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Drinking-Water and drinking water: Trajectories of Provision and Consumption in the UK, Taiwan and Delhi

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Abstract:

In many advanced economies, water is one of the most taken-for-granted and 'ordinary' objects of consumption. However, the emergence of all-purpose (including drinking) water was the outcome of long and varied historical processes, involving major changes in both systems of provision and patterns of consumption. In many parts of the world, there are still different types and sources of water for different consumption purposes, and there are significant inequalities in rights over this most basic resource, especially water fit for drinking. Water presents a critical lens to explore organisations of economies of a good, which are often a complex mix of private, commercial, or public systems of provision. This paper will argue that an "instituted economic process" approach is fruitful in exploring diverse configurations of production, appropriation, distribution and consumption of water. In particular, it will argue that practices of consumption are best analysed as integral and necessary dimensions of these wider configurations of economic organisation. The analysis will draw on my current comparative research in the UK, Delhi and Taiwan, and empirically demonstrates the need to problematise water as a consumption good, in order to understand its rich and complex diversity. This research arose from my comparative research on bottled water, undertaken in the wider research programme of the *ESRC Sustainable Practices Research Group*.

Keywords/tags:

Economies of water, configurations, transitions, 'instituted economic process', comparative historical method

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1 INTRODUCTION

Water as it comes out of taps in most advanced economies of the world appears both one of the most ordinary, and most basic, goods for consumption. Comparative, and especially comparative historical, perspectives on the emergence of tapwater, however, serve to problematise this liquid necessity, as well as to highlight that water is not just water, but many different liquids for many different uses, only one of which, of course, is drinking. And, in these wider perspectives, drinking water is not just drinking 'drinking-water', when water from many sources is not fit for drinking unless subject to various processes, boiled, used to produce alcoholic drinks, or combined with various flavourings, such as tea or coffee. This paper is based on comparative research which places bottled water (again, many kinds, spring, mineral, processed, deep ocean, etc.) in different water contexts (in Delhi, Taiwan, the UK and Europe). Initially, and in the context of sustainability of water consumption, bottled water appears as a substitute for tapwater, bearing a stigma of relative unsustainability with its high carbon footprint in relation to tapwater (Swiss Gas and Water Association, 2006; Botto, 2009; Gleick and Cooley, 2009). However, if most people mostly drink little tapwater unless in the form of tea or coffee, and if a new consumption practice of drinking water has historically emerged with the provision of dedicated 'drinking-water' in bottles, then initial appearances need to be discounted, at least partly, and assumptions about relative unsustainability revisited. Moreover, in contemporary Delhi, to take but one example, tapwater is intermittently available for only one in ten households, and, unless treated, is unfit for drinking, providing a context for bottled water – there called 'packaged water' – quite different from Europe or the USA. For many, bottled water is the only immediately drinkable water, and for many millions, bottled water is unaffordable. In Taiwan, drinking unboiled water, even relatively hygienic and reliable tapwater, is almost unthinkable, culturally undrinkable. And there, the dominant new market for a dedicated bottled drink is tea, outselling bottled water by a large margin.

Methodologically, just as the tomato can be employed as both a probe and object of research to explore tomato soups and ketchups as pioneers of emergent mass production for mass consumption or the distinctive character of the contemporary UK supermarket tomato universe (Harvey et al. 2002), so water, and more narrowly, drinking-water, provides an exceptionally powerful lens for exploring and refracting capitalist economic development. In Marx's terms, water, including the drinking of water, is certainly 'socially necessary for the reproduction of labour power'. And yet, water, *pace* Marx, has historically been one of the most contested goods for commodification, and has scarcely ever been a 'commodity like any other', until it comes close to becoming one with the emergence of markets for bottled water. Close, but perhaps still not quite like any other, in that bottled drinking-water is often drawn from aquifers under public license, and the ownership of aquifers, public or private, has also been widely contested. So, water is a means of researching the boundaries and forms of capitalist market development and, as importantly, for understanding the emergence of a prototypical public good in many countries, (including in the US heartland of capitalist markets) (Millward, 2000, 2005, 2007). Similarly, the liquid politics of who pays how much for what water can be interesting both in its own right as to what is special about water as an object of consumer politics, and as a critical instance of the wider emergence of the consumer-citizen in late nineteenth century England (Taylor and Trentmann, 2011; Trentmann and Taylor, 2005).Who appropriates and who consumes rain, river, ground or deep ocean water, *and how*, can reveal much about the nature of economic, social and cultural organisation, historically and contemporaneously. Bottles of drinking-water refract major societal variations, and so contain sources for understanding them.

