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Cities vs. agriculture: A review of intersectoral water re-allocation

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Abstract

Water demand management, or making better use of the water we have — as opposed to augmenting supply — is increasingly proposed as a way of mitigating water-scarcity problems. Moving water away from agriculture to uses with higher economic value is one of the main measures widely seen as desirable. Sectoral "allocation stress" is seen as resulting from the disproportionate share, and inefficient use of water in the agricultural sector. This apparent misallocation is often attributed to the failure of government to allocate water rationally.

This paper revisits this commonly-accepted wisdom and examines the nature of urban water scarcity, showing the importance of economic and political factors, shaped by incentives to decision-makers, and sometimes compounded by climatic conditions. It shows that cities' growth is not generally constrained by competition with agriculture. In general, rather than using a narrow financial criterion, cities select options that go along the "path of least resistance," whereby economic, social and political costs are considered in conjunction. The question of allocation stress is thus reframed into an inquiry of how transfers effectively occur and can be made more effective.

Keywords: Water resources; Allocation; Sectoral competition; Irrigation; Water supply; Water markets.

1. Introduction

Human use of water is reportedly increasing with population growth and economic activity (Molden *et al.*, 2007). As irrigation diversions rise, they tend to displace water's natural functions and impact on ecosystem health. And as cities and economies expand, domestic, industrial, and in-stream uses also start to impinge on the quantity, quality and timing of water flows, not only for the environment but also for existing and potential agricultural uses. Conflicts amongst and between environmental and human uses intensify, and mechanisms emerge — some planned, many unplanned — to rebalance sectoral allocations. In many river basins, water resource development has by now reached — or exceeded — its limits; marginal additional sources provide only very costly alternatives; and new projects reallocate water already appropriated for human or crucial environmental use (Molle *et al.*, 2007a).

Handling these conflicts and the sectoral re-balancing that is implied are a major concern of recent literature on water management. Many believe that better use can be made of the resources at our disposal (Gleick, 2003; Molden, 2007), that water is too often devoted to economically inefficient, low return (usually agricultural) uses and that reallocation to more efficient, high return (usually urban) uses would increase total economic welfare. Others consider that human uses have been satisfied at unacceptable costs to the environment and that this must be redressed. Associated with issues of value are questions related to the mechanisms of effecting transfers to optimize value (however value is determined). What mix of political, administrative and market mechanisms is to be preferred and under what conditions? And how far and in what ways should the resultant mix be regulated to ensure that transfers are achieved in an efficient and effective manner?

Optimization of sectoral allocations is seen by many observers as one pillar of water demand management, defined as a "policy that stresses making better use of existing supplies, rather than developing new ones" (Winpenny, 1997). Demand management employs a variety of measures including price incentives, market mechanisms, quotas, subsidies, conservation, treatment, re-cycling, awareness-raising and education (Frederick, 1993; Hamdy *et al.*, 1995; Winpenny, 1997; Brooks, 1997). For Gleick (2003) such efforts together with decentralization and user participation define a "soft path" approach. Pricing and markets to balance supply and demand have received particular attention (Rosegrant and Binswanger, 1994; Bhatia

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et al., 1994; Tsur and Dinar, 1995; Thobani, 1997; Dinar and Subramanian, 1997; Easter *et al.*, 1998; Johansson, 2000).

Making better economic use of water implies emphasis on its productivity and the economic welfare that can be derived from alternate uses. Misallocation is held to be a manifestation of poor water management and to result in economic inefficiency. Dinar (1998), for example, holds that: "the potential for economic benefits from allocation-oriented institutional change are not only substantial but also increasing with each increase in water scarcity." Rosegrant and Cline (2002) posit that "there is considerable scope for water savings and economic gains through water reallocation to higher-value uses", while Merrett (2003) states that "in the field of water resources management a widely held *belief* exists that allocation stress is to be found in many parts of the world" (emphasis added). The World Bank's (1993) policy paper remarks that the value of water differs greatly between agriculture and other sectors "often indicating gross misallocations if judged by economic criteria" but goes one step further in pointing towards a possible remedy: "Setting prices at the right level is not enough; prices need to be paid if they are to enhance the efficient allocation of resources." Price and market mechanisms are thus not only presented as a means of cost recovery and demand regulation but also as a way of reallocating water towards higher-value uses.

The apparent strength of these arguments is predicated on four interconnected assertions:

1. That agriculture gets the *"lion's share"* of all diverted water resources (70% at world level: much more (80–95%) in developing countries);
2. That agricultural use incurs large wastage, typified by ubiquitous statements to the effect that two-thirds of water delivered to agriculture fails to reach the crop or that irrigation efficiency is typically 30–40%;
3. That the value of water in non-agricultural sectors is much higher than in agriculture, typically by an order of magnitude; and
4. That cities are frequently water short, as shown by cities that ration supplies or fail to guarantee water pressure, either permanently or during dry spells, and by urban areas with precarious or non-existent water supply facilities.

The narrative based on these four statements suggests that water is misallocated, with two implicit corollaries. First, responsibility for this is attributed to the State, since it is generally assumed that the State allocates water through centralized management. This assumed failure prompts proposals for pricing and market mechanisms as an alternative (Holden and Thobani, 1996; Anderson and Snyder, 1997; Dinar, 1998; Rosegrant and Cline, 2002). Second, the contrasting share of water used in agriculture with that in other uses suggests that a relatively limited level of water saving in agriculture would easily make up for the additional needs of the urban sector. This is well exemplified by Gleick (2001) who states that: "The largest single consumer of water is agriculture — and this use is largely inefficient ... as much as half of all water diverted for agriculture never yields any food. Thus, even modest improvements in agricultural efficiency could free up huge quantities of water."[1]

In other words, irrigation profligacy and bureaucratic ineffectiveness help explain urban shortage.[2] Consequently, solutions lie, in part, in demand management in the urban sector but more fundamentally in the improvement of efficiency in agricultural use. Substantial quantities of water can be freed and used in higher value uses, reducing the allocation stress for the common good. Water markets may be instrumental in such reallocation and avoid government failure.

