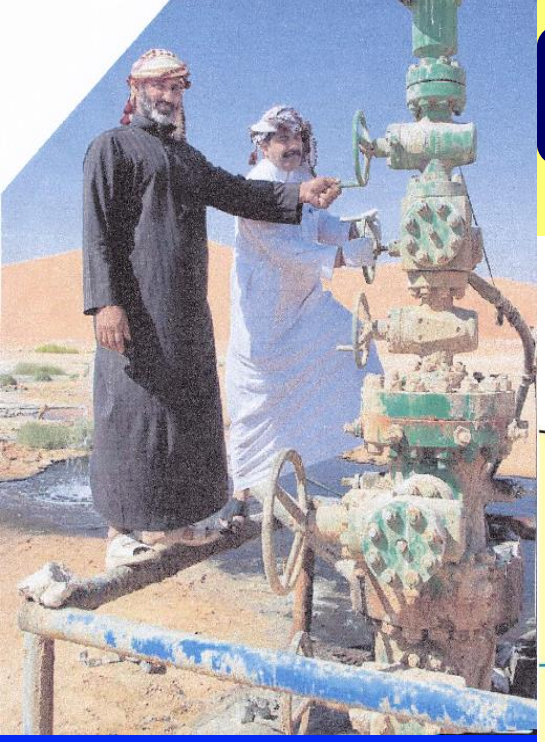
NATURAL VEGETATION, ROUGH GRAZING & UNIRRIGATED FARMLAND

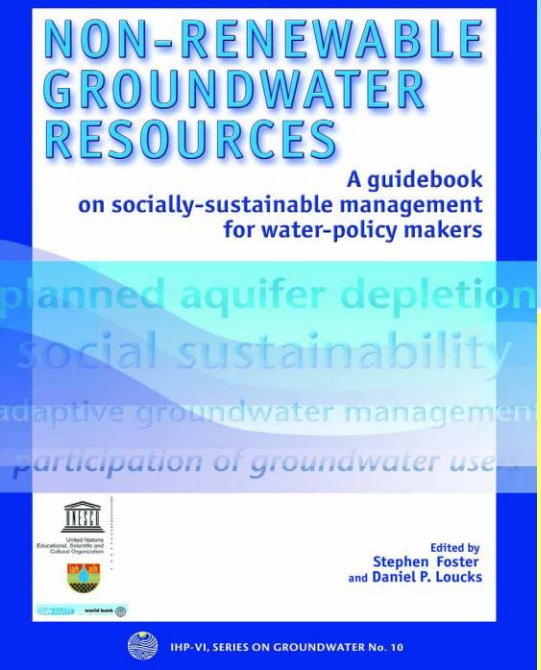
Southern Africa composite research data

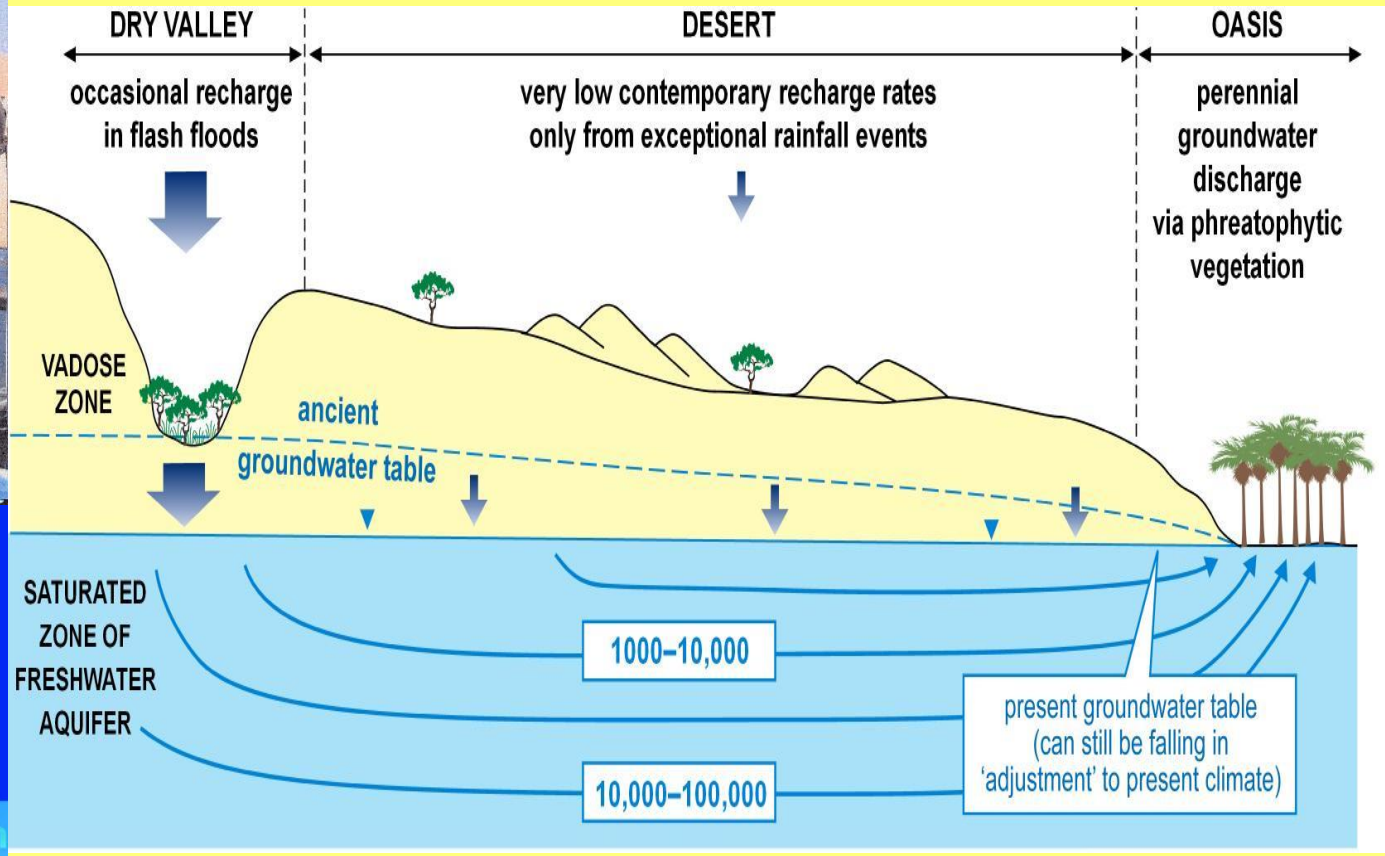




NON-RENEWABLE GROUNDWATER RESOURCES
strategic reserve – resilient to climate change