Theoretically, this paper adopts the 'instituted economic process' approach, with its focus on configurations of production, distribution, appropriation and consumption (Harvey, 2007). In this instance, socio-economies of water, in particular drinking-water, will be analysed in terms of such configurations: how water is produced for human consumption uses in all their diversity; how water is stored and distributed to different social categories; how water is appropriated, initially from different 'natural' sources, and by what social entity, private-market, private-domestic, community, or state, and then how 'ownership' is transferred to end consumers; and finally how water is used, which types of water for which types of purposes,

and where drinking-water fits in to the panoply of uses. Four aspects of this analysis need emphasis for the account which follows. Firstly, an economy of water is only constituted by the interrelationship between these four processes, none of which is self-standing. In saying this, however, although dynamically interdependent, each of these processes is specific and distinct. So, for example, changes in use, from use in production to use in end consumption, is a specific process. Consumption practices[1] cannot either be reduced to, or scripted by, the entities or services as they are produced, distributed, or appropriated, but, on the other hand, nor are they considered practices of consumption unless in dynamic relation within a configuration of production, distribution and appropriation. So, in this case in point, how tapwater is consumed, what practices of consumption it enters into, are societally, socially and culturally varied, from drinking to quench thirst to ritual ablution. Yet, walking in the rain, like many other practices, in this approach does not count as consumption of rain: it is important to distinguish between consumption and non-consumption practices. Swimming in the sea may be a leisure activity, but is not consuming the sea, although may well be consuming snorkels and flippers.[2] The analytical approach adopted here is that for a practice to be consumption, it does so in relation to the other three processes constituting, in this case, an economy of water. Likewise, water only becomes an economic entity when qualitatively transformed by human practices of work, but many human transformative practices do not become 'production', unless within a configuration. So, when children (or adults) build sandcastles, and channel water in ways that would not occur without human intervention, such practices, of which there are many, differentiate themselves from economic practices of production. To conclude this point, the practices of consumption of tapwater – and of the consumption of other forms of water economy – are difficult to comprehend independently of the process of production, distribution and appropriation of water: they constitute a distinct phase and process, but only in relation to the configurations of which they form part. The comparative method highlights this point, when contrasting the practices of water consumption in the UK, Delhi and Taiwan.

Secondly, before leaving this discussion of consumption, the analysis of various economies of water illustrate the significance of Glucksmann's concept of consumption work (Glucksmann, 2009), and the need to distinguish consumption work from practices of consumption as such. The concept refers to work by the consumer undertaken after the final act of ownership transfer (market or non-market) and distribution to the end consumer, prior to, and necessary for, consuming the good or service. The concept is useful here precisely because some economies of tapwater, unlike many other economies of water, provide 'ready-to-use' water to the end consumer. The taken-for-granted character of tapwater, however, even then masks the work of consumers and its significance in the provision of tapwater. Historically, as we shall see, the point of connection between the general system of water provision, and the individual household was one of controversy and technological challenge, as domestic plumbing had to be compatible with new systems of continuous piped provision, under pressure. The consumer was, and now routinely is, responsible for domestic plumbing – and the consumption work entailed emerges most conspicuously now in times of bursts and leaks, even if requiring no more than the arranging of the expert services of a plumber. In Delhi today, especially in unauthorised slums, the very fabric of the buildings almost precludes the possibility of domestic plumbing, and at the same time, the range of tasks required by their inhabitants to fetch, store, and treat water prior to use for many different purposes absorbs a significant amount of time and preoccupation. Even the most 'ready-to-consume' good, therefore, assumes consumer responsibilities, skills, and work that accompany final consumption; and other types of water provision entail a far more extensive range of consumption work, pointing to the interdependence between work undertaken by consumers and others in any economic configuration. Moreover, as with other goods, the consumer also coordinates and articulates the various practices of water consumption with those of other goods. The work of consumer coordination, much underestimated, and not only in economic literature that assigns so much

[1] The term practice is used in this paper to denote social actions understood as shared characteristics of social groups varying in scale, including temporal and spatial scale. Practices are thus integral to configurations of (water) economies, a dynamic aspect of those economies, rather being seen as actions emanating from individuals. As against practice reductionists advocating 'flat ontology' (e.g. Shatzke, 1996, 2005), practices are only one amongst many entities in a differentiated, relational and multi-layered and scaled ontology.

[2] In that respect, the analysis may agree with Warde's suggestion that most practices entail a moment of consumption (Warde, 2005), but also argues for the need to distinguish consumption from using or doing in general. In short, it posits the economic within the social, without reducing or subordinating one to the other.

to the market, is a critical component of consumption work. In that sense, for any 'complete' economy of tapwater, the work of consumers forms an important aspect of the analysis of the overall societal division of labour.