This narrative presents us with a riddle: if large economic benefits are waiting to be realized by shifting water out of agriculture through marginal improvements in irrigation efficiency why do reallocation and related improvements seem so problematic? Why have governments failed to recognize these benefits, especially in contexts where urban bias is pervasive? While not necessarily discarding all the foregoing arguments, we review here the validity of the implicit causal links inherent in the conventional knowledge outlined above. We first briefly look at the validity of the four abovementioned statements, then question the nature of urban water scarcity, and finally analyse empirical evidence on intersectoral transfers. This will take us to the final section where we attempt to revisit the "allocation gap" and its conventional explicative framework. The paper is anchored in a comprehensive review of urban–rural water conflicts worldwide, to which the reader is referred for more detail (Molle and Berkoff, 2006).

2. Agricultural water use and productivity

2.1. Most water is used by irrigation

To stress that agriculture gets the lion's share implicitly establishes a causal relationship between its large share and the allegedly unfulfilled needs of non-agriculture sectors. But irrigated agriculture is a biophysical process that inherently needs a lot of water. In most cases, if practiced, irrigation requires much more water than other consumptive

[1] These points are repeated in countless publications. Winpenny (1997) states that: "The fact that agriculture is such a dominant and, by many accounts, a profligate user of water has led many people to believe that relatively small savings in its water use would be easy to achieve." See similar statements in IRN (2003), Simon (1998), Schiffler (1998), and Postel (2001), among others.

[2] An example of the putative causal link between agricultural wastage and urban water scarcity is given by the World Water Commission (WWC) (2000): "In many public irrigation systems only 30% of water supplied is actually used by plants. This is unacceptable when half of the people of the developing world live on less than $2 a day — and when more than 1 billion people have no access to clean water and 2 billion lack adequate sanitation." See a similar statement in ADB (2000).

uses.[3] Moreover, agriculture's share is typically dominant when the needs of other activities — apart from those of the environment — have yet to demand comparable amounts. This has been aggravated by the fact that states have invested massively in subsidized irrigation development for a host of (sometimes controversial) socioeconomic and political reasons, reasons which tend to be forgotten with time.[4] Where other human uses do in fact compete for significant amounts, the balance shifts and irrigation almost always becomes the *residual* human use after other needs have been met. To stay with animal metaphors, the lion's share is perhaps better described as the hyena's share. In many cases, however, agriculture compensates for this loss by reusing wastewater (as in Israel and Jordan) and/or by displacing nature. Nature thus can be considered the *ultimate residual "user"*; this is discussed later.

Furthermore, irrigation often utilizes flood flows and other marginal sources that cannot provide the level of dependability required by domestic and industrial users. Irrigation thus typically uses a lot of water *at times when* it has no alternative use. In other cases, irrigation and urban networks are disconnected hydraulically and either transfers are impracticable or the costs of storage and/or integration are prohibitively expensive.

2.2. Farmers waste water

Irrigation's dominant share appears consistent with the conventional belief that farmers waste water: therefore, are not large consumers squanderers? The alleged wastage in irrigation has been the subject of a large body of literature, and decision makers and the media worldwide continue to refer to classical irrigation inefficiency in order to stress alleged mismanagement or to justify interventions of one sort or another. Without entering into the details of this question, it is important to emphasize that waste is often relative: if water has no other economic use and is not scarce then *'wastage'* is of little concern other than for any impacts it has on the environment. During the rainy season or in surplus river basins, low irrigation efficiency is thus typically irrelevant.

Even in water short basins, a loss at one point typically flows back to the river or an aquifer and — subject to water quality — can often be recycled downstream. If so, efficiency at basin-level is much higher than within any individual use level. Wasteful practices that result in true losses to the system occur but are not the general rule (Burt, 1995; Keller *et al.*, 1996; Perry, 1999; Molden and Sakthivadivel, 1999; Molle *et al.*, 2004).

In situations of scarcity, tales of irrigation waste are both misleading and unfair to farmers. First, farmers seldom have a say in the amount of water allocated (or not) to them. And, second, irrigation managers and farmers respond to physical scarcity by optimizing water's value to them — adjusting crops, practices and calendars, and developing conjunctive use by digging ponds or wells and installing pumps (Molle, 2004b; Loeve *et al.*, 2003). Except in fully controlled on-demand systems — the rare exception rather than the rule — the stochastic and varying nature of water supply means that the *"hidden hand of scarcity"* provides both real time and longer term incentives for efficient water use; and prompts (costly) adjustments that are often overlooked (Berkoff, 2003).

2.3. Low water productivity in agriculture

That urban water uses usually have higher value to society than irrigation uses is predicated on the assumption that their water productivity, i.e., the ratio of total monetary output to the amount of water used, is higher. But this can be presented in ambiguous terms, either because water does not really constitute a production factor or because like is not being compared with like. According to Gleick (2001), for instance, "supporting 100,000 high-tech California jobs requires some 250 million gallons of water a year; the same amount of water used in the agriculture sector sustains fewer than 10 jobs — a stunning difference". He sees a shift from the latter to the former as providing "tremendous gains in efficiency" as if they were really in competition. There is no indication that high-tech industry is ever short of water and it is equivocal to suggest it competes with agriculture (UNDP, 2006). Only in a few cases is water a significant industrial cost and it is thus often misleading to express total added value in terms of returns to a single factor.