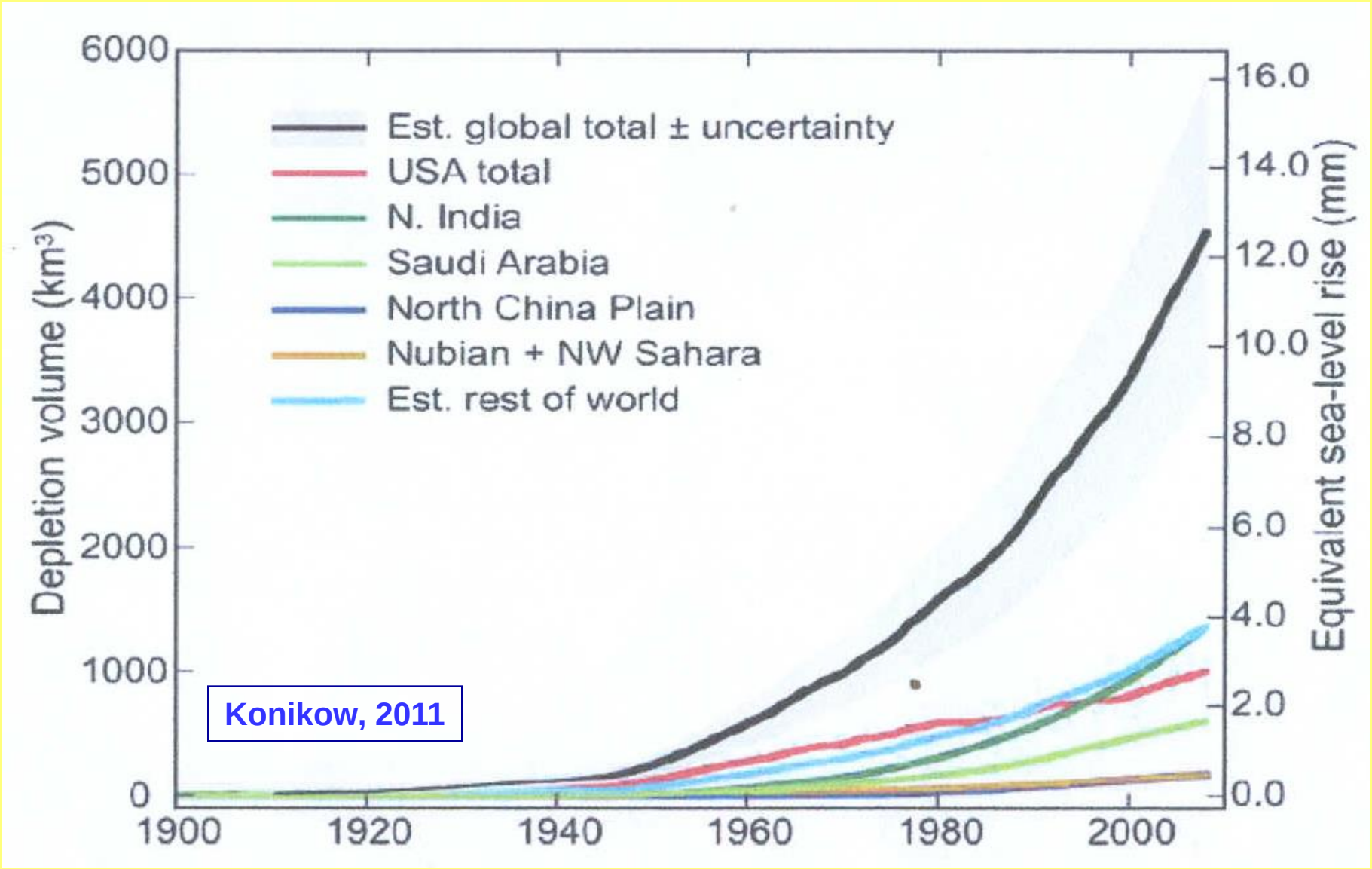






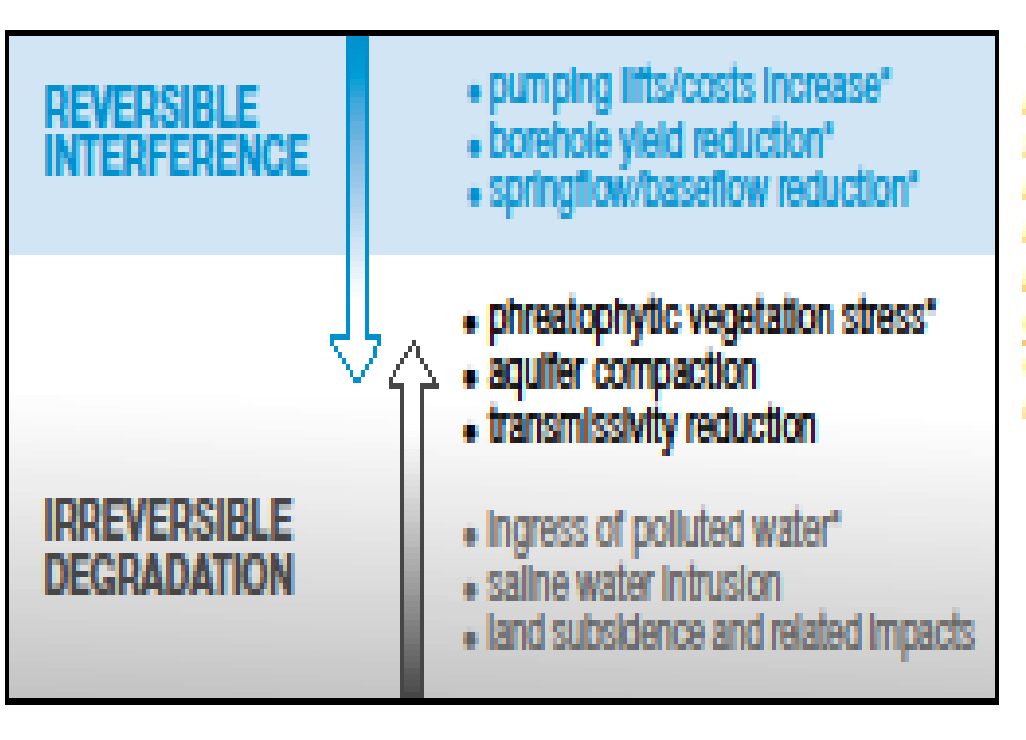
Algeria, Libya & Saudi Arabia
(Australia, Botswana, Iran & Peru)

