GLOBAL WORKSHOP
CONJUNCTIVE MANAGEMENT OF SURFACE WATER AND GROUNDWATER: NATIONAL TO TRANSBOUNDARY LEVEL
16 – 17 (am) October 2023
UN ECE Geneva

Conjunctive use, management & governance

Present status, future trajectory, actions suggested

Shammy Puri, Director, Centre for Sustainable Solutions with Practical Hydrogeology

Findings from the pre workshop questionnaire

Summary of responses

SUMMARY	**No of replies**	**67**
Fully engaged		42
planning at advanced level		33
Implementation > 5 yrs ago		35
…. domestic project		29
….. transboundary project		34
It is both domestic & transboundary		15
…. of these, the number with regs in place		10
Governing rules in place		31
	Note 11 'null' entries in questionnaire	
	Thus actual respondents =	**56**

Main Points (see also the TECHNICAL NOTE)

Present status..

Most river basins in imbalance … ie “not enough water …or too much at times..” Why ? Anthropogenic impact with sup erimposed climate change

Globally primary surface water use is for agriculture – as shortage gets persistent, users drill wells and pump to augment declining irrigation water… ie they are drawing on two sources of water – this is conjunctive use.

Literature shows that this action is “spontaneous” : shortage? Augment from another source…. A lot of users acting spont aneously means chaotic water withdrawals and consequent tragedy of the commons.

Future trajectory …

Either …. Continuing spontaneous actions … due to past governance failures

Or ….. Planned actions – but since ‘the horse has bolted’, so need for retrofitting …

Actions suggested…..

In any new investments, carry out the required planning, & pre investment feasibilities.

Transform the **spontaneous** situations to a new regime, through **retrofitting** suitable techniques, taregtted investments, revised institutional responsibilities and a relevant legal framework.

This is not easy – but problem is not unsurmountable.

It will need quantitative science … direct link between the science and policy, explicit statement of economic benefits, poli tical will, access to finance (if subsidised, then with explicit costing in of externalities),

This is already complex at the domestic scale

At the transboundary scale the complexity is orders of magnitude greater - again – Not insurmountable, but resources ne eded (human, financial, technical) will discourage most investments in the current global socio political conditions)

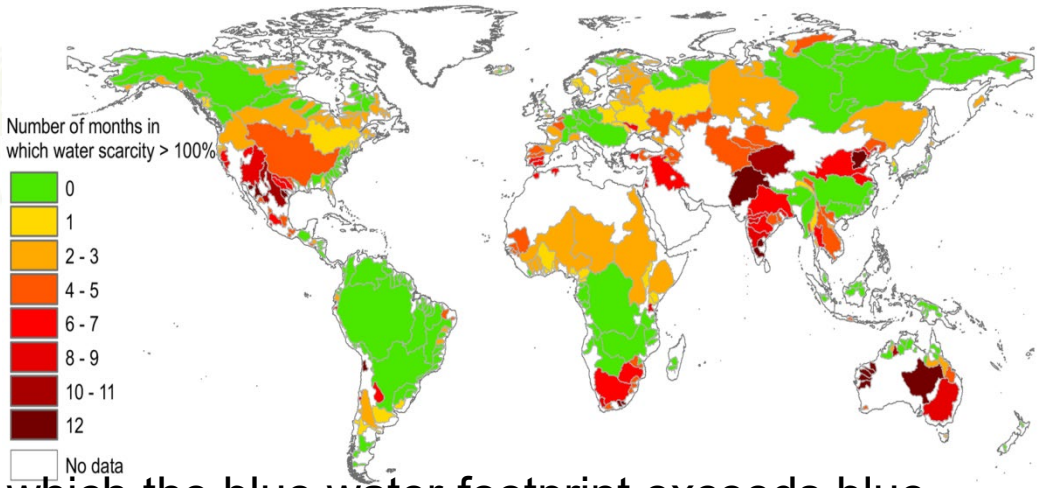
However, the effort is needed more urgently than ever before.

Globally, river basins are in imbalance

Hoekstra AY, et al (2012 & 2016) Global Monthly Water Scarcity: Blue Water Footprints versus Blue Water Availability.