3. The nature of urban water scarcity

Urban water scarcity is often associated with percentages of population not having access to tap water, occurrence of water-borne diseases, or other accounts of poor Water Supply & Sanitation (WS&S) conditions. It is sometimes also linked to alleged constraints on urban expansion or industrial development. This section investigates the nature of domestic urban scarcity and whether economic development is constrained by water being locked up in low-value agricultural uses.

3.1. Physical and economic water scarcity

Records of many "thirsty cities", affected by droughts, suggest physical water scarcity. Cities in arid settings understandably

[3] Whether in rainfed or irrigated agriculture, water needs for basic food requirement are in the order of ten times larger than our basic need for domestic water, and in the order of 500 times larger than our need for water to drink (Abernethy, 2005).

[4] Irrigation has been widely promoted as a tool to deal with food insecurity, rural poverty, unemployment and regional development. Along with its rent-seeking and pork-barrel dimensions, this has frequently resulted in the overbuilding of irrigation systems and the (over)commitment of much of the available water resources (Molle, 2008).

run out of water in their immediate vicinity and must usually opt for costly and distant transfers. Indeed, many cities have developed in the *"wrong"* place and are chronically water short (Winpenny, 1994). Chennai, Mexico City, Las Vegas and Amman are cities that have mushroomed despite limited nearby water resources. Ta'iz grew between 1986–94 at a rate of 7.9%, despite being one of the most water-stressed cities in the world. Even in water-abundant areas, cities outstrip proximate resources when located in upper catchments (e.g., São Paulo, Atlanta, Kuala Lumpur) or in small coastal catchments (e.g., Manila, New York, Boston).

Numerous cities provide water only one or two days per week, conveying a sense of sheer deprivation. Yet, Amman, for example, with its one-day-a-week delivery, still consumes 135 l/c/day (i.e., roughly the European average) (Darmame, 2004). Intermittent supply is at least in part due to a concern for limiting the leakage that would result from constant pressure and is typically dealt with by storage at the household level (Decker, 2004; Briscoe, 1999). Low figures tend to be associated with less-than-ideal water conditions but it is often difficult to distinguish between core needs, comfort, superfluity, excess, and waste. Malé, capital of the Maldives, relies on desalinated water. Consumption is no more than 34 l/c/day though supply is 24-hour and reliable (McIntosh, 2003) and is less problematic, for instance, than Chennai with its 68 l/c/day (Brisset, 2003).

The loose causal link between physical water availability and actual supply is shown by the fact that water-short cities have often been faced with insufficient supply throughout their history, regardless of size.[5] Likewise, there is no shortage of large cities in water-abundant regions with deficient water supply and sanitation systems: e.g., Lagos (Olukoya, 2004) and Calcutta, with their contaminated sources, dilapidated networks and limited treatment and distribution. Bangladesh is another country with abundant water, yet a total of 2.5 million people in the slums of Dhaka are said to suffer from very precarious provision of water and sanitation (UNESCO, 2003). Ho Chi Minh City has quite abundant sources of water, but only 44% of the people have piped water connections to their homes and service is intermittent in 25% of the service area (McIntosh, 2003).

This suggests that the core problem is economic rather than physical scarcity, even if the latter may compound the former. Precarious or underdeveloped infrastructure reflects both inadequate funds and a lack of political will. As stressed by Camdessus (2003) "The root cause [of poor water supply to population] is our negligence and our resignation in the face of inequality . . . All governments, agreeing on the importance of water, subscribe to internationally inspired commitments and undertakings. But their spending performance is at odds with their rhetoric: in most countries the water sector is given a disproportionately small share in the budget." The capital needed for infrastructural development varies widely but the central question is — unambiguously — who is to pay? Not, where are we going to find the water?[6]

3.2. Urban scarcity in times of drought

Instances of drought leading to shortage and conflict are often said to epitomise allocation problems. They also suggest that allocation conflicts are not usually a problem of average but of extreme events, when scarcity has to be shared among users. Are crises due to unrestrained use in agriculture and failure to spare cities by reallocating irrigation water?

In practice, there is overwhelming evidence that the domestic and non-agricultural sectors get priority in times of shortage. In 2005, for example, shortages in industry and tourism in the "Eastern Seaboard" near Bangkok have been quickly diffused by the implementation of six inter-basin transfers and the drilling of 290 artesian wells for short-term relief (Samabuddhi, 2005). Page (2001) cites a survey of Hebei province that showed "how local officials enforced restrictions on farmers but overlooked those on industry to lure projects from which they could profit". The California State Water Project cut off farmers in 1991, and the Bureau of Reclamation reduced supplies in the Central Valley by 75% (Anderson and Snyder, 1997). When Indonesia was hit with a major drought in 1994, residents' wells ran dry but supply to Jakarta's golf courses was ensured so as not to impact on tourism. In 1998, in the midst of a 3-year drought, the Government of Cyprus cut the water supply to farmers by 50% while guaranteeing the country's annual two million tourists the water they needed (Barlow and Clarke, 2003). Other examples where agriculture suffered first include droughts in Amman, Chennai (Ramakrishnan, 2002), the Guadaquiver basin in Spain (Fereres and Cena, 1997), the Alentejo region in Portugal (Caldas *et al.*, 1997), Bangkok (Molle, 2004b), and Manila (McIntosh, 2003).

It is important to note, however, that per capita water supply is usually socially segregated both in normal times and in times of shortage. Amman East, for example, the poorer area of the capital uses 75 l/c/day, about half of the consumption in affluent areas (Darmame, 2004). In Ahmedabad, India, 25% of the population consumed 90% of the water while 75% consumed 10%. In Calcutta, slum areas received 80 l/day, while non-slum areas were supplied 240 l/day (UNDP, 1998). Phoenix in arid Arizona, with average consumption of more than 1,000 l/c/day, has wealthy satellite towns like Paradise Valley where consumption is over 1,600 l/c/day. In other words, urban elites are largely

[5] See for example Darmame (2004) for Amman, Swyngedouw (2003) for Guayaquil, and Ducrot *et al.* (2003) for São Paulo.