GROUNDWATER RESOURCE DEPLETION
a widespread and accelerating phenomenon

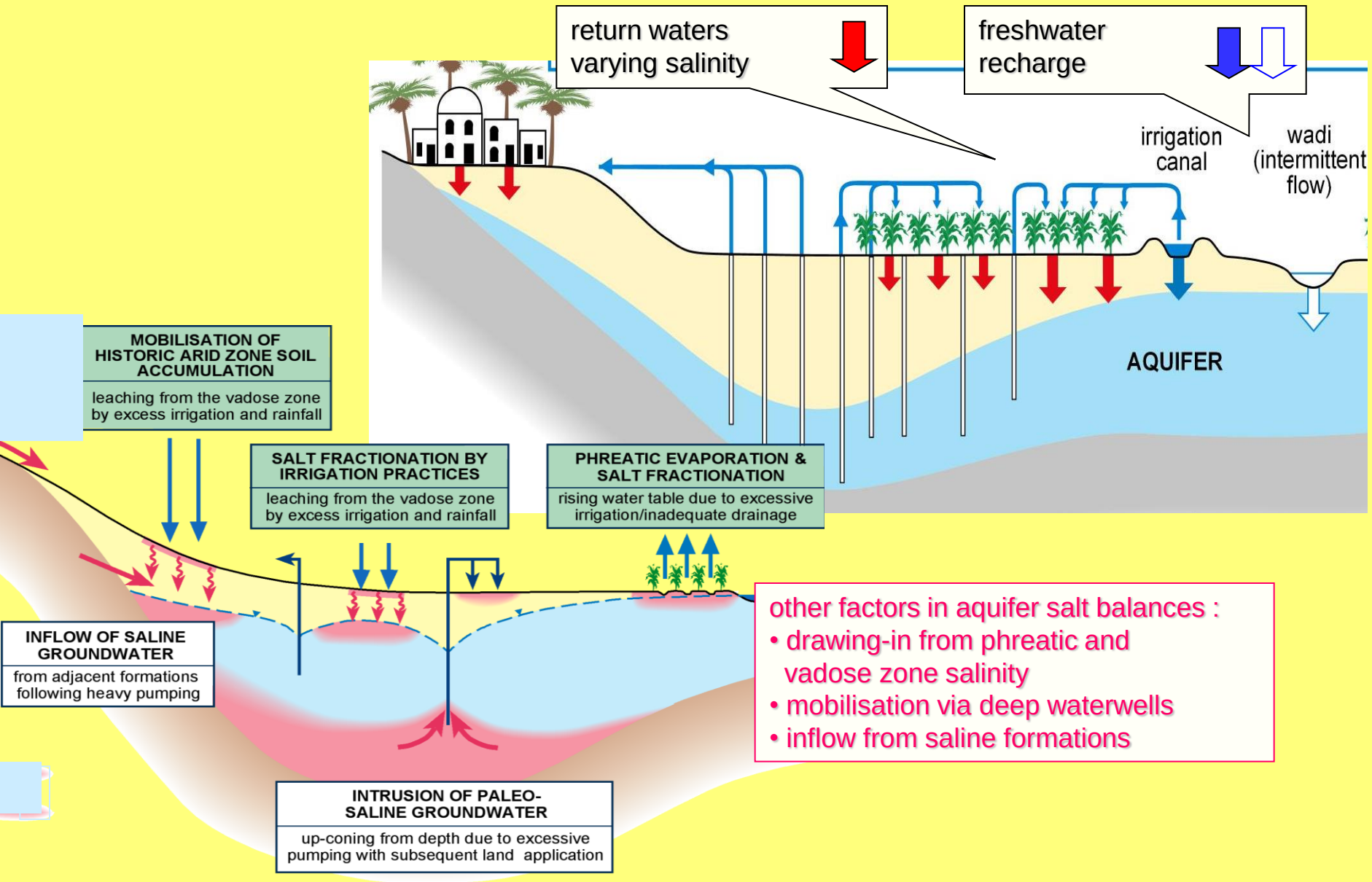


NEGATIVE EXTERNALITIES OF GROUNDWATER DEPLETION
onset and impact varies widely with aquifer type

- energy consumption
- carbon footprint
- contribution SL rise



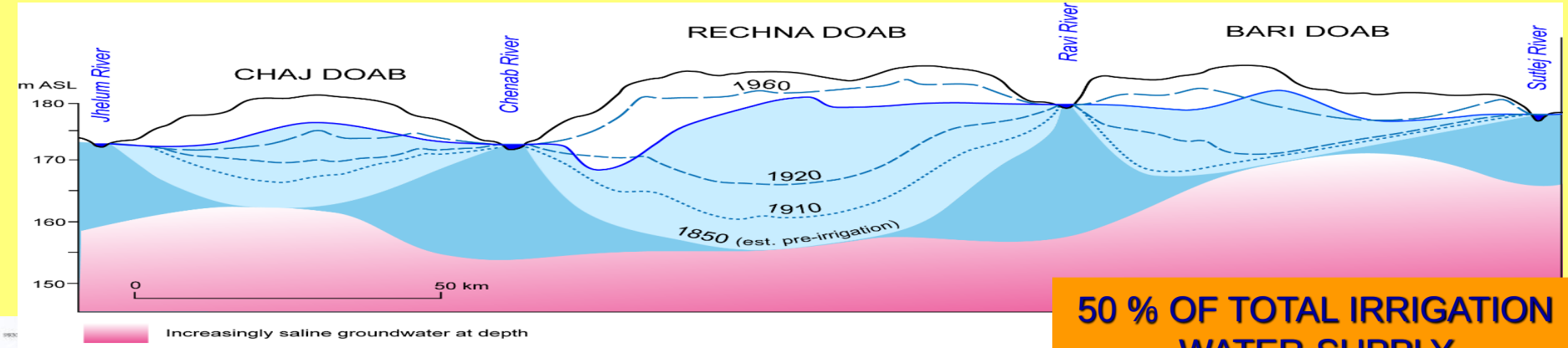
PROCESSES OF GROUNDWATER SALINISATION
factors entering into aquifer salt balances in arid areas



