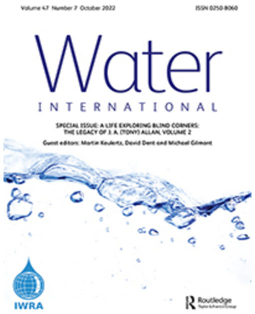

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VIEWPOINT

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Irrigated agriculture: more than 'big water' and 'accountants will [not] save the world'

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ABSTRACT

Two of Tony Allan's phrases – *big water* and *accountants will save the world* – invite me to argue that irrigation is poorly served when its hydrology is seen solely as *big* or via *accounts*. While *big* applies because irrigated areas deplete considerable volumes of water, irrigation systems contain many more water relations, behaviours and puzzles. In this problematic, environmental, social and governance (ESG) and water accountants and accounts will become a dominant force. This is worrying for the degree to which individual irrigation systems are rendered into catchment-level accounting abstractions, removing us from a more vital, multidisciplinary, cross-scale and action-oriented approach.

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Corporate accounting; environmental; social and governance (ESG); food water; hydrology; irrigation efficiency

Introduction

Two of Tony Allan's phrases – *big water* and *accountants will save the world* – prompt me to voice concerns about the future of irrigation hydrology knowledge (IHK). I worry that IHK is moving towards *accounting–abstraction–absolutism* (AAA), by which I mean desk-based modelling, supported by remotely accessed data, leading to quantification abstractions that create blueprint irrigation policies and quasi-scientific paradigms and principles. With this shift, IHK is moving away from *system–action–transformation* (SAT) characterized by an action-oriented, grounded, field-based, farmer-partnering, system-specific, empirical approach that acts in the real world; testing, experimenting, observing and measuring. I fear that if current trends continue, accountants will swamp, rather than save, the world. That is, they and their methods will shape our thinking and policies for many years to come. This will bring some benefits but, on the whole, it will make the change management of sustainable catchment-fitting irrigation systems much more difficult. If my AAA fears come to pass, the future of IHK will not be recognizable as saving the world.[1]

The expression *big water* works because irrigated agriculture as a sector and total area consumes huge volumes of water, produces considerable amounts of food, feed and fibre, and creates sharp externalities and opportunity costs that fall on other sectors such as cities and the environment (Keulertz & Allan, 2019). *Big* also allows us to distinguish the difference between this water and non-food water (Allan, 2013), meaning water for other sectors. Into this problemscape, accountants, business consultants and economists and their hydrological accounts (note, not the financial accounts of irrigation systems, nor hydrologists with

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hydrological computations) are set to become a dominant force in the science and understanding of irrigated hydrology – as Tony predicted when he affirmed Peter Bakker's argument (Allan, 2019; Bakker, 2013), that 'accountants will save the world' (AWSTW) as part of Tony's prognosis that 'farmers, accountants and optimism' (FAO) will help meet global water challenges.

Just as with his *virtual water* concept (Allan, 2011), we can marvel at Tony's ability to capture a changing problem/waterscape in so few words. His use of expressions and handles encouraged debate, invited non-irrigation policymakers to the table and released funds for research. It is a skill that few of us have and more need. In the spirit of that invitation to debate, I now comment on the downside of irrigation accounting.

Irrigated agriculture is more than a *big* volume

The volume of water withdrawn into and consumed by global irrigated agriculture is *big*. Assuming the global area under irrigation in 2022 is 350 million ha, and the average depth equivalent of water consumed (not withdrawn) is 800 mm per annum (equivalent to one season of rice cropping or two non-rice crops), then approximately 2800 km^3/year of water is consumed. For comparison, this is about 50 times the daily domestic water consumption of, say, 20 litres per person per day for the world's 8 billion people. Furthermore, *big* continues to expand: the growth in global area irrigated exceeds global population growth (Puy, 2018).