[6] Likewise, the World Water Assessment Program (WWAP: UNESCO, 2003) report and Anton's (1995) review of water supply in Latin American and Caribbean cities do not refer to physical water scarcity as a problem, let alone an agriculture-based one, and emphasize the financial implications of supplying cities.

insulated from water shortage and also have the means to buy tanker water in extreme conditions.

Except for situations where irrigation holds 'senior' water rights and regulation is effective (Colby, 1993)[7] or where allocation to agriculture is not reduced in time (crops have already been planted), agriculture clearly stands at the losing end and has to relinquish its share first; shortages only affect domestic use secondarily (and partially), while industries are usually affected last (but many rely on groundwater). Evidence shows that instances of short-term urban scarcity are thus due to a varying combination of extreme climatic events, lax management of inter-annual security stocks, and insufficient preparedness, rather than to agriculture's lion's share (unless rigid water rights dictate otherwise) (Molle *et al.*, 2007b; Del Moral Ituarte and Giansante, 2000).

3.3. Industries and urban economic activities

Discussions of urban scarcity generally focus on domestic WS&S services, with little reference to stress undergone by industries. Combining municipal and industrial (M&I) uses because they are often spatially concentrated can be confusing. They are distinct from both a physical and a political-economic point of view. *First*, industries generally require a secure and continuous supply of high-quality water. They thus tend to exploit deep aquifers where feasible. In Bangkok, for example, 90% of industries resort to groundwater (TDRI, 1990) mostly because the quality of water from the river is too poor. *Second*, the industrial sector represents an interest group that is affluent, powerful and closely linked to the highest levels of political and bureaucratic apparatus.

Whether longer-term investments in services and industry are constrained by water remains a matter for debate. This is true at a certain level, since very high water-consuming industries, such as aluminum, are unlikely to settle in water-short areas. Chan and Shimou (1999) refer to industries in coastal China that are occasionally affected by water shortages, with suggestions that water-intensive industries should be moved inland, but the option to increase supply through the South–North transfer seems to have prevailed. Even so, there is little evidence that cities and industries are seriously constrained in their growth by water. By and large, industries that offer to create jobs and increase business taxes are unlikely to be denied preferential access to municipal water. Alternatively, they abstract groundwater regardless of whether this is sustainable or not. Ramakrishnan (2002), for example, describes the drastic restrictions on water supply in Chennai in the late 1990s drought but, at the same time, reports that the Chennai Petroleum Corporation's demand for an additional 15,000 m^3/day needed for its expansion project (in addition to the existing supply of 18,000 m^3) had been readily agreed to.

Simon (1998) notes that: "Ironically, the areas of the world with the fastest growing populations are also the areas with already severe water problems, and the shortage will get much worse." This serves to show that lack of water does not hinder expansion although growth outpaces financial capacity to expand supply networks. Such situations often prevail when rural–urban transfers are characterized as a push process, whereby impoverished rural families migrate to cities out of despair, regardless of the conditions they are likely to face in the cities. This contrasts starkly with the situation in some western countries where water is a prerequisite to expansion: many cities in the Western US, for example, require developers to prove their access to adequate provision of water before construction begins (Emel, 1990; Lund and Israel, 1993).

3.4. The political economy of urban water supply

Given the prominence of the financial and political dimensions of urban water scarcity, the central question becomes: how do such investments become a priority? Several documents (Rijsberman, 2004; UNESCO, 2003; Hecht, 2004) give varying estimates of the financial resources needed to meet MDG targets or to bring urban WS&S services up to standard. These amounts are substantial but not beyond the financial capacity of consumers, countries and international institutions. Incentives to decision makers, the political clout of a given city, and public mobilization all matter in defining priorities.

In European history, in the late 19th and early 20th centuries, extension of WS&S facilities beyond the affluent can be attributed to a combination of the hygienist movement, a perceived "threat from below" (Chaplin, 1999) and/or the need "to preserve order, cleanliness and a healthy workforce" (Goubert, 1986). As early as the mid-18th century it was recognized that "prevention of further environmental degradation was cheaper and more effective ... than continuing with expenditure on poor relief" (Chaplin, 1999). Similarly, in more recent times, elites in Guayaquil (Swyngedouw, 2003) and Monterrey (Bennett, 1995) reacted in response to social unrest. In contrast, Chaplin (1999) attributes the negative picture in India to a failure by both the lower and middle classes to pressure government to invest.

The capacity of city managers and politicians to fund investment is also closely linked to a city's location within the state/region/nation, both in geographical and in political terms. Capital cities are more likely to get access to public funds than other cities (e.g., Mexico: Connolly, 1999). How taxes are distributed amongst administrative layers — central to local government — is also crucial (e.g., Coimbatore: Saravanan and Appasamy, 2001). Swyngedouw's study (2003) on Guayaquil and Bennett's (1995) on Monterrey show that the distribution of power determined whether investments were made or not, who paid for them, and what

[7] In practice, these situations are largely limited to the western USA and the assumption that they are widely distributed can be very misleading (see below).

sources of water were to be tapped. Some cities attract foreign subsidies (e.g., EU funds for Athens) or benefit from geopolitical considerations (e.g., Amman) or broad reconstruction efforts (e.g., Phnom Penh). If society is receptive to privatization, the financial burden can be shifted to users, as in the UK. Actual governance, the existence of environmentalist NGOs and other civil society entities, the influence of international institutions, the historical background of political struggles, all shape the viability of particular solutions and the final distribution of costs and benefits.

In general, notwithstanding the fact that water projects may be costly or not, the state of the WS&S systems depends far more on political and financial circumstances than on competition with other sectors for the basic water resource (though of course the lack of available resources close to megalopolises and the difficulty of keeping up with booming populations may make solutions harder to find, or more costly).