Thirdly, and now in a Polanyian sense of placing economy in society, any configurational analysis of economies of water assumes they are open to interactions with cultural, political, and natural processes. In the case of water, as with the tomato, a particular focus on the economy-nature interaction enables a distinct problematisation of the 'natural'. Apart from the geographical significances contrasting sub-tropical, monsoon, climates with northern temperate regions, making the capture and storage of rainwater such a significant feature of Moghul India with extensive systems of 'tanks' and channels (Sharma, 2009; Hosagrahar, 2010), the problem of ownership of naturally occurring resources such as rivers and aquifers raises distinct issues whether of public (what public, how constituted?) or private (what kind of private?) appropriation. We will see this, notably, in the case of Delhi's two million private-domestic borewells. Finally, there is the articulated opposition between natural – purportedly non-processed – bottled water (with regulatory distinctions between spring and mineral water), and chemically processed and filtered water, whether from taps or, in the case of India or the US, also in bottles. In these economy-nature interactions, issues of sustainability and depletion of finite natural resources are ever-present.

Fourthly, the comparative and historical method inherent in the IEP approach requires the comparison of different trajectories of configurational transformation. In such historical accounts, any starting point is, to an extent, arbitrary. The starting point is a particular configuration – including of consumption practices within their configurational context – and its subsequent transformation. In other words, as opposed to an explanatory imperative to explore and develop atemporal layers of greater and greater abstraction, the IEP approach explores significant transitions and trajectories, assuming highly situated and contingent explanations. In this paper, the contribution to conceptualising transitions is firstly the focus on the varied economies within which technologies arise, rather than a central focus on technological transitions with less emphasis on economic organisation (Geels, 2002, 2006; Geels and Schot, 2007). Secondly, it will be apparent that transitions of economies of water are highly 'political' transitions, with levels of political controversy and intervention, as already hinted. They are certainly not simply market processes of innovation and creative destruction. Thirdly, the particular comparative cases chosen provide a contrast between what might be described as relatively endogenous politico-economic transitions in the case of England, and the exogenous politico-economic transitions resulting from invasion and colonisation, in India first by the Moghul Empire, and then overlaid by the British Empire; and in Taiwan, by the Japanese invasion and colonisation. In both cases, these resulted in major exogenous transformations, even suppressions and ruptures, of prior economies of water, contributing various distinctive hybrids and layerings of economic and cultural organisation of water.

To conclude this introduction, this paper will embrace 'drinking-water' as an object in its own right, and as a probe into critical issues of capitalist economic organisations and their transformation. The essentially anthropological perspective derived from Polanyi's later works provides the IEP approach with the analytical flexibility to interpret a wide range of forms of economic organisation and processes of variation, public, market, domestic-private, formal, informal and illegal, without assuming any prior rigid categorisation. In a way, water as a probe problematises standard categorisations of 'public' versus 'private' goods, and that is what makes it a particularly useful research probe. Moreover, while insisting on the specificity of economic organisation, embodied in configurations of production, distribution, appropriation and consumption, the IEP approach is open to exploring different dynamics of economy-culture, economy-polity, and economy-nature interactions in different historical trajectories.

The case studies that follow, necessarily schematic, will focus particularly on configurational change and difference. Firstly, the case of England and especially London will be considered from the 17th through to the mid-20th century, treated as an instance of successive relatively 'endogenous' configurational transitions. Second, the case of India, whilst noting the distinctiveness of pre-British economies and cultures of water, will concentrate on the analysis of the multiple economies of water evident in contemporary Delhi. Lastly, the case of Taiwan provides another contrasting case of the development of economies of water, first following the Meiji Restoration and colonisation of Taiwan, and then the present emergence of a distinctive

pan-Taiwanese economy of water. The paper then will draw some conclusions by comparison of these different historical trajectories.

2 THE INDUSTRIALISATION OF WATER AND SEWAGE IN ENGLAND, 1600-1950

Particularly when comparing water provision in rapidly urbanising global cities in the 20th century, it is worth emphasising just how long it took, and through how many successive major transitions, to deliver continuous hygienic piped water to almost the whole population in England. It was not until well after the Second World War, even the 1970s, that baths and indoor toilets became universal, and not before the mid-1950s that the standard of chlorinated safe water reached similarly universal coverage. It was a development that took at least two centuries. Employing the IEP configurational analysis, and taking London as exemplary[3], it is possible to identify four major configurations with transitions between them, which we can denote the pre-industrial (1615-1800), the early industrial (1800-1854), the post-crisis water-sewerage configuration (1854-1904); and the integrated municipalised configuration (1904-1990).