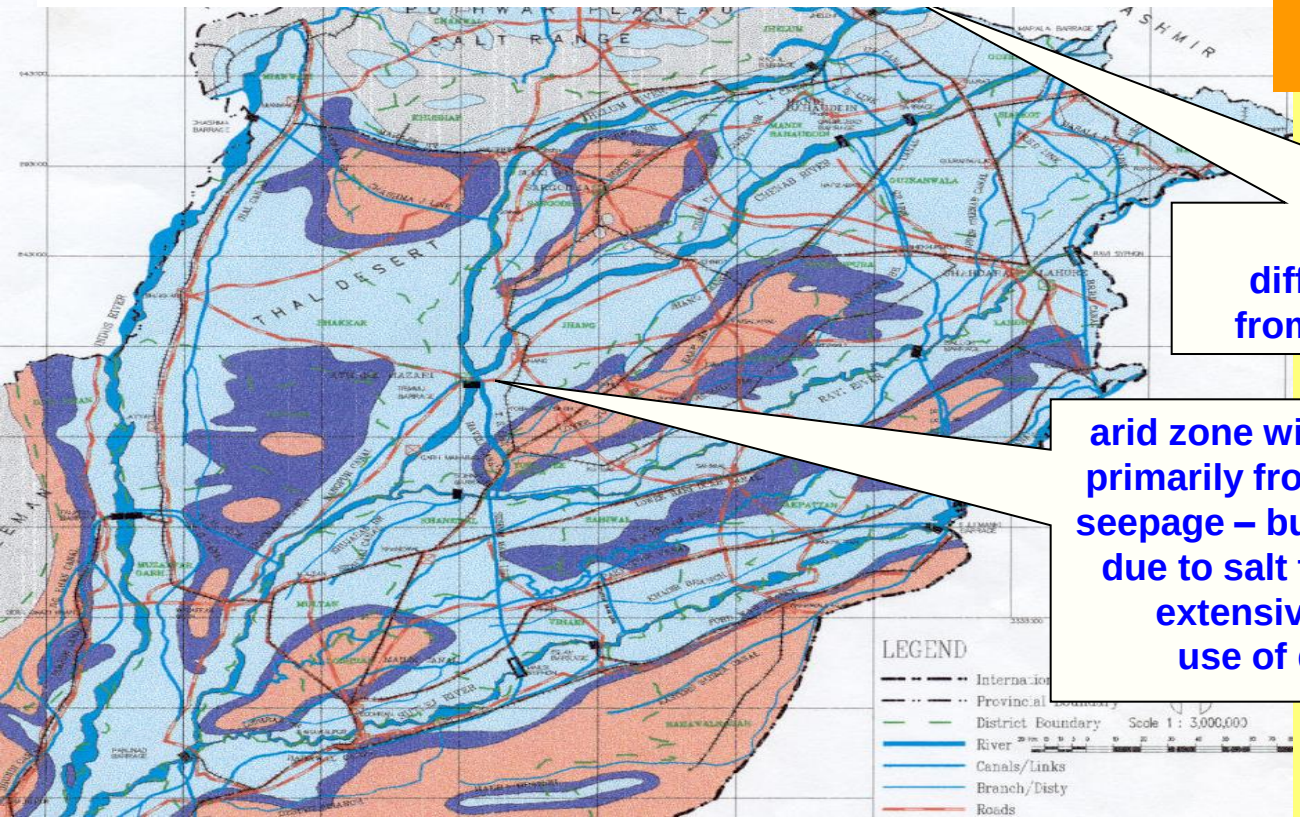
other factors in aquifer salt balances :
- drawing-in from phreatic and vadose zone salinity
- mobilisation via deep waterwells
- inflow from saline formations

GROUNDWATER RESOURCES OF PAKISTAN PUNJAB

growing dependence for staple crops but major salinity concerns



50 % OF TOTAL IRRIGATION WATER-SUPPLY FROM WATERWELLS



semi-arid zone with diffuse groundwater recharge from annual monsoonal rainfall

arid zone with fresh groundwater recharge primarily from riverbed and irrigation canal seepage – but freshwater salinity increasing due to salt fractionation in irrigated soils, extensive phreatic evaporation and use of deep irrigation waterwells

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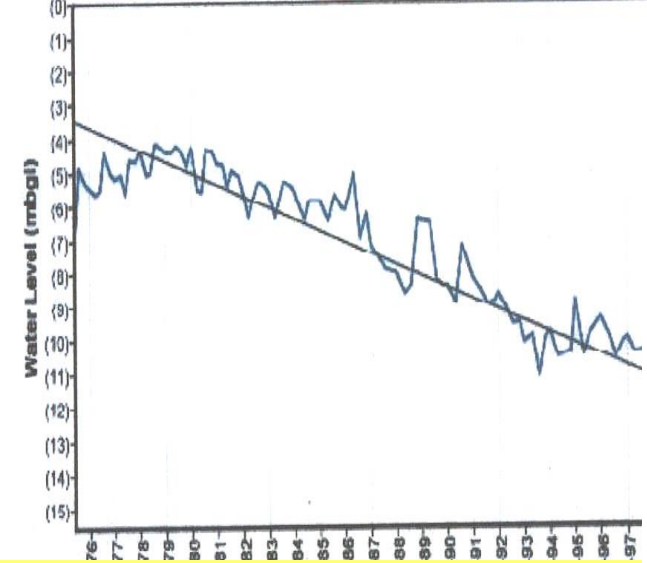
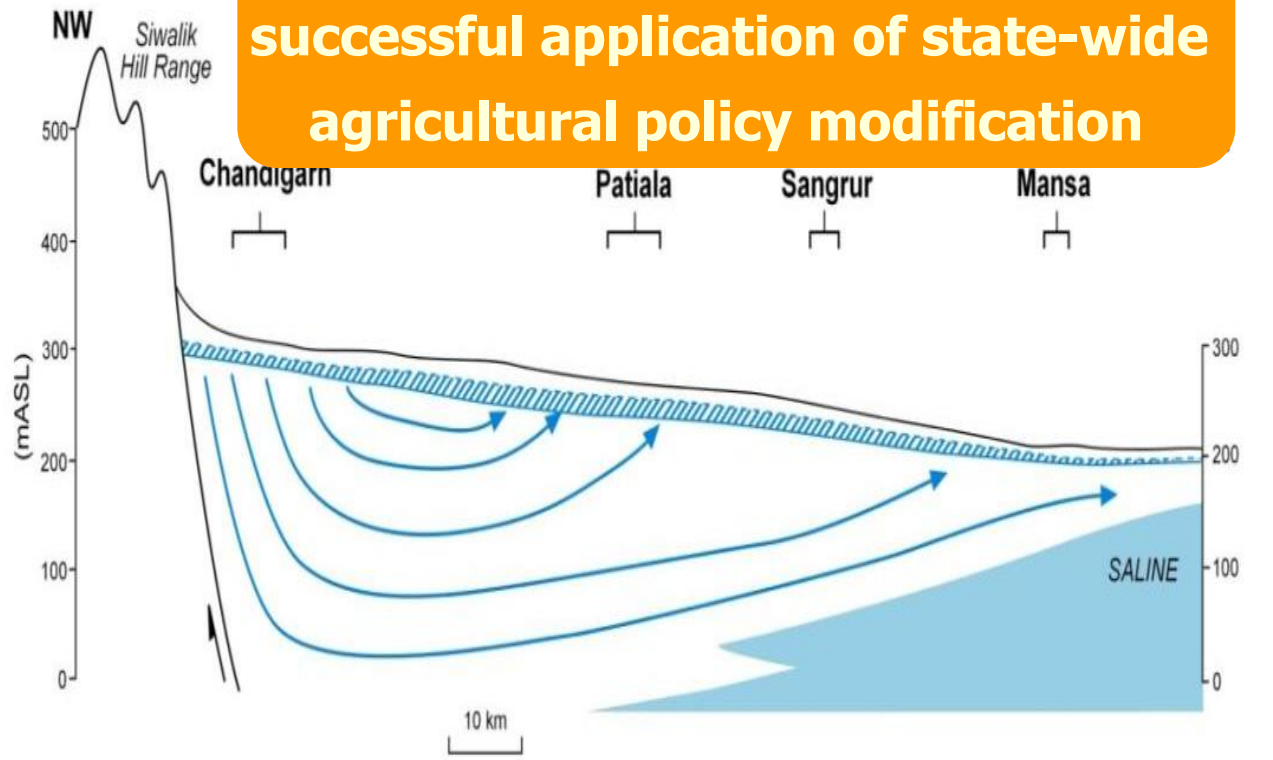
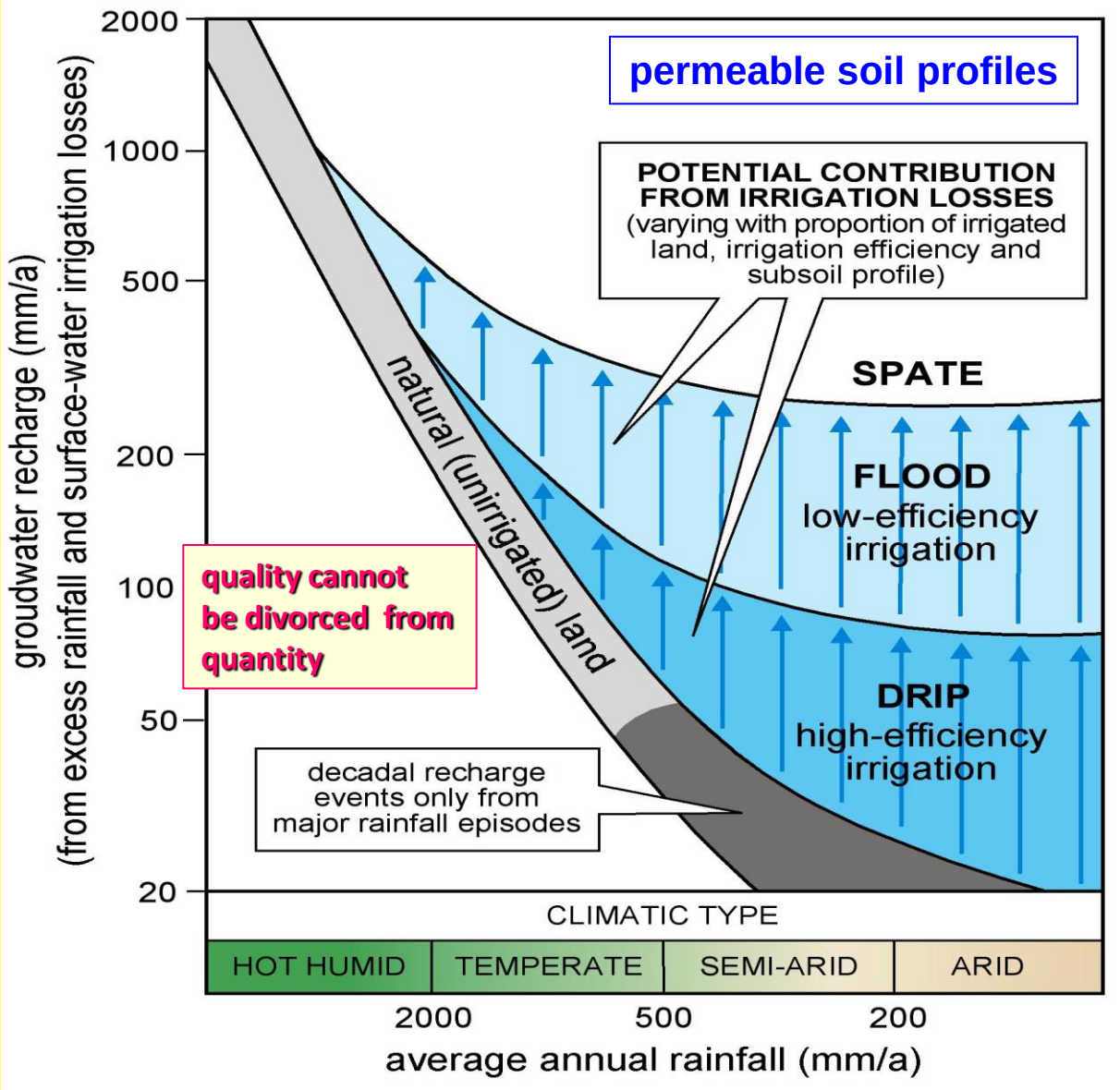
PUNJAB PENEPLAIN - INDIA
successful application of state-wide agricultural policy modification