Global Monthly Water Scarcity: Blue Water Footprints vs Blue Water Availability (~ agric)

405 river basins = 69% global run off, 65% world population data 1996- 2005



Number of months during the year in which the blue water footprint exceeds blue water availability for the world's major river basins, based on the period of 1996–2005. (NOTE- the conditions to 2023 have worsened significantly)

Blue water availability refers to natural flows (through rivers and groundwater) minus the presumed environmental flow requirement. Aquifer storage is disregarded

Axarquía town halls set to agree on joint water-saving plan as drought crisis continues

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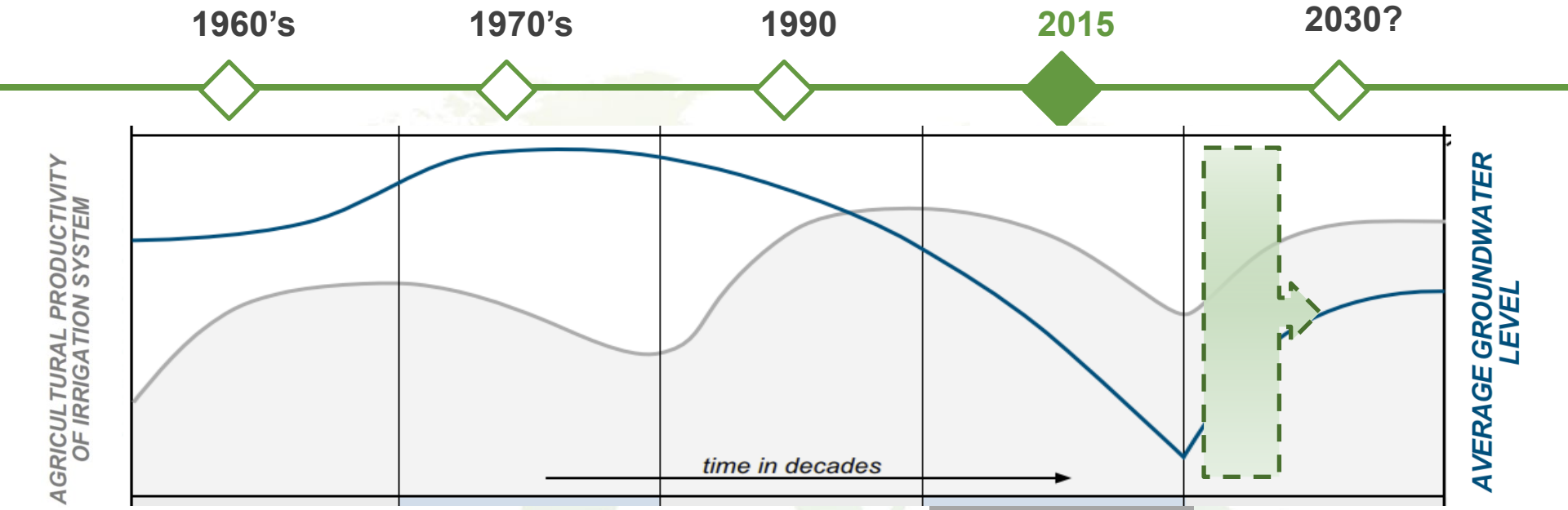
How did we get here …?

Surface water irrigation to “spontaneous” (chaotic) conjunctive use



SURFACE WATER: Initial benefits

SURFACE WATER: excess irrigation - over draughts

RANDOM WELL DRILLING Improved agricultural productivity

CHAOTIC WELLFIELD expansions – surface & groundwater exhausting..

RETROFITTING: rearrangements, optimisation

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PAPER

Below the radar: the boom of groundwater use in the central part of the Nile Delta in Egypt

Doaa E. El-Agha[1] · Alvar Closas[1] · François Molle[1,2]

Spontaneous!!

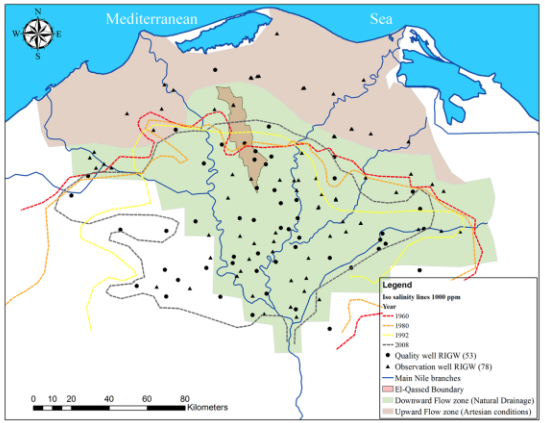
Received: 5 June 2016 / Accepted: 8 March 2017 / Published online: 3 April 2017