2.1 *The pre-industrial water-sewage configurations*.

In the pre-industrial period, London as a growing mercantile, craft and financial city already faced significant challenges to expand its supply of water to a population of 250,000 (Hassan, 1995, 1998). During this period there was increasing reliance on river water as a primary source, yet, at the same time, water from springs and wells continued to play a significant role. One of the most exceptional developments, which began to distinguish the English innovation of water supply and distribution from Europe (Goubert, 1986), was the formation of the New River Company in 1614 (Graham-Leigh, 2000; Ruddan, 1985). A 40-mile length with 10 rows of wooden pipes made with 9ft lengths of hollowed-out tree trunks formed a 400 miles of piped main supply to London, serving 55,000 houses by 1800. Technologically, these pipes running from a source in the river Lea in Hertfordshire to central London, relied on an engineering feat of gravity-fed water over long distance, similar to the conduit systems found in many towns and cities. Houses could only be supplied to ground and basement level. As Ruddan has pointed out, these early water charter companies were typical forms of enterprise where there were as yet no clear boundaries or economic concepts of public versus private. In the case of the New River Company, formed by royal charter, it was also initially part-owned by shares held by the king, as well as being obligated to provide a public utility, and given legal protection as such. Supply was intermittent, often one day off, another on, and, as there were no means of measuring volume, the exchange with householders was based on an annual rate – instituting a mode of paying for water that was to last and distinguish the United Kingdom, right through to the 21st century – a remarkable example of an instituted exchange process, even if it subsequently underwent significant modifications.

Another interesting feature of the New River Company was its mode of appropriation of water, in this case, from the River Lea. Given rights to divert water by royal charter, the Company was immediately immersed in conflicts with the interests of bargemen transporting corn in to London, on the grounds of interference by damming and reducing water levels. Legal disputes for extraction and diversion of river water also applied to mill-owners, but by 1670, the New River Company fully secured its rights to extract 'public' water, and then sell it to householders in a form of market exchange. Moreover, further legal issues arose concerning the property rights of the land over which the pipes were laid, and this too led to a distinction between a public right of way, limited to the distribution of water. So the company appropriated the water and the rights of its distribution to an end exchange. Initially, moreover, and given the investment in infrastructure, the Company obtained effective monopoly rights for distributing water to households at the terminus of the pipes. Finally, the householders themselves had to supply the lead pipes connecting to the wooden mains. From an IEP perspective, domestic

[3] Many urban centres in England followed similar trajectories (e.g. Leeds, Manchester, Derby), although with some important variations (Hassan, 1985, 1998), and the intention here is not to provide an overall history of water in the United Kingdom, but rather to explore a transition process or trajectory of development in an exemplary instance of urbanisation.

private infrastructures were linked to a semi-private-commercial infrastructure, which in turn obtained rights of commercial ownership of a public resource (the river Lea), through public license. Although, as we shall see, the company changed character many times, remarkably it existed continuously as a legal entity from 1614 to 1904, when it was municipalised (taken into public ownership by the local state).