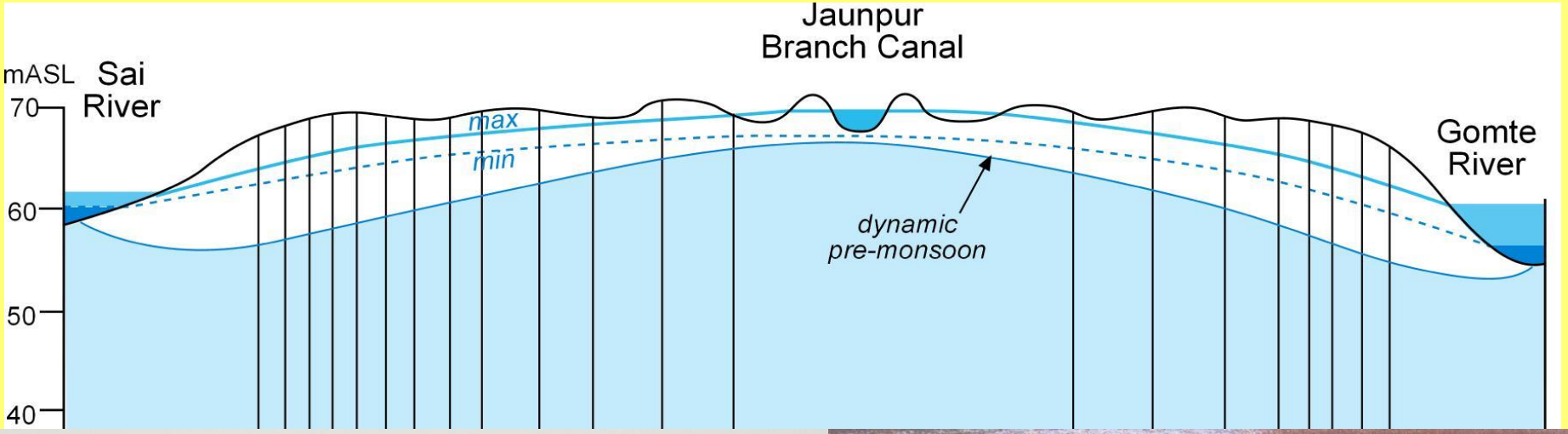


- 'national grain basket' with almost entire land area cropped for rabi wheat/kharib rice – some 70% with waterwell irrigation
- resultant excessive groundwater abstraction equivalent to 120-150 mm/a – water-table continuously declining at 0.5-0.8 m/a
- but about 35-40% of recharge by irrigation canal seepage
- salinisation down-gradient and severe depletion around all towns
- since 2008 statutory deferral of paddy planting to June (by up to 35 days) estimated to have reduced by NBET by 80-100 mm/a ?