4. Inter-sectoral transfers in practice

4.1. Types of transfer mechanisms

Inter-sectoral water transfers do happen in practice and take several forms. *Temporary transfers* typically occur during a drought. *Permanent transfers* occur when a source of water already tapped by several users is diverted to the benefit of a city. Such transfers can be gradual, often first amounting to a limited percentage of the source of origin, and their effects tend to be diffuse and unidentifiable if the source continues to provide a large share of water to other users. But they can also be *outright,* and if they amount to a large part or all of an existing source (e.g., the conversion of irrigation reservoirs to municipal use, as is reported to have occurred in Tsingtao) then they are likely to be problematic if no compensation is paid.

Transfers can also be categorized based on the mechanisms utilized in their implementation, with three apparent main types.[8] A first type of transfer occurs through the transfer of *formal rights* to the use of water (or sometimes through the transfer of the land to which they are attached). These are typified by practices in developed countries, notably the west US and other arid regions, but increasingly also in the eastern US and in other developed countries (for instance in the UK, where traditional riparian rights were modified in 1969 by the introduction of abstraction permits). Formal rights can in principle be transferred in a free market with the price reflecting market conditions either in real time, or over a longer period (a season or year), or permanently. Free markets, however, often fail to account for externalities or third party effects and sales of formal rights are generally only permitted in a regulated market, with the terms of the sale set, monitored and enforced by a public agency, as in the example of the California drought bank. Alternatively, legislation sets out the terms on which transfers are to be made, for instance by establishing clear priorities at times of drought, or limiting the term of the right so that it can be transferred to a higher value use once the term has expired (as in the UK). Markets in *informal rights,* in contrast, develop spontaneously but generally involve farmer-to-farmer sales rather than inter-sectoral sales. An exception is the conversion of irrigation wells to tanker operations in Amman and some cities in India, which represents a significant case of an unregulated market transaction from agricultural to urban use.

A second type of transfer, *administrative decision*, has been by far the principal means of transferring water from one use to another, both historically in developed countries and to this day in developing countries. *Formal administrative decisions* are taken by a national, provincial/state or basin entity depending on the functions assigned to each under the constitution or in law. Formal administrative decisions with compensation typically occur where the farmers giving up supplies are readily identifiable and can bring political pressure to bear on the decision makers. They involve varying degrees of consultation between the interested parties (Seville, Tsingtao, etc.). Direct expropriation is problematic for any government, even an authoritarian one, especially in contexts where the local economy revolves around irrigated agriculture. This is true even if no formal rights are held. In the few cases in which formal rights exist and are effective, expropriation is precluded. The buying out of agricultural wells around some cities (Chennai) is an example of outright and total reallocation of minor sources with appropriate compensation.

Negotiations can include financial compensation and/or efforts by the city to reduce its losses or its consumption. El Paso, for example, obtained water from the Rio Grande on condition that it reduce per capita consumption, recycle sewage water and eliminate leakage (Earl, 1996). Dongyang, Zheijang Province, obtained water from a dam managed by the Yiwu city but had to increase the height of the dam and line irrigation canals (Liu, 2003). Well known agreements between the Imperial Valley Irrigation district and the Southern California Metropolitan Water Authority (CGER, 1992), or between Delhi and the Upper Ganga irrigation scheme included lining of irrigation canals paid by the cities.

When formal administrative decisions to transfer water are taken unilaterally, they merge imperceptibly into the final type — informal *transfers by stealth*. This may occur as a result of investment decisions (as in the case of transfers from reservoirs to cities such as Hyderabad, Amman, Karachi or Bandung) or management decisions (as in the case of the Angat reservoir near Manila), or development decisions (as in the occupation of tanks in Bangalore or the conversion

[8] The potential of water pricing as a means for eliciting reallocation from agriculture to other sectors has also been emphasized by some economists but is now widely considered as negligible (Savenije and van der Zaag, 2002; Cornish and Perry, 2003; Hellegers and Perry, 2004; Molle and Berkoff, 2007), a point recently acknowledged by the World Bank (2003).

of irrigated land to urban use as in many expanding cities). Transfers by stealth by definition do not allow for compensation.

Some such transfers are explicit and obvious to observers, not least to the farmers; others are more surreptitious. Diversions through canals or large pumping stations are overt, especially when they correspond to a large share of the source of origin. On the other hand, there may be a long distance between the point of diversion and the downstream farmers/users. Groundwater abstraction by a city, or reappropriation of water through gradual encroachment upon irrigated land (e.g., Manila, Lima, Bangkok, Cairo) can pass virtually unnoticed at first[9] but the impact on other groundwater users tends to become manifest with time.

A special case is when transfers concern a source of water that still has some "excess flow". Residents in the basin are then in a weaker position to oppose a transfer, especially if it can be presented as crucial for economic development or to ensure "equity" between regions. The benefits foregone — not least in environmental uses — are invariably glossed over even if they are already apparent (as in the Piracicaba diversion to São Paulo), likely to surface in the mid-term (as in the diversion of the Mae Klong to Bangkok or of the Kurhang to Isfahan), or may materialize in the long run (as in the Melamchi basin, where water is diverted to Katmandu).

In support of transfers out of agriculture it is sometimes argued that farmers, who typically paid only a small fraction (if any) of the costs of irrigation, cannot object if the state subsequently withdraws a part of the water allocated to them. This has less force once the value of water is capitalized in land prices. Another argument is that the real costs to farmers of partial "expropriation" may be lower than appears at first sight, given the room for adjustment in many irrigation systems and the fact that the *"hidden hand of scarcity"* elicits changes in behaviour and factor use (Berkoff, 2003).