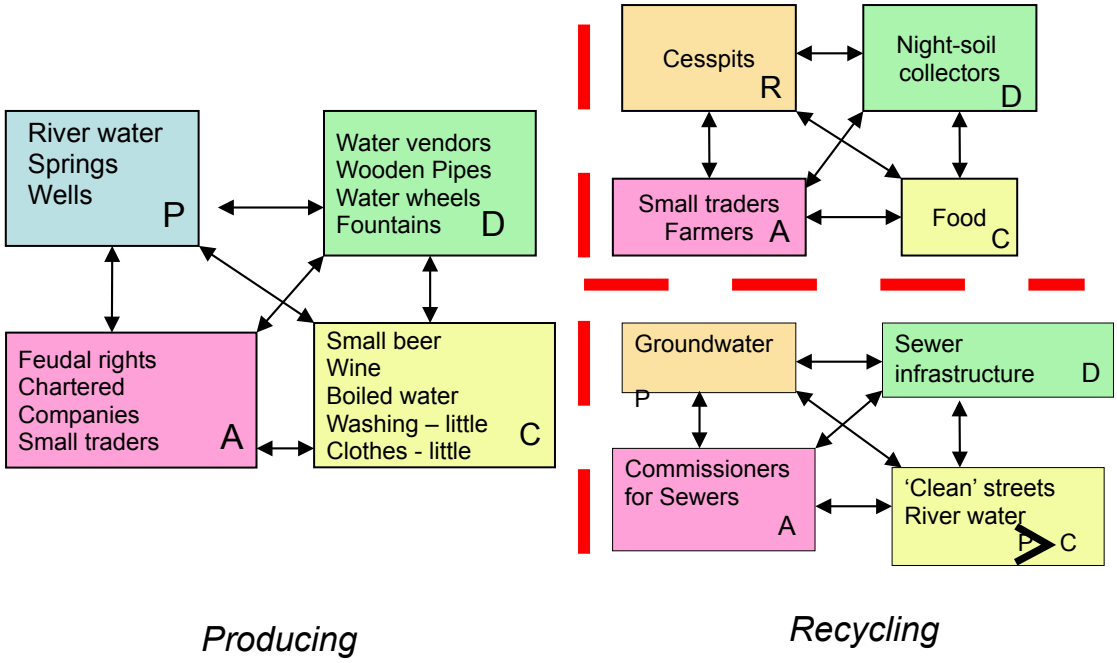

Figure 1: Pre-industrial configurations of water and sewage

However, only wealthier households, and at that time a small minority, had water delivered by pipe-mains or conduit. Wells and springs remained significant, and a water wheel also raised river water from the Thames. Water was widely delivered to households by water vendors, sold by volume – a system which in Paris was significant for drinking water right up to the end of the 19th century (Goubert, 1985). So, in this pre-industrial period, there were many sources of water for many different uses.

The evidence of consumption practices is hard to come by, particularly for any but the rich. Generally, clothes and human bodies were washed very infrequently, even never. Water was certainly used for cooking and boiled for sterilisation. It is uncertain how much water as such was drunk as a drink, and except for the very poorest, probably not much at all. Small beer – a low-alcohol drink requiring boiled water and fermentation – was a more usual mode of drinking water. Progressively, from the 18th century onwards, drinking tea, with sugar, became the 'respectable' way of drinking water, again only for the better-off, along with the increasing fashion of coffee in coffee-houses (Mintz, 1985; Austen and Smith, 1985). Drinking water from wells and springs, or using such water for cooking, relied on the purity of the source, and urban contexts, this became increasingly unsustainable from a wide range of activities polluting the groundwater and shallow aquifers, not only cesspits.

The water economic configuration, the left-hand section of Figure 1, was thus a combination of different sources of water for different uses, combining several modes of ownership and distribution, organised exchanges, and distinctive pre-industrial consumption uses. This water economic configuration was complemented by two others: sewage and groundwater from rainfall, each with their distinctive instituted economies. Although at that time not economically interdependent with the water configuration in any significant way, already by the 18th century and then increasingly, they were materially linked in that both sewers dealing with surface water and cesspits with human waste were risking serious pollution of river and groundwater respectively. In that respect, they formed a significant precondition for subsequent configurational transitions, which then integrated these different elements into a single industrial water-sewage configuration. Water fit for many consumption uses required an

economic organisation dealing with both water provision and waste systems in an integrated way, often not fully reflected in historical accounts (e.g. Halliday, 2001) or transition theoretical perspectives (e.g. Geels, 2006).

Unlike Moghul India with its dependency and utilisation of monsoon rains, rain and surface water was not regarded as a major source of water provision, but rather, in an urban context, as something which required channelling to ensure streets were navigable. Sewers, in this context, were gutters, surface channels, and during this historical period, were a public responsibility of the Commissioners for Sewers, paid for by household rates according to property values, and regulated by propertied classes in the Vestries, the local government organisation. Significantly, until 1817 this regulation proscribed the dumping of waste or depositing of human excreta into the sewers, although enforcement was meagre, and moral norms less than universally effective. Stretching terminology slightly, the public good of navigable streets produced by this economy of surface water, was a valued object of consumption, making moving about in narrow streets both easier and more pleasant.

The cesspit economy, by contrast, was much closer to a market economy, but with a scope and scale limited by the dynamics of that economy. In this system, wealthier households with domestic-private owned cesspits paid nightsoil collectors to empty the cesspits regularly, and transport the waste to farms at the periphery of the city, where it was sold to farmers. Farmers, using the manure, in turn then produced food for the capital. Consumers purchased and ate the food, and the virtuous economic circle was complete. To some extent, this cesspit system was to endure to the end of the 19th century, although with massively diminishing scope. As the city expanded, the cesspit economy came under increasing strains. Density and size of population made cesspits increasingly difficult to maintain without 'negative externalities' to groundwater, on the one hand; on the other, as the city expanded, the distance for transporting human excreta grew, placing strains on the costs of transport. Increasing proportions of the population were failing to pay nightsoil collectors, so adding to the expanding risk of pollution of groundwater. By 1810, there were 200,000 cesspits, for a population of 1 million. In short, the cesspit economy was leaking away before a social, technological and economic revolution sunk it. Many attempts were made to revive a market human waste economy both in England and India, including famously by Chadwick (Halliday, 2001), but, until very recently, to little effect.