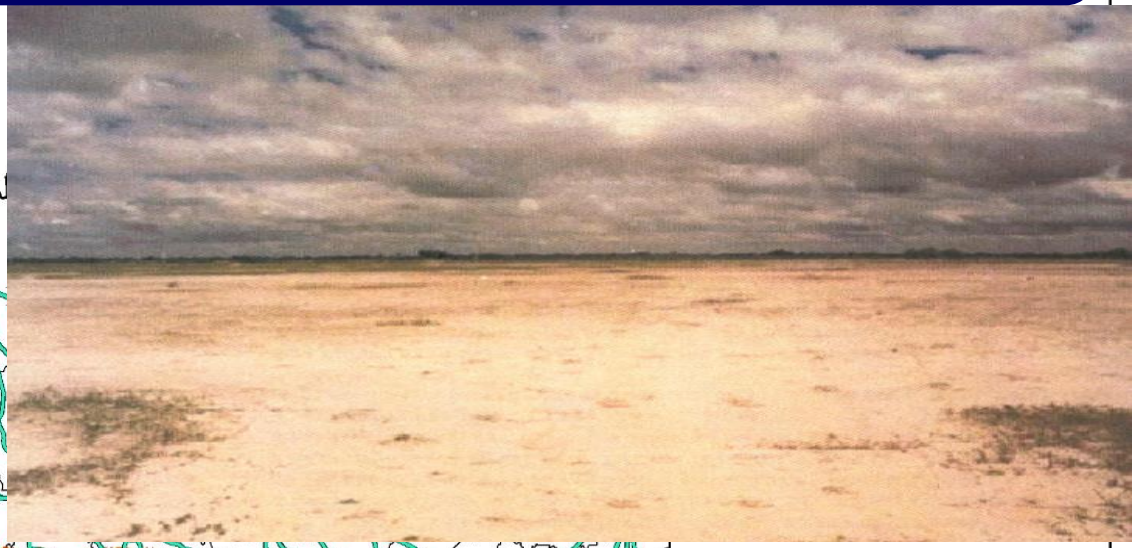
GROUNDWATER RESOURCES & IRRIGATED AGRICULTURE
recharge quality & rate greatly influenced by water management



GANGETIC PLAIN OF UTTAR PRADESH-INDIA
modification of hydrogeological regime



GANGETIC PLAIN OF UTTAR PRADESH-INDIA
Soil Water-Logging & Salinisation



Prepared by :
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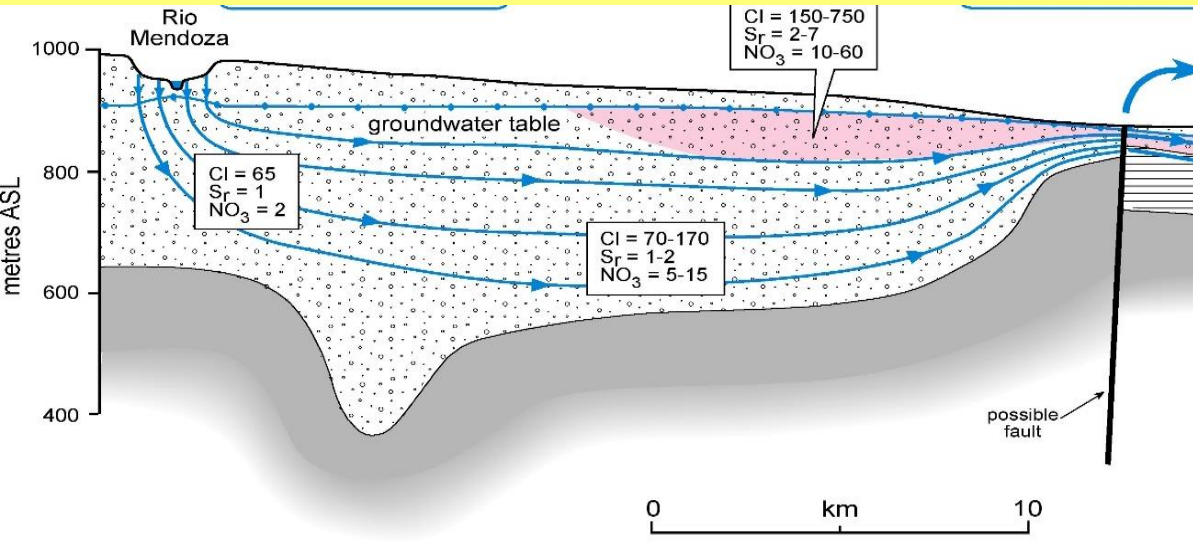
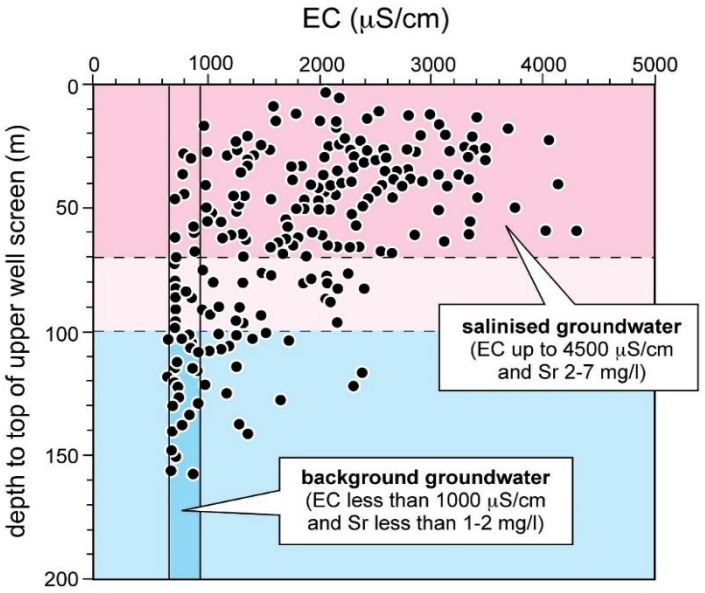
sh Bhumi Sudhar Nigam

ARGENTINA-MENDOZA VITICULTURE PRODUCTION
locally threatened by increasing groundwater salinity





CARRIZAL AQUIFER

- mobilisation of salinity from vadose zone in areas cleared of desert vegetation for irrigated agriculture
- salt fractionation during irrigation-water cycling
- some zones now only suitable for onion and garlic cultivation