So significant are these volumes that irrigation systems reshape the hydrology and society of the catchments they occupy (Damonte & Boelens, 2019). This reshaping brings water-governance problems such as how to share water between competing sectors (e.g., the environment and growing cities) whilst retaining desirable agricultural outcomes. Tony posited 'FAO' as the answer to these questions. I fully accept FAO as a partial answer, but believe it falls short of the mark. To follow my criticism requires some discussion of whether irrigation is more than *big*.

What is the puzzle (or problematic) of irrigation? Once we might have defined irrigation as the withdrawal and distribution of water from an intake via canals, pipes, outlets and fields to meet crop evapotranspiration needs (ET) not furnished by rainfall. This anodyne definition contains some of the volumetric accounting aspects of irrigation such as the deficit between rainfall and ET, and the difference between withdrawal and ET consumption.

However, irrigation is much more than a *big* volume or that is captured by 'in and out' accounts. In today's water-scarce/-variable catchments, the hydrological puzzle of irrigation is sharply drawn and is growing. In my humble attempt to mimic Tony's handles, irrigation is a puzzle because it is:

- *Turn water*: farmers on gravity systems[2] share, use and pass on flows of water known as leadstreams (*main d'eau*). This means farmers are socially and materially connected to each other and to how water cascades, bifurcates and distributes through an irrigation network.
- *Timely water*: in a soil profile with a limited storage capacity of 3–15 days of available water, irrigation must be applied on time. To time irrigation requires a gamut of design, operation and maintenance factors to work coherently. Low irrigation efficiency in canals and fields slows down this timing.

- *Fractal divisional water*: the continuous division of water happens from intakes on a river down to secondary and tertiary canals, and on down to farms, fields, parts of fields and individual plants. This sets up competing/equity relations between branches of those bifurcations not easily captured in water accounts (Lankford, 2012). Furthermore, unlike all-too-neat water accounts, which sees water clearly split into 'disposal fractions', the ever-cascading division of water flowing through an irrigation system is coupled, obscure, difficult to track, hard to measure and nearly impossible to manage separately and distinctively.
- *Conjunctive water*: farmers are adept at managing overlapping sources of water from soil water storage, direct rainfall, groundwater, rainfall runoff/harvesting, capillary rise from shallow water tables, and water from streams, rivers, storage and non-conventional sources, e.g. wastewater. This means it is difficult to ascribe changes in cropping patterns solely to one source of water or to one variable such as irrigation efficiency.
- *Common water*: via withdrawal and consumption, irrigation is part of a commons connecting people competitively and cooperatively at all scales, for example, farmers on canals, and cities to their neighbouring irrigation systems. Even the *water commons* can be further characterized, for example, via the non-consumption and release of freed-up water salvages, irrigation systems play their role in the catchment *paracommons* (Lankford, 2013).

Even these handles do not describe the 'more-than-big' and 'more-than-accounting' aspects of governing catchment-, climate- and economy-fitting irrigation.[3] In irrigation systems that are often inadequately designed, operated and maintained, water supplies have to match demand in the face of imperfect information in a highly socialized, spatially differentiated knowledge-scape: that of farmers and water-use groups. This imperfectly known environment is easily buffeted and shaped by an array of experts who decree that 'today's irrigation is inefficient' or 'is consumptive', but 'tomorrow's will be more efficient and less (or paradoxically more) consumptive' as long as 'this technology', 'that rule and institution', or 'these *xyz* methods of analysis' are adopted or that 'water depletion only should be managed'. Put simply, my comprehension of the puzzle of irrigation means we need SAT. Favouring such an approach, I question the rise of water accounts, accountants and accounting in IHK.

Accountants will save the world (AWSTW)

In emails dated 29 September 2015, I cross-checked with Tony what or whom he meant by accountants. In the light of this exchange, his writings and presentations, I surmise he meant people with accounting, business, financial and economic backgrounds who report on hydrological accounts of water use in irrigated systems and food supply chains. What he was driving at was that water should be properly valued and this value should be accounted for in the price of things water goes into, especially food (Allan, 2019; Allan & Dent, 2021). With AWSTW, Tony wanted accountants to shift their focus from corporate risk-measuring to being much more involved in wider monitoring, and in deeper ethical decisions about societal- and consumer-led trends in global value chains. Quoting from his emails:

> When speaking about the role of accountants in public, my purpose is to draw attention to their potential role in changing behaviour in private sector food supply chains and Better Accounting Rules, Responsible Private Investment and Sustainable Public Policy so that we have sustainable markets rather than blind and dangerous ones.