2.2 *The early industrial water-sewage instituted configuration*

The pre-industrial configurations represented in Figure 1 were, as suggested, relatively economically disconnected but materially interdependent. The dynamics of transition to a new instituted economic configuration, however, demonstrate just how significant this interdependence was to prove. The overwhelming driver for change was undoubtedly the rapidly expanding population of London, doubling from just below 1 million in 1800, to just below 2 million in 1850. The whole mode of production of water underwent major changes: the overwhelming source of water became rivers, the Thames above all, followed by the Lea, the Fleet and lesser rivers. The treatment of river water was progressively changed, with large-scale infrastructures of settling reservoirs, and multiple sets of slow-sand filter beds extracting organic matter. In short, there was extraction and transformation of the quality of water on an industrial scale.

Secondly, there was the beginnings and rapid expansion of the new technology of cast-iron pipes, replacing conduits and wooden pipes, which permitted the distribution of water under pressure using steam-pumps, so releasing water from the grip of gravity. The consequence of this change for domestic infrastructure, domestic-private plumbing systems, was profound and caused tensions at the interface between the general and domestic infrastructures for most of the century. Companies were given rights to enter and inspect domestic installations and enforce adequate provision in successive Metropolitan Water Acts, as the system changed from intermittent gravity fed supply to continuous, secure, supply, so removing the need for extensive domestic storage.

Thirdly, piped water under pressure permitted the rapid expansion of the water closet as the dominant means of removing human waste: water provision and waste removal were

technologically integrated, under a new economic configuration.[4] From 1817, the old proscription of human waste into sewers was replaced by a prescription that all new installations of water closets be connected to the sewers, the waste now going directly into the rivers, so creating the basis of an emergent sustainability crisis. As Thomas Cubitt graphically expressed it in 1840:

> "Fifty years ago nearly all London had every house cleansed into a large cesspool…Now sewers having been very much improved, scarcely any person thinks of making a cesspool, but it is carried off at once into the river: the Thames is now made a great cesspool instead of each person having one of his own." (cit. Halliday, 2001, 35).

Thus, water closets also undermined the economy of human waste: it literally went down the pan; there was no collection of human excrement for manure. Public sewers and public water resources were channels for removal of waste. Human excreta ceased to be a market tradable good, and there was no longer brass where there was muck.

These technological transformations of production and distribution were at the same time achieved through economic turmoil combined with intense political activity around the emergent new configuration. Prior to the introduction of an infrastructure of cast-iron pipes, companies were established with local monopolies in settled boundaries by parliamentary statute. Competition between old infrastructures, and then stone, but ultimately iron pipes intensified in the second decade of the 19th century, with the old wooden pipe companies (the Chelsea Company; York Buildings Company, and The London Bridge Company) confronting the new entrants with new technologies (South London, West Middlesex and East London Water Works). The competition was intense, with mutual sabotage of pipes, strident negative advertising about price and quality of water from competitors, and several companies digging up the same roads to supply the prime residences. This in turn led to major friction between the public authorities, the vestries and commission for sewers, and the private water companies. Competition became so intense as to become self-destructive, eventually leading to deals between companies to swap infrastructures and re-establish local monopolies. The public response to this was the emergence of a 'consumer movement', the Anti-Water Monopoly Association, active through the decades prior to 1850. Usually a powerful advocate of free markets, even John Stuart Mill campaigned for water to be a public utility, on anti-monopoly and common basic public goods grounds (Schwartz, 1966). The negotiated outcome, engineered through the 1821 Parliamentary Select Committee, was to establish strict private monopolies, but under continuous regulatory monitoring and quality regulation leading up to the 1852 Metropolis Water Act. A deal was also struck, although inadequately enforced, to regulate any potential price rises – an all too familiar story now with a long historical tail.