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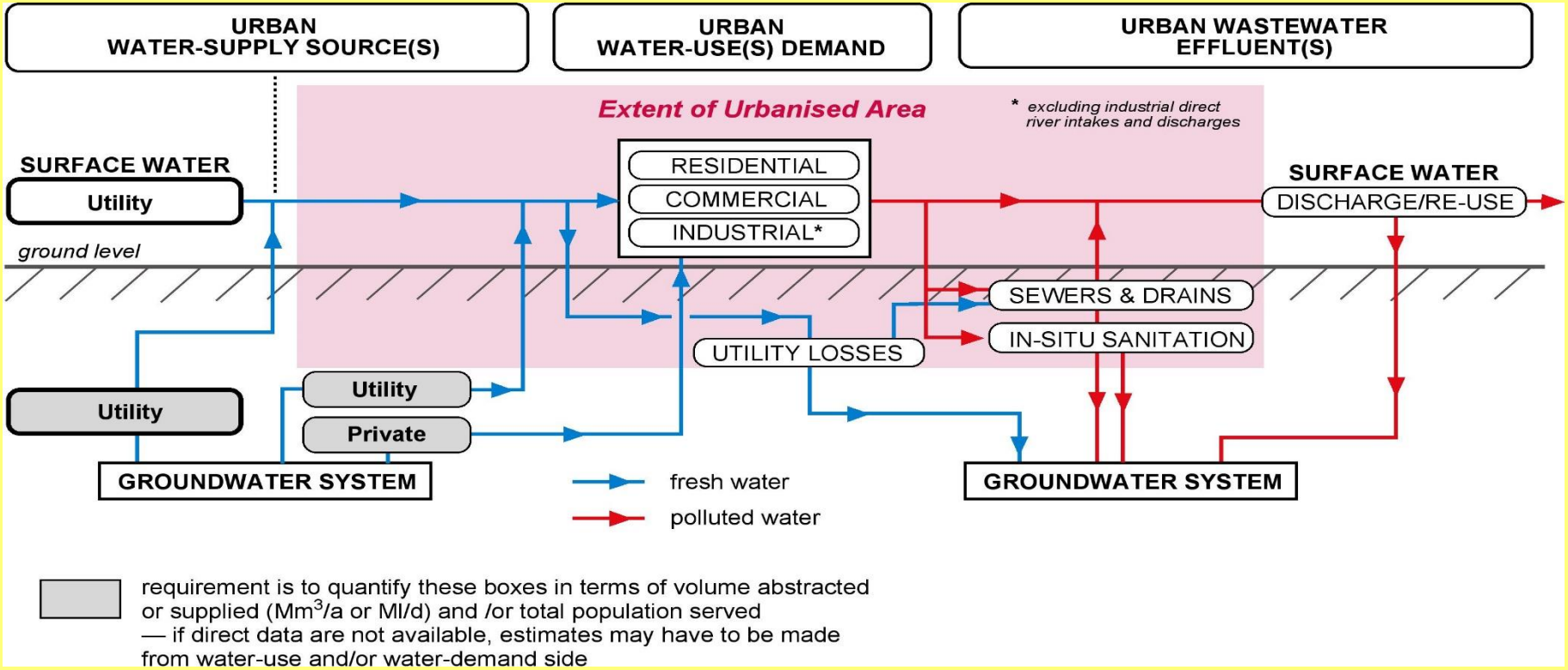
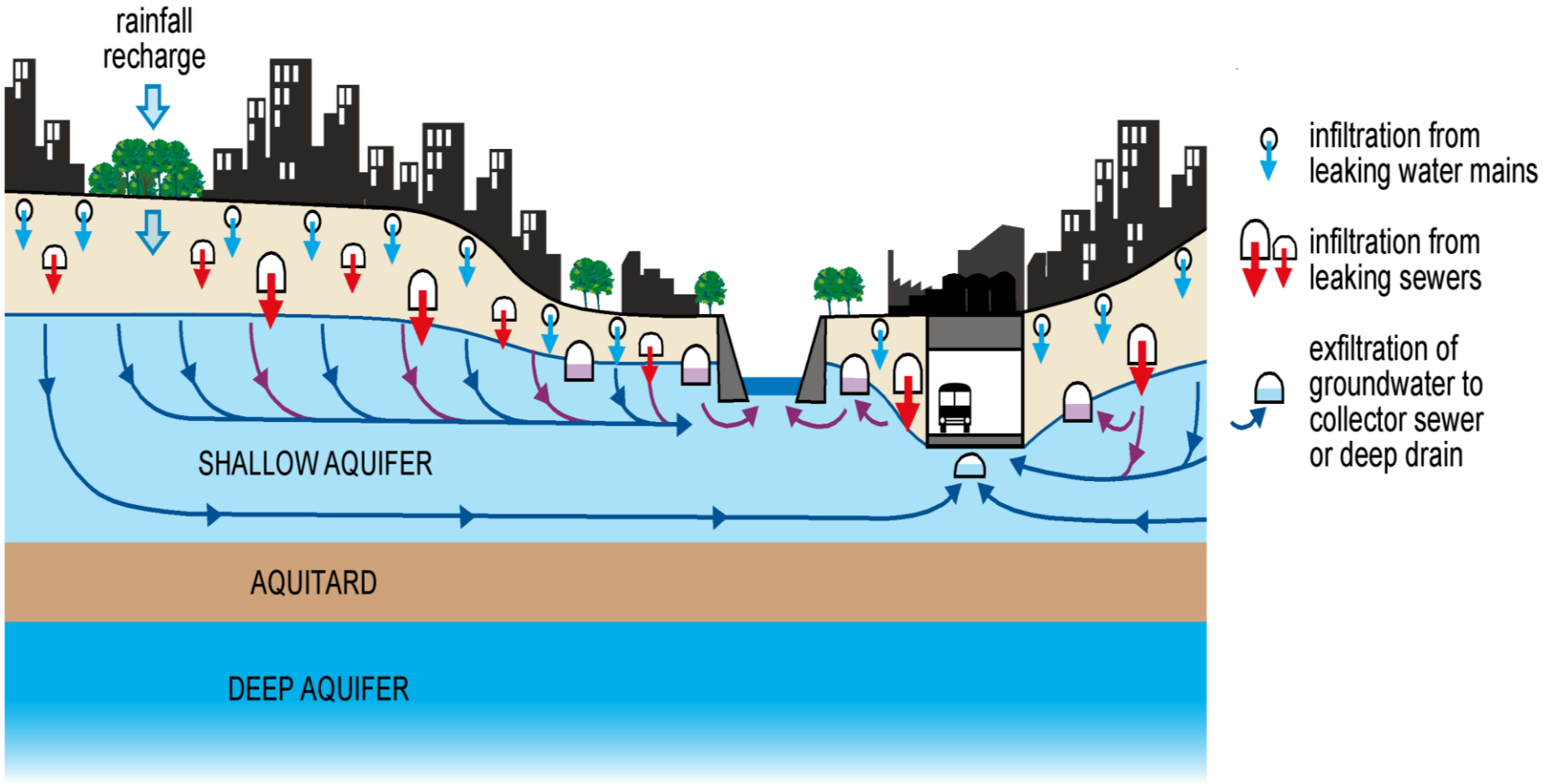
GROUNDWATER AND THE CITY
an intimate but often unrecognised relationship



SIGNIFICANT VARIATION WITH

- **HYDROGEOLOGIC SETTING – especially aquifer yield potential, accessibility, and physical confinement/oxidation status**
- **UTILITY WATER-SERVICE ARRANGEMENTS – evolution, water-supply availability/affordability, and sewerage system coverage**