In keeping with his *virtual water* insight (Aldaya et al., 2010; Allan, 2011) he wanted society to bring light to 'blind' markets that cause crops to be irrigated in water-scarce catchments despite consuming much more water and bringing less income than, say, microchips or hotels.

So here we are in 2022, and Tony's prescience was spot on, and as evidence of that I draw attention to a growing need for non-financial environmental, social and governance (ESG) reporting (Markota Vukić et al., 2018), and the burgeoning ESG staff recruitment plan by the 'Big Four' (PwC, KPMG, EY, etc.) and other accounting firms to fill that growing need.[4]

However, much as I see the benefits of well researched water accounts, I am far from convinced about AWSTW. From now on, I characterize *accountants* by method and training rather than by career designation; in other words, an irrigation engineer can be an accountant if he or she intervenes in irrigated systems primarily via accounting methods. And an accountant by job title is an *irrigation transformer* when working with farmers applying multiple IHK methods. Also, the quality of engagement on both sides matters; irrigation systems can be informed and transformed by diligent accounting of the right metrics at the right scale, or be harmed either by accounting delivered to lax standards (Bennett & James, 2017) or by SAT that is not systematic and self-learning.[5]

Towards accounting–abstraction–absolutism (AAA): accountants swamping not saving

Let me be clear; if well conducted, resource accounting brings clearer science and policy oversight to economic, hydrological and environmental trajectories at the basin level (Delavar et al., 2020) plus visibility to inter-state/-nation water conflicts (Bassi et al., 2020). What I fear is that handing sole or major responsibility for steering these trajectories to accountants will substitute other expertise and greatly weaken our ability to deliver water systems that are equitable, productive and sustainable. Far from the forensic oversight that Tony sought, accounting reports are often incomplete, without a common framework and in need of reform (Davies et al., 2020). Worse still, they can be incurious, blind and biased, or narrowly descriptive, as demonstrated by Coca Cola's claim for replenishment that aims to 'safely return to communities and nature an amount of water equal to what we use in our finished beverages' (quoted in Rudebeck, 2019), which highlights the water consumed for manufacturing beverages but ignores the water consumed in irrigating sugarcane. We should be further concerned by the political economy and financialization of resource accounting (Rudebeck, 2022) and ask who pays for and referees ESG accountants and their methods and reports, which Tariq Fancy terms 'convenient fantasies' (Fancy, 2021).[6]

But even good ESG accounts will be insufficient to incorporate the puzzles I introduced above in order to steer complex, multi-scale irrigated systems towards desirable basin-level outcomes. The shortfall lies with the substantive way that accountants render and abstract the world into *accounts* (Sullivan & Hannis, 2017) which emphasize selected countable or quantifiable dimensions of the material world but demote or exclude other dimensions. An

Table 1. Irrigation hydrology knowledge (IHK): accounting–abstraction–absolutism (AAA) and system–action–transformation (SAT).

Future IHK pathways	AAA	SAT
Main foci and benefits	Higher scale outcomes and trajectories at the basin or system level over longer time periods. To guide decisions on basin allocation and sustainability	Lower scale, quicker time-span workings and underlying factors that create higher scale outcomes. To guide water management to achieve system performance and basin sustainability
Main location	Desk based	Field, system and farmer based
Knowledge evolution and ethical praxis	Towards accounting abstraction	Empirically triangulated by the material and human world
Quantitative calculations	Cost-curve methods, water accounting, water footprints	Bespoke calculations for the problem at hand
Views on irrigation efficiency (IE)	All traditional systems are inefficient and leaky. All modern systems are efficient but either save water or consume more water	Fluid, recursive, hybrid, heterogeneous and overlapping
Sources of IE information	The first few pages of returns from a web search engine	Multiple sources working at all scales
Professional training	Professional accounting qualifications plus MBAs that include environmental, social and governance (ESG)	Irrigation, soil science, agronomy, hydrology, engineering, social science, practical experience
Evidence for growth/ shrinkage	'Big Four' ESG recruitment. More than 2500 MBAs available in English globally[a]	At the time of writing, no dedicated MSc/ MEngs globally on irrigation