Predictably, cities do not publicize their water projects, minimize their impacts, and avoid talk of compensation. Analyses of conflicts (see above) show that non-agricultural uses almost always get priority but also that the crux of the matter is not so much the average amount diverted to cities but *what this share becomes at times of shortage*. When a drought occurs and the impact felt becomes critical, it is always possible to naturalize crises, blaming it on climatic change, El Niño, "the rain gods" (*The Hindu*, 2003), or bad luck. Controversial transfers from the Veeranam tank to Chennai, from the Kinjhar lake to Karachi, or from El Cuchillo dam to Monterrey, all officially claim to use "only excess water" and to "preserve existing uses", despite evidence to the contrary.

4.2. Environmental impacts of transfers

In many cases, reallocation to cities occurs by taking more water from the environment, directly "displacing nature". When this option is limited, or exhausted, cities gradually displace agriculture, which has to adjust and respond to the squeeze. Part of the response comes through an increase in efficiency, notably at the basin level where a greater part of return flows is reused and depleted, or through the use of wastewater instead of freshwater.

The transfer of water to cities generally results in more wastewater being generated, and subsequently an increased emission of pollutants and contaminants. Cities dispose of 80% of the water they divert as wastewater. Only 10% of the effluents from cities in developing countries are treated (UNEP, 2003). The growth of urban/industrial needs plays out not only in terms of transfer of equivalent volumes of water but also in terms of reduction of the stock of usable water by rendering part of it unfit for human, and even agricultural, use. A good example of this is provided by Janakarajan (2003) who describes the impact of tanneries on the Palar river basin, in Tamil Nadu.[10] Tanneries use many toxic chemicals and generate heavy pollution to the point that downstream farmers have refused to use the river. This has also happened in the Damodar river (India) due to coalmines and other industries (Hardoy *et al.*, 2001), in South Africa because of mines, and in the Huai river basin (China) because of paper industries and tanneries (Postel, 1999).

It must be noted, however, that agricultural activities are now increasingly contributing their own pollution load and contribute to making surface water and groundwater unusable for cities. Seville, for example, cannot use water from the Guadalquivir that flows by because of pesticide and fertilizer residues (Del Moral Ituarte and Giansante, 2000). The cost of agricultural pollution in the US is estimated at $9 billion per year (Bate, 2002).

As noted earlier, one common way to meet growing urban needs, or to respond to displacement by cities in the case of agriculture, has been to exploit/overexploit groundwater resources. Tapping groundwater is the easiest solution because it generally relies on individual or corporate investments (as opposed to public ones), it is spatially spread with little need for major infrastructure, and it penalizes constituencies that often have little voice (nature and subsequent generations). Between 1.5 and 2 billion

[9] Although the undefined or open-access nature of groundwater has provided cities with other opportunities for ambiguity, tapping groundwater has sometimes generated a backlash: farmers have clashed with the police after wells were dug in areas adjacent to their lands to supply Jaipur (Londhe *et al.*, 2004). Similar examples are provided by Ta'iz, where most agricultural wells ran dry and led to civil unrest, and by Athens, where its use of a well-field in the Yliki lake area allegedly lowered the water table, provoking complaints from nearby small-scale farmers (Kallis, 2004).

[10] In the Palar basin these industries contribute to about Rs 50 billion (US$1,052 million) by way of foreign exchange annually, besides employing 100,000 people directly and indirectly (Janakarajan, 2003). A similar story unfolded in Tirupur, where the hosiery industry generated Rs30 billion in 1999, with more than half of the population depending on this industry for their living (Narain, 1999).

humans in the world, of which one billion urban dwellers in Asia (Foster, 1999), almost 99% of the US rural population, and 80% of India's population (Sampat, 2000), are reported to rely on groundwater for domestic consumption. That gives an idea of how widely this solution has been resorted to. The hidden costs are becoming increasingly apparent and include:

- A reduction in available stocks, falling water levels and increasing pumping and related expenditures. Other aquifers are pumped out (e.g., China: Kendy *et al.*, 2003).
- Land subsidence in cities like Mexico City, Manila, Jakarta, Cangzhou, Beijing, or Bangkok (a third of the city is now under sea level). Subsidence affects not only buildings and roads but also the future water storing capacity of the aquifer itself.
- The quality of groundwater almost everywhere. Realization of its extent is increasing in proportion to the number of measures and investigations being carried out (Sampat, 2000).
- Salinity intrusion due to the overdraft of coastal aquifers rendering water unfit for both domestic and agricultural use, in cities such as Tel Aviv (Swyngedouw *et al.*, 2002), Lima (Masson, 2002), Manila (Fellizar, 1994), Jakarta and Dakar.
- The drying up of springs and wetlands fed by groundwater flows that are affected by the lowering of watertables (e.g., in Jordan, the overdraft of the aquifer to supply Amman and irrigated crops has dried up the Azraq wetland, a Ramsar site used by migratory birds).

The overall picture is that if cities have generally found ways of increasing their water supply, this has often been in an unsustainable and damaging way, displacing agriculture and nature, and critically impacting on water quality and the amount of usable water.

4.3. Reallocation stress: political and social costs

In a situation of competition, cities will generally have to re-appropriate water already used, allocated or "owned" (when a formal right exists) by other users, generally agriculturalists or nature itself, and this inevitably generates stress. Such transfers breed political tension irrespective of the mechanism used — whether unilateral bureaucratic decision, coercion, compensation or market transactions. Political stress is generated in proportion to the political clout of the constituencies that stand to lose in the transfer (the water users in the first place but also surrounding communities). Urban industrialists generally command considerable influence over politicians. Conversely the cost of doing nothing, or little, is less when urban populations affected by prevailing poor conditions of WS&S are also voiceless. As the Camdessus Report put it: "with the mass of people not serviced politically weak or disempowered, it is tempting to postpone spending on maintenance and periodic replacements, likewise on investments with a long gestation period."