Abstract The Nile Delta of Egypt is known for its large irrigated area supplied with water diverted from the Nile River, with a limited use of groundwater, largely for domestic and industrial use. Official statistics for the whole delta indicate that there are a few thousand individual wells used for agriculture by a population of over 2 million farmers. This study, however, shows that a phenomenon of groundwater development for irrigation has been unfolding over the last few years, largely below the radar of managers and researchers. A survey was carried out in the central part of the delta with the objective of (1) uncovering the actual situation of groundwater use in this part of the delta and (2) speculating on its implications. The results of the survey pointed to a recent and booming tube-well drilling industry, with well densities in some parts explores the implications of unchecked abstraction at the farm, local and delta scales.

Keywords Egypt · Socio-economic aspects · Over-abstraction · Legislation

Introduction

Groundwater plays an increasingly important role in water supply all over the world, as the competition for water resources increases (Famiglietti 2014; Gleeson et al. 2012; Wada et al. 2012). Intensive groundwater use for agriculture



Well documented

Rich literature that records the situation in all regions – but actions are rare, while urgency is greater

Conjunctive groundwater use: a 'lost opportunity' for water management in the developing world?

Stephen Foster · Frank van Steenbergen

Keywords Water resources · Conjunctive use · Groundwater management · Groundwater resources

Conjunctive groundwater use: an important but neglected topic

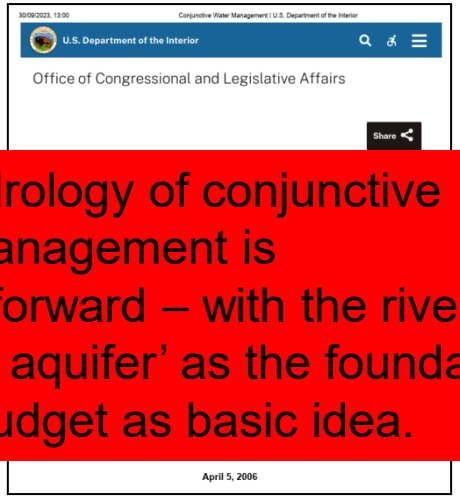
Conjunctive groundwater use with surface-water resources has only occasionally been considered in the hydrogeological literature and at scientific conferences (e.g. Bredehoeft and Young 1983; Sahuquillo 2002), although *in terms of practical water management* it represents one of the most important responses to improving drought water-supply security and for long-term climate-change adaptation, and *in terms of underpinning science* its design requires a refined understanding of resource interconnectivity (both naturally and perturbed by irrigation works or practices) and of aquifer salinisation processes.

The aim of this essay is to provide an overview of current conjunctive use in the developing world for both irrigated agriculture and urban water-supply, and to highlight the great potential that planned 'conjunctive management' has as a climate-change adaptation strategy. It is primarily relevant to larger alluvial plains, which often have important rivers, large-scale irrigation systems and major aquifers in close juxtaposition—although the potential for conjunctive management can be present in a wider range of settings.

There is no rigorous definition for 'conjunctive use'; however, for the present purpose it is proposed to consider only situations where *both* groundwater and surface water

Adopting this rather narrow definition excludes consideration here of artificial recharge of aquifers with surface runoff or by rain-water harvesting (without direct supply from the surface-water source), use of groundwater pumping to support river baseflows (without direct supply from water wells) and catchment-scale integrated water-resources management embracing everything from flood protection to wastewater reuse - because of insufficient finance as yet to apply these techniques in the developing world, although it is recognised that all such techniques can play an important role in water-resources management.

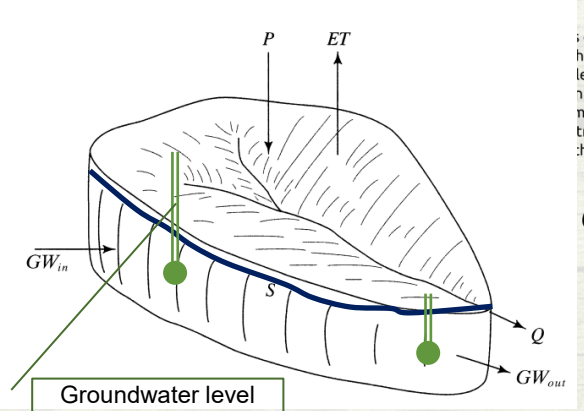
A key characteristic of conjunctive use is that it deploys the large natural groundwater storage associated with most aquifers to buffer the high flow variability and drought propensity of many surface watercourses (Foster et al. 2010a), and is thus capable (at varying levels of efficiency) of achieving: (1) much greater water-supply security—by taking advantage of natural aquifer storage, (2) larger net water-supply yield than would generally be possible using one source alone, (3) better timing of irrigation-water delivery—since groundwater can be rapidly deployed to compensate for any shortfall in canal-water availability at critical times for crop growth, (4) reduced environmental impact—by counteracting land water-logging and salinisation, and excessive river-flow depletion or aquifer over-exploitation. These benefits have been the driving force for spontaneous conjunctive use of shallow aquifers in irrigation-canal commands worldwide.