Note: [a]See https://find-mba.com/what-is-an-mba/.

irrigation system is a true system wherein many underlying, smaller, more numerous or seemingly inconsequential, qualitative, human or non-material dimensions affect other, larger or more material outcomes. Therefore, the change management of irrigation with its many factors cannot be guided by ESG accounts that report on meta- or basin-level water disposals. On the contrary, irrigation systems need the integrated thinking that I label SAT; partnering with irrigation systems and their farmers and engineers using an array of worldviews, skills and work modalities.

I have divided these two approaches to IHK in Table 1. On the left, AAA abstracts the complex world of irrigated systems into numbers and axioms. On the right, SAT puzzles out this world using heterodox methods and information sources.

The rise and rise of the ESG and water accounts and accountants

I predict the next decade will see AAA ascend and SAT decline. What is driving this?

- The need for international companies, including financial companies, involved in the food-value chain to identify risks whereby a lack of water might disrupt production and profitability (Rudebeck, 2022).
- The Big Four recruitment drive for ESG analysts responds to other growing forces: the need for organizations to report on environmental sustainability to shareholders and the wider public, or for investment (Davies et al., 2020) and regulatory purposes (Markota Vukić et al., 2018).
- The economics of ESG/AAA are attractive: desk studies are extremely cost-effective. A consulting company can charge considerable daily rates for environmental reporting, and if reports appear to show numeracy and competence, there is no need to add costs by visiting the field and meeting farmers (let alone measuring agrometeorology, water flows, start–stop times and areas irrigated).

- AAA methods, accounting aims and system comprehension co-create what appear to be credible change-management paradigms. For example, McKinsey devised the *Cost-curve Model for Decision-making* as a basis for investing in and modernizing irrigation systems (2030WRG, 2009), which eventually brought 2030WRG-led switches from canal to drip irrigation in Karnataka, India (Meland, 2021). As a contribution, it merits discussion, but as a universal blueprint, it ignores local geography, sensibilities and trajectories (Dyer & Counsell, 2010) and fails to identify who bears the costs of such changes (Lobina & Hall, 2009).
- Similarly, water research institutes need to sell water accounting services and thus claim these services span a very wide set of scales 'from field-to-basin' and serve 'communities'.[7]
- It is relatively easy for a water accounting person to advise how to improve irrigation systems when reproducing advice from internet-based sources. Over the years, many people (ecologists, economists, civil engineers, agronomists, etc.) have told me what constitutes better irrigation, despite no sign they have managed or systematically researched irrigation performance. Recommendations tend to be: line canals; irrigate at night; add soil moisture measurement; instal drip irrigation; laser-level fields; fix leaks; meter canal flows; train farmers on soil and water management; and create water user groups. It is not that these are individually wrong, but what troubles me is *how* they are dropped into the discussion. To me these shibboleths reveal that the adviser knows little about irrigation. There is no commensurate sense of how to think about these solutions such as: what the baseline performance might be; how effective they might be (for different purposes); their cost and who bears this; in what order of priority; their 'system' fit (to each other and to the local situation); how farmers might use and own these technologies or have equivalent solutions and different priorities;[8] or that many 'design-manageability' reforms never get mentioned such as the density of canal network per hectare, retrofitting of manageable hardware or how to design-in the water duty down to a tertiary scale (Lankford, 1992; Lankford & Gowing, 1998). And it appears there is little awareness that there is a debate (still incomplete in my view) on irrigation manageability (Horst, 1999; Plusquellec, 2002; Plusquellec et al., 1994).
- Similar to the previous point, it is relatively easy to confidently take up a position on one side of the *inefficient–efficient* binary. For example, one can assert that gravity irrigation schemes are inefficient, should save water and need to be modernized (for the critical discussion on this, see Lankford, 2004; or De Bont et al., 2019) or that modern irrigation systems are efficient but, paradoxically, raise water consumption (Food and Agriculture Organisation (FAO), 2017). But axiomatic pronouncements about the efficiency status of heterogeneous *peopled* irrigation systems in a state of flux do not equate to the delivery of future performance towards desired aims.
- Irrigation is no longer a senior or international career track. Unlike 20–30 years ago, there are globally no dedicated irrigation master's degrees that view the topic as more than, but includes, engineering. With very few exceptions, irrigated agriculture continues not to attract science research, university posts and teaching, careers and professional development.[9]