In terms of consumption, the increasing domestic availability of 'all-purpose' water provided a precondition, but no more, for the emergence of a wide range of new consumption processes, as well as a transformation of the consumption work of storing, treating, filtering, and carrying water within the domestic context, but also from a water source to the household. For example, new elaborate filtering units, with charcoal filters, graced Victorian households during this period (Hartley, 1966). Again, there is little solid evidence concerning how much water was drunk, as such, straight from a domestic tap. Tea drinking certainly became much more widespread during this period, with the growth of tea imports from the new plantation economies in India and Sri Lanka (Austin and Smith, 1992). Washing clothes became more of a domestic activity undertaken by servants, significantly also a consequence of the huge growth in industrially produced cotton fabrics, but this was also accompanied by the emergence of municipal baths supplied by the iron pipe system, both for laundry and washing bodies – a new morality of bodily hygiene marked a significant shift in consumer practices (Crook, 2006). In contrast to France, where water carriers, drinking from separate public fountain sources, extensive clothes and body washing in the river Seine on elaborate floating boats continued until the 20th century (Goubert, 1986), the all-purpose piped tapwater in England was thus largely appropriated by burgeoning domestic consumption practices.

[4] The water closet with flushing mechanisms was first patented for commercial purposes by Alexander Cummings in 1775, and Joseph Bramah in 1778, who had sold 6,000 by 1797 (Halliday, 2001).

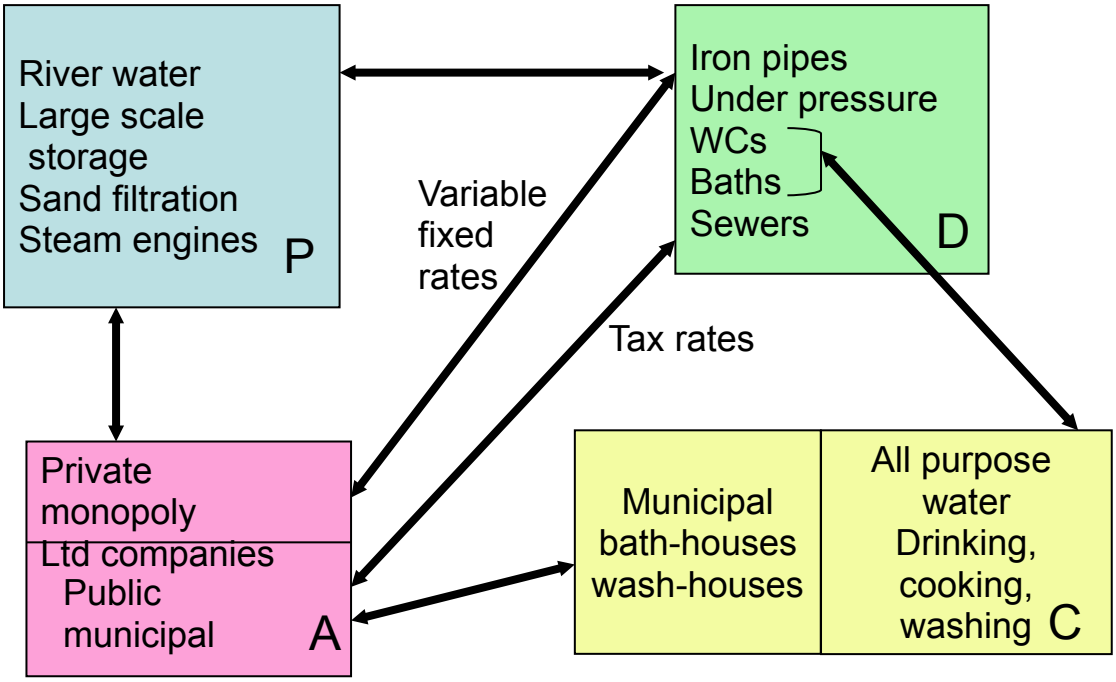

Figure 2: The first industrial economic configuration of water and sewage

Figure 2 portrays the newly emergent instituted configuration of production (P), Appropriation and exchange (A), distribution (D) and consumption (C). As pointed out, not all the elements of the old configuration disappeared in London, let alone across the United Kingdom. The process of instituting a new configuration progressively enlarged in scale, and was replicated in other urban centres to varying degrees. In terms of the processes of instituting this new configuration, some key aspects of the dynamics can be highlighted. Firstly, there was undoubtedly an economic dynamic of new entrant firms seeking profits by expanding market share, and deploying new technologies of water extraction, transformation and distribution to do so. In terms of demand, there was an expansion of demand arising from an exploding urban population, but also convenience, safety and quality of such a good reflected an enduring need, which even at that time was considered as 'basic'. Configurational change entails complementary dynamics within each of the four interrelated processes, so consumption practices emerged pari-passu with changes in the other three processes, involving transformation of past consumption practices.