The hydrology of conjunctive use / management is straightforward – with the river 'basin – aquifer' as the foundation & water budget as basic idea.

". Its in the water budget…, stupid!" (with apologies to Bill Clinton)

The calculations can be trivial, but tricky…



Groundwater level observation wells

discharge
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Q

Assumptions

Erroneous –
And can be quantified in the field quite easily with the help of instrumentation, data loggers, etc

Inputs (I), outputs (O) and storage (S):
I: Precipitation (P)
Groundwater in (G_{in})
O: Evapotranspiration (ET)
Groundwater out (G_{out})
River discharge (Q)
Storage (S): In groundwater, rivers and lakes

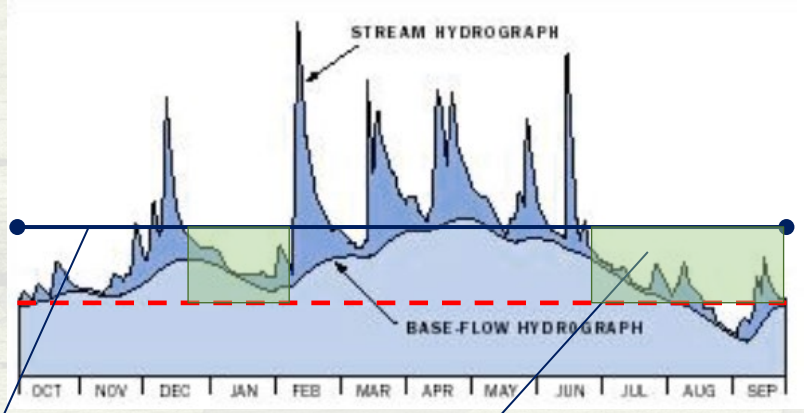
What can we usually measure?

P: rain gauges
Q: stream gauges
ET: hard to get except local values
G_{in}: hard to get, assume zero
G_{out}: hard to get, assume zero
S: often hard to get

$\Delta S = P + G_{in} - (Q + ET + G_{out})$

If we assume that G_{in} and G_{out} are negligible, and that for the long-term annual mean, ΔS is zero, then:

$P = ET + Q$, or $ET = P - Q$



Canal diversions

Aquifer withdrawals

Water level logger

SKU: BL108

PS ID: 5225

£319.00

Water level recording equipment can be used for several applications: Short term installations, for example to monitor water level draw [...]

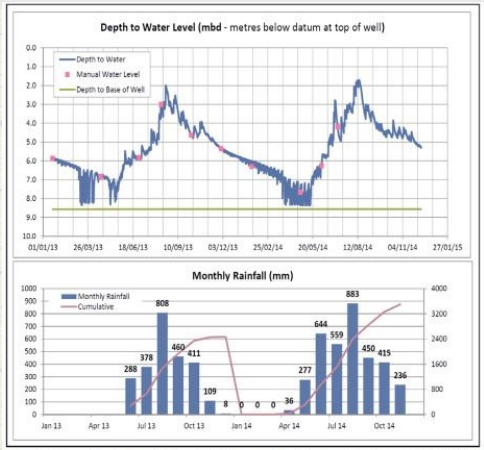


Figure 2: Groundwater level data collected every 15 minutes using Rugged TROLL® 100 Data Loggers, compared to monthly rainfall totals.