The difficulty of acquiring more water is also dependent on the political structure and administrative boundaries. A transfer within the same state, region or district — whatever the local structure — is easier to handle than one that involves different provinces/states in a federal system. The latter is typically more difficult and depends on the respective powers vested in the central government and the states, and on the clarity of their roles (see Barajas (1999) on Mexico and Richards and Singh (2002) on India).

It is tempting to circumvent political intricacies by choosing between inter-sectoral transfers, supply augmentation,[11] and other options based on a full cost assessment. In practice, however, decision-making incorporates wider aspects of the local political economy, including: social, transactional, political, and sometimes environmental costs attached to the various demand — or supply — oriented options; the nature of the possible source of funding; the degree of mobilization/pressure by various constituencies; and/or pre-existing customary (or other) rights and water uses (Howe, 1987; Howe *et al.*, 1990). Eventually, decision makers tend to follow the *"path of least resistance"* (Kenney, 2004), which may well differ from what economic rationality might, *prima facie*, suggest. Pursuing a mere economic logic is moreover likely to be detrimental to equity, though unchecked centralized and obscure decision making in turn may favour costly options that only benefit a few constituencies. Political mediation has to follow a narrow path between public and private interests (Schwartz and Schouten, 2007).

5. Revisiting the allocation gap: Conclusions and perspectives

5.1. The allocation gap revisited

Industrial and domestic water use is often believed to be constrained by the excess water used in agriculture. Since agriculture is usually inefficient both in technical (it incurs many losses) and economic terms (the value of produce per cubic meter is low), this situation is said to create an "allocation gap" that amounts to an economic loss to society. This paper has challenged the magnitude of this gap and given alternative analyses of the nature of urban water scarcity, distinguishing between municipal and industrial uses, and between short-term and long-term reallocation.

Temporary reallocation often occurs in times of drought. Short-term crises may be partly due to climatic variability

[11] Bhatia and Falkenmark (1993) and Serageldin (1995) estimate that the financial and environmental costs of tapping new supplies will be, on average, two or three times those of existing investments, because most of the low-cost, accessible water reserves have already been exploited.

but they are compounded by lax management of reserves in storage and pervasive lack of preparedness. Except for situations where irrigation holds a 'senior' water right or where allocations are not reduced in time (crops have already been planted), agriculture typically must relinquish its share first, with shortages only secondarily (and partially) affecting domestic use, and ultimately industrial use (if industries do not use groundwater).

Over the long run, cities also appear little constrained by competition from agriculture. While suboptimal WS&S conditions in many cities, particularly in arid climates, point to a lack of water, this situation is mainly due to insufficient investments that have economic and political roots, and eventually reflect incentives to decision-makers for prioritizing such investments. Industries, in turn, either rely on groundwater or receive priority allocation justified by their economic importance, and contribution to the local tax base and employment.

Thus, contrary to much received wisdom on state failure, governments give priority to cities and industries because of their economic significance and elite interests.[12] Transfers *do* occur and the alleged economic benefits waiting to be realized are often much inflated. In other words, the opportunity costs of irrigation water though positive at the margin are often only weakly so and, once urban demands are satisfied, these opportunity costs fall to zero. Thus, in both the short and long-term, as many analysts have observed, farmers are "losing out" (Winpenny, 1994), urban interests are getting the "upper hand" (Lundqvist, 1993), and "without a doubt, cities will continue to siphon water away from agriculture" (Postel, 1999).

Even so, it is widely believed that increased supply to cities could enhance economic output, and that physical scarcity is mainly due to available water being locked up in agriculture. In the Asian Development Banks's (ADB, 2000) view, for example, "Irrigation is particularly voracious, accounting for up to 80% of water demand in hot dry regions ... Major obstacles to the rational reallocation of water among users ... are the legal and regulatory constraints on water transfers and, in many countries, the complex systems of water rights that inhibit the free movement of water as an economic good." Why does the literature appear to place such emphasis on the gains from reallocation, if these are in fact quite limited? Perhaps the answer lies in part with an over-hasty generalization of the situation in the Western US (where the prior-appropriation doctrine has sometimes constrained the transfer of water out of low-value uses[13]) to contexts where centralized management has by and large ensured inter-sectoral reallocation. It may also reflect the ideological inclination of those advocating markets as an allocation mechanism (Bauer, 2004).

The paper has therefore reframed the question of the allocation gap within an inquiry of how transfers in practice occur. While cities by and large succeed in accessing the supplies that they need, this has often been sub-optimal in economic, social or environmental terms. Water has often been over-abstracted from aquifers, taken from ecosystems or from agriculture (which, in turn, has often displaced nature too), or diverted from distant sources at a high cost. Economic rationality has often been ignored with decision making reflecting wider social and political considerations that are not easily captured by valuation techniques. All things considered, as mentioned earlier, cities generally select the path of least resistance. "Politics" is often construed in a negative sense due to its rent-seeking and pork-barrel dimensions, but these aspects must be set against the democratization of decision making and increased public access to data. Political mediation, in practice, can also be an effective way of balancing antagonistic interests and world views, rather than simply being a way to further vested interests (Schwartz and Schouten, 2007).

Finally, the frequent statement that reallocating a minor fraction of irrigation water to cities would suffice to cater to the needs of people with poor water supply conditions is in many instances deceptive: both the arithmetic and the causality are erroneous. Much of the water used by irrigation is diverted at times and places where there is no alternative use and a large part of return flows — in water short basins — is reused downstream. Our contention is that the causal association between, on the one hand, the insufficient and precarious conditions of access to water in "thirsty cities," highlighted in times of crises, and, on the other, water scarcity allegedly caused by a wasteful irrigation sector, is largely misleading.