URBAN GROUNDWATER RECHARGE
relation with water-service infrastructure



URBAN GROUNDWATER MANAGEMENT
filling the 'institutional vacuum'

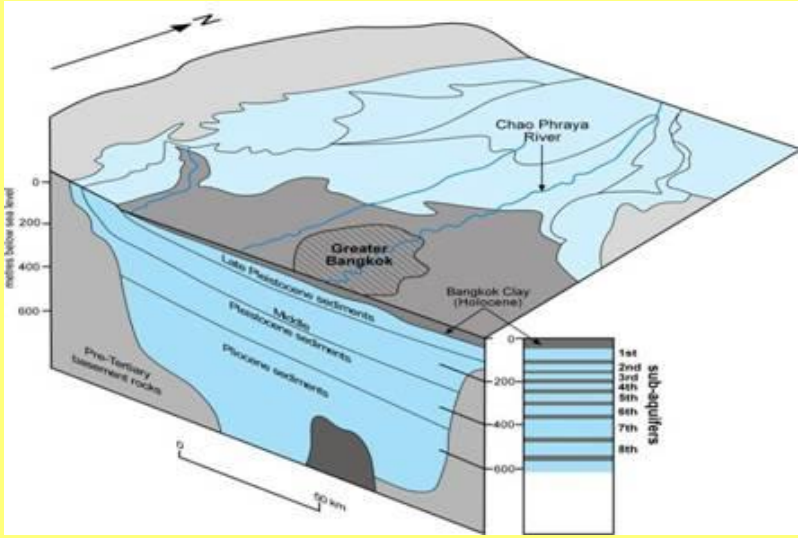
- groundwater use much more significant in overall water-supply than generally appreciated, and it forms 'invisible link' between various facets of infrastructure
- much water use/effluent disposal is unregulated or 'illegal' – thus little discussed by infrastructure sector
- urban groundwater affects 'everybody' but often responsibility of no 'body' – institutional vacuum
- broad stakeholder involvement needed through 'standing review panel' or 'stakeholder consortium' - but who should take management lead ?

(municipal authority, water resource regulatory agency, public health ministry, water utility, chamber of commerce, etc)

LIMA - PERU
successful application of demand-side and supply-side measures

720 Ml/d
(+320 Ml/d private)

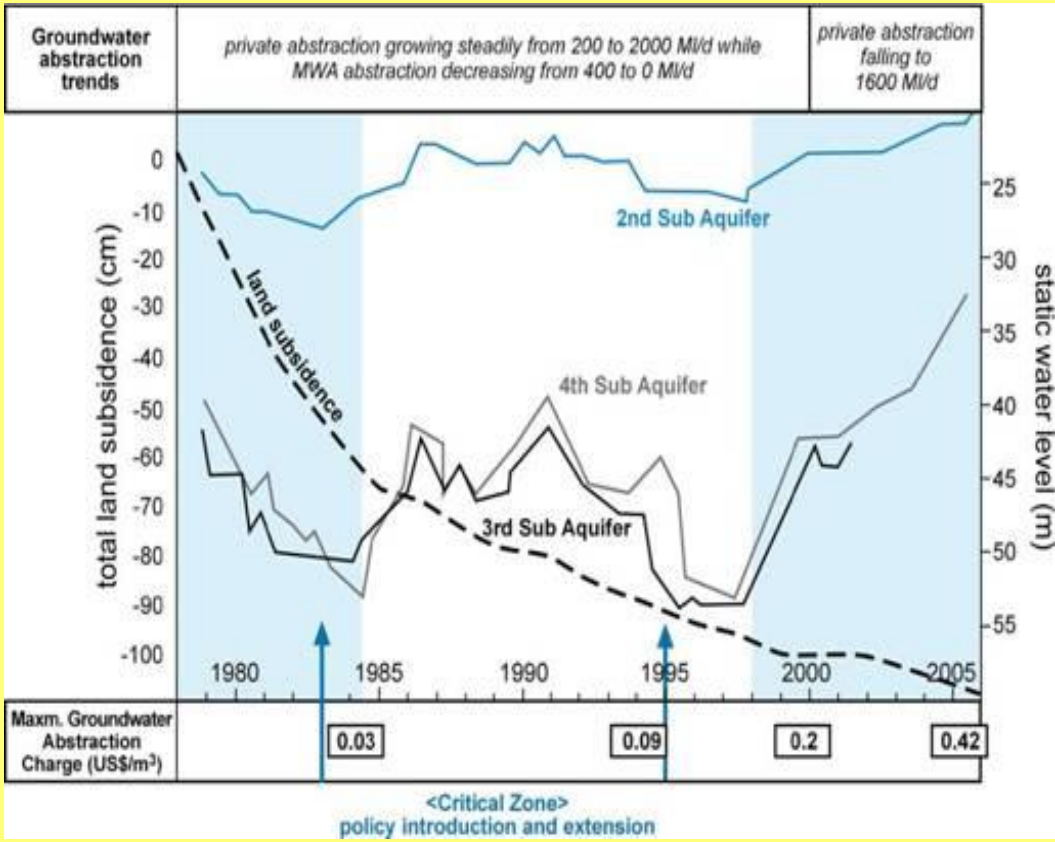
BANGKOK - THAILAND
successful aquifer stabilisation through integrated management



- excessive (private) groundwater exploitation threatened irreversible aquifer degradation and environmental impacts

- variety of measures taken :
  - partial ban on new waterwell construction and period for closure of some existing wells
  - alternative source of municipal water-supplies in some areas
  - metering and progressive charging for groundwater use

- succeeded in stabilising aquifer condition in late 1990s with some subsequent recovery



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GROUNDWATER GOVERNANCE FRAMEWORK
key provisions

- **CLEAR MANDATE**
  to specific national/local agency for groundwater governance (responsibility, authority, finance, capacity and accountability) in parallel with surface-water management
- **SYSTEMATIC PROCEDURE**
  for agencies to follow for groundwater management and protection planning (involving identification of key groundwater bodies and their socio-economic/ecological importance, assessment of resource and quality status/risks, definition management measures, periodic review of effectiveness – ensuring 'vertical integration' between local and national agencies)
- **POLICY INTEGRATION**
  by national agency – effective coordination with agricultural production, urban water-supply, energy pricing, land-use control

GROUNDWATER RESOURCES MANAGEMENT
key instruments and tools

- uncertain water-futures due to effects of land-use and climate change, and varying economic drivers
- groundwater use rights should be subject to periodic review – with 'restriction zones' established as needed
- user participation essential (to move social behavior from 'destructive competition for dwindling storage' to 'productive use of available recharge') – with information transparency to counteract corruption
- much improved measurement/monitoring required to refine resource evaluation and provide evidence for management decision-making
- finance of agreed programme of management measures (demand management, supply augmentation and crop changes as appropriate)

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