Conjunctive management

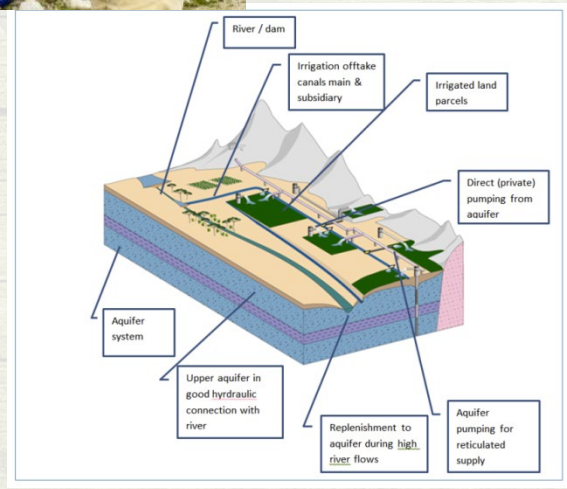
Riverflow hydrograph

Baseflow separation

Groundwater level hydrograph

=

Operating rules



Use, Management & Governance

When two (or more) resources are deployed to complement each other

Use: specific definition of what the water will be deployed for – irrigation, municipal needs, industry, aquatic ecological needs

Enables proper definition of the financial flows required

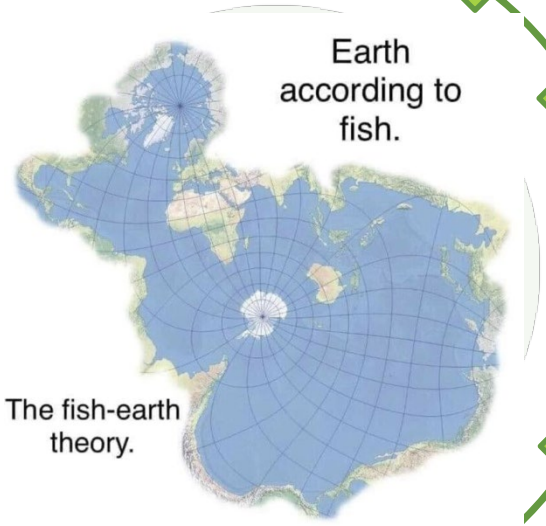
Management: physical operation of the system opening / closing diversion canals, turning off / on of pumps,

Defines who will do what – irrigation operators / well owners

Governance: the set of rules, regulations, and obligations .. that all parties agree with, and adhere to.

Provides a com mon framework for regulators and regulated

Operation is conjunctive when….



- **A** — **Know your demand**: Well defined demand – so that financial flows can be put in place … charges, fees, subsidies
- **B** — **Quantify hydrology**: Flood flows, mean flows, minimum flows, ecological requirements
- **C** — **Quantify hydrogeology**: Well yields, drawdown distribution, annual recharge, pumping rates, borehole design
- **D** — **Formulate operational rules**: Behavioral science, user needs, gender, socio – economy, willingness & ability to pay
- **E** — **Ensure Cost recovery**: Operation & maintenance, charging system, taxation / subsidy, user organisation

Climate change and water: warmer oceans: flooding and droughts – EEA 2018.

There is an inevitability, that unless we can transform to conjunctive governance, we can expect serious multi sector disruptions

Domestic vs transboundary

All that was domestic – transposed into both jurisdictions

If inevitable in the domestic context – it is crucial in the transboundary context – but caution and good preparation are critical

Retrofitting to spontaneous investments

The horse has bolted – bring the horse back to the stable

01

INVESTMENTS

Infrastructure is already in place – some organised (canals), some chaotic private wells

02

OPERATIONS

Canal delivery systems operated by an agency; Well operations – private and as needed

03

GOVERNANCE

Regulations & institutions serving canal delivery; no rules for well drilling, pumping and use

04

GOOD THEORY – POOR PRACTiCE*

A 1991 review concluded that the practice was constrained. Current situation has not changed significantly.

Future Trajectory ??

*Vincent & Dempsey 1991 – Irrigation Management Network ODI, Network Paper 4

The opinion of practitioner experts and think tanks is, that Business as Usual must not be an option.
Many good practices are underway.
From them, there are some lessons, which will help to change behaviour – from chaos to consistency.
UN ECE & Partners could take the advocacy lead.
Member states contribute & benefit.

Practitioner study initiative

Historical review, analysis of success and failures, innovatitive solutions,

Global inventory

Catalogue of success case histories

1 size does not fit – series of typologies

Demonstration programme

Inventory

Literature search, on line surveys, selected interviews

Case Histories

Sifting case histories for compiling best practices

Typologies

Hydrological – hydrogeological – agriculture, muncipality

Demonstration

Through donor funding, agro – industry investments

If you would like to help with the practitioner study, please get in touch

Thank you !

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