Somewhat ironically, it seems that reallocation is truly problematic only where water rights are formally defined and enforced and thus liable to formal transactions. In all cases, however, the crux remains to rationalize and compensate for transfers[14] while the difficulty of accounting for third-party and environmental impacts remains a challenge endlessly renewed by climate variability and shifting patterns of power.

5.2. *How to improve reallocation of water*

The option of water markets.

Small-scale water markets have long existed in many arid countries. Users sharing a common source (spring, qanat, etc) occasionally swap, lend, borrow, sell or buy water turns

[12] China has publicly announced that agriculture would be the residual claimant, while in the middle-East/Northern Africa region "the growth and the demand for water in cities and by industry is satisfied by taking water from agriculture. This is offset by importing grain" (Brown, 2000).

[13] When presenting these conclusions at a congress on irrigation and drainage in Sacramento, US, one of the authors was told by several attendees that for all the debate on prior appropriation rights, transfers to cities also did happen in the western US without substantially constraining urban sprawl.

[14] Although market mechanisms are thought to offer an adequate compensation mechanism to the seller, systemic or induced regional impacts are harder to compensate for (Howe *et al.*, 1990; Rosegrant and Ringler, 1998).

in order to fine-tune supply to time-specific individual demands. This also occurs in large-scale irrigation systems (e.g., warabandi in Pakistan and Northwest India). At this scale, transaction costs are minimized because users know each other (Reidinger, 1994), can readily communicate, and transfers are across short distances without costly infrastructures or significant losses. Permanent transfer of ownership is also socially controlled and local third-party impacts are more easily identified and taken into account. The extension of market mechanisms on a larger scale has been much less frequent and more difficult (Livingston, 1995). Markets in the western US are limited by constraints that reflect the crucial nature of water for life and the complexity of the hydrological cycle, which invariably generates third-party impacts (Dellapenna, 2000; Kenney, 2003; Libecap, 2003). In the Colorado-Big-Thompson system, market transactions have allowed smooth and gradual transfer partly because trading is occurring only within the system and because the water district holds the right to all return-flows (Howe and Goemans, 2003; Libecap, 2003). Water markets in Australia (Isaac, 2002; Turral *et al.*, 2004) and in Chile (Alicera *et al.*, 1999; Bauer, 2004) remain limited in terms of volume traded but reallocation has performed reasonably well, although third party impacts and speculative behaviour reduce their efficiency. China also started experimenting with inter-provincial trading of water but soon discovered the implications in terms of return-flows and environmental impacts (Fu and Hu, 2002).

Positive experience with markets seems to be confined to countries with a strong legal, institutional and regulatory background and relatively wealthy stakeholders. Proposals for their adoption in countries where hydrological data are scarce, physical infrastructure is lacking, and states have weak monitoring and enforcement capacity, are unrealistic. One may question why states that have allegedly failed to allocate water efficiently would be capable of creating the preconditions and safeguards needed to ensure fair and transparent markets (Molle, 2004a). While mechanisms that facilitate flexibility in allocation have always developed at a scale where social control and hydraulic infrastructure made them possible, it is doubtful that fully-fledged markets will constitute a major tool for the reallocation of water in the near future, most especially in developing countries (Frederik, 1998; Dellapenna, 2000; Livingston, 1995; Meinzen-Dick and Appasamy, 2002).

Contingency planning and temporary transfers. Conflicts between cities and agriculture surface primarily during water crises, when the share diverted by the former rises from a low average to a much larger share. This implies that permanent transfers of rights are often not necessary (Savenije and van der Zaag, 2002). Agricultural and non-agricultural uses can usually coexist, if shares are expressed in terms of average. Emphasis should be placed on the design and provision of mechanisms to compensate farmers for losses and deprivation that *will* occur in times of shortage. This is easier to achieve than permanent expropriation of agricultural water, while allowing for a more efficient use of water.

State or cities which tap other sources prefer to present (and obscure) the impact of diversions in average terms. Technical agencies, too, are reluctant to engage in debates that would reveal that domestic supply is not fully reliable and undermine their professional legitimacy. There is thus little incentive to develop explicit contingency plans for dry years, which would shed a different light on the future impact of diversions. Yet, drought-management strategies are needed to provide an early warning of possible shortages and as a predefined set of actions for different conditions (Frederiksen, 1992; Michelsen and Young, 1993). If priorities are well-established and transparent information provided, negotiations can prepare for such arrangements and avoid the outcry and political crises that often accompany severe water shortages. Although market-based options are possible in certain settings (see above), *ad hoc* negotiating processes mediated by state institutions seem to prevail. Compensations can be discussed and negotiated irrespective of the degree of formalization of rights and of the type of government. Examples include Chinese municipalities or provinces, cities like Seville, the “drought bank” set up in 1991 in California (Teerink and Nakashima, 1993), and the compensatory measures planned in Japan (Kobayashi, 2006).

Participation and environmental justice. The displacement of agriculture and nature by growing cities/industries as well as their indirect impact through their contamination of freshwater have heavy social, environmental, and health costs. The magnitude and the distribution of these externalities are very much a reflection of the governance structure of the society. The “stamina” and mobilization of the “people living downstream” (Narain, 1999), and the political space offered to disenfranchised groups to voice their concerns are paramount (Anderson, 1995). They ultimately determine not only whether externalities are recognized and internalized, but also who pays.

Because WS&S projects usually involve large outlays of money, decision-making remains largely centralized and technology-oriented. A more equitable distribution of benefits and costs is possible when a more inclusive and informed process of decision making on infrastructure development or water reallocation options is observed. A shift from supply-oriented paternalistic development to process-oriented approaches leading to “informed consent” (Delli Priscoli, 2004) is materializing only slowly. Deliberative development enables a better definition of social choice but can only develop in a political configuration where redistribution of power is possible.

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