Conclusions

Within the space of IHK, the role of accountants in environmental reporting is on the increase. While this to be welcomed for the oversight brought to water governance, it should not substitute for other disciplines whose management modalities involve working with and alongside farmers and their knowledge, practices, irrigation systems and material resources. Plus, although we all need irrigation actors to be more quantitative, accountancy is not the only quantitative voice.

Beyond concerns of: (1) accountants numerically substituting field-based, multi-stakeholder-oriented irrigation actors; and (2) the quality of ESG reporting, there is also a risk of an ontological substitution. By this I mean the manner in which accountants abstract the material world into *high-level accounts* (Sullivan & Hannis, 2017), which, by definition, have removed other important information and, then, generalize from these speculations back down to factors and parameters operating at lower scales. Moreover, the risk is that non-accountants fail to see the significance of this elision and are unable to judge how AAA and SAT work together. Similarly, Wichelns (2011, p. 609), with reference to water footprint analyses, is also concerned about the weaknesses of water accounting abstractions:

> Estimates of water footprints do not contain sufficient information to enhance understanding of water's role in any of its many functions, or to guide policy makers wishing to motivate improvements in water management.

Notes

1. I take this phrase at face value and do not unpack *saving the world*. Also, I did not witness Tony suggesting accountants be seen as additive and complimentary to other irrigation world-views, expertises and skills. Furthermore, I only focus on the 'accountants will save the world' (AWSTW) part of 'farmers, accountants and optimism' (FAO).
2. Water-sharing and turn-waiting also occur in pressurized piped systems if they are poorly designed, operated and pressurized.
3. Many more labels cover the challenges of irrigation. For example, to source and distribute water, farmers manage different energy (e.g., gravity, solar, diesel) and information types (e.g., timing, depth equivalents, area covered, flows).
4. See https://www.reuters.com/business/sustainable-business/pwc-planning-hire-100000-over-five-years-major-esg-push-2021-06-15/; and Big Four accounting firms rush to join the ESG bandwagon
5. During my six years working on and researching irrigation systems in Swaziland, I observed many ad hoc and weak SAT-type attempts to improve irrigation performance in sugarcane systems that had little effect, such as HR Wallingford's failure to get their irrigation software developed for divisional canal systems on flat Asian floodplains to work on rotational canals located on the more undulating landscape of the Simunye system.
6. Fancy is ex-head of sustainable investing at BlackRock.
7. Such as expressed in two quotations from a 2021 job vacancy at a global water research institute for a Water Accounting and Hydrology Postdoc, who should be 'trained in spatial hydrology, remote sensing and water accounting developing tools for water accounting and water balance assessments applicable to a range of scales (from field to basin)'. The job had a remit 'to understand water availability and use, water risks, and water values, the aim is to enhance the ability of African governments, communities and companies to better manage their water resources'.

8. After I used the participatory tool 'the River Basin Game' with irrigators in Usangu, southern Tanzania, they asked not for water training but for bookkeeping training. They knew how to manage water, but wanted to do this more collectively and needed to be confident that their shared financial contributions to the operation and maintenance of irrigation systems could be tracked.
9. 27 May 2021; I checked with Joshua Newton who runs the excellent database at www.joshswaterjobs.com that approximately 1% of jobs posted in the last five years referred to irrigation or irrigated agriculture.

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