But the specifically economic instituting process was complemented and affected by political processes throughout. In this period, water companies required parliamentary statute to be able to operate, and in that sense, were politically instituted enterprises. Parliamentary lobbying was heightened by extra-parliamentary agitation from the Anti-Water Monopoly Association – a wealthy householder consumer movement, certainly, but one with political leverage articulated additionally through vestry government. The establishment of monopoly in 1821 equally was a politically instituted monopoly, which, in turn, was complemented by regulation of price and quality. It would be wrong, therefore, to describe the processes of exchange and appropriation as typical commercial markets regulated by the state. Water was not like other commodities in its economic organisation or arrangements, partly as the material nature of its flows through an infrastructure which was singular with respect to each final point of delivery: a technological 'monopoly' of distribution. So political processes, in interaction with economic processes resulted in new forms of politico-economically instituted economic configurations. Moreover, parallel with exchanges between private customers and commercial companies, a public delivery of sewage services – even if leading to impending crisis – relied on revenues from rates linked to property values, a public economy for dealing with privately generated waste. Significantly, this public economy of waste replaced the earlier market forms linked to cesspit technology, and, in the absence of a tradable product, required a compulsory tax-based flow of revenue.

2.3 *The great sustainability crisis and the late 19th century water-sewage configuration*

The inevitable consequence of the dominant source of 'all-purpose' water, the river Thames, becoming at the same time the compulsory destination of sewage, manifested itself in what was misappropriately called the Great Stink – not that the stench of the river in the summer 1858 was unimportant for its political consequence of suspension of sittings in the House of Commons. But the main sustainability crisis was bacterial pollution of the water supply (Halliday, 2001), especially since the arrival of cholera in England in 1831. It was a liquidity crisis, not a miasmic smell crisis as the medical theories of the day assumed – as did the great reformer behind the next transition, Chadwick. Moreover, the crisis was not only generated by sewage flowing directly into the source of drinking water, but was compounded by the continuing breakdown of the cesspit system, which was also polluting groundwater. Indeed, the discovery of the water-borne and microbial source of cholera by John Snow was a result of detective work on a particular groundwater well in Bow Street, in 1854.

If the dynamics of this transition were provoked by an environmental and human biological crisis, the instituting of the new configuration was politico-economic. Many aspects of the first industrial configuration persisted, expanding significantly in scale during the second half of the century. The most dramatic change was the construction of an integrated sewer system, with primary intercept sewers along the purpose-constructed Thames Embankment, fed with networks of underground piped sewers from across London (Hamlin, 1992). It has been described as one of the greatest engineering achievements of the 19th century. However, for such a technological feat to occur, at least as significant was the co-evolution of state finance for such a vast scheme *and* the development in the form of the local state. To raise the money, a bond was established linked to the assured future revenues from dedicated sewerage rates, and during the same period, a new, London-wide organisation, the Metropolitan Board of Works, superseded the fragmented vestry system and Commissioners of Sewers, first with the Metropolitan Sewers Act of 1848, followed by the Metropolis Local Management Bill of 1855 (Hanley, 2006). Critically, the scale of the scheme (it cost £2.4 million at the time) – in particular how far downstream the sewage farm outlets were to be situated – was the outcome of political battles, the resultant compromise falling well short of ensuring the restoration of the River Thames. Chadwick and others had had ambitious plans for converting the sewage into manure, to supplement taxation with a revenue stream for the public purse. But the plan never materialised, despite several attempts. Instead, Bazalgette, the prime engineer and architect of the sewage system commissioned the construction of six ships to carry the now separated solid waste to be dumped into the North Sea, while the purified liquid waste was returned to the river Thames. It was a system that operated until 1996, when banned by European legislation. Nonetheless, the new sewage system opened in 1865, after which, unlike most European cities, London never again experienced the cholera epidemics that terrified Londoners in the 1830s-1850s (Hennock, 2000).

The post-crisis configuration therefore instituted a new public economy of waste, which, through its London-wide integration, contrasted sharply with the continuing fragmented private monopolies of water supply (see Figure 3). Although the piped-water system was continuously expanding throughout the second half of the century, embracing the ongoing growth in population, as Trentmann and Taylor have shown (Trentmann and Taylor, 2005; Taylor and Trentmann, 2011), inequalities of supply, regular interruptions in frequent periods of drought notably to poorer areas of London, and especially the variation and vagaries of pricing water by different companies, all using the institution of rates linked to property values rather than any volumetric basis, resulted in thriving political campaigns by a variety of 'consumer' movements (the Sheffield Bath Defence Association, the East London Consumer Defence League, and many other Water Consumers' Defence Leagues across London). Companies attempted to charge extra percentages on the basic rates if consumers installed baths or WCs, the development of consumer practices destabilising the price institution of the water rate. Baths were definitely a new 'extra', as far as water companies were concerned, promoting disputes with consumers who considered baths to be normal domestic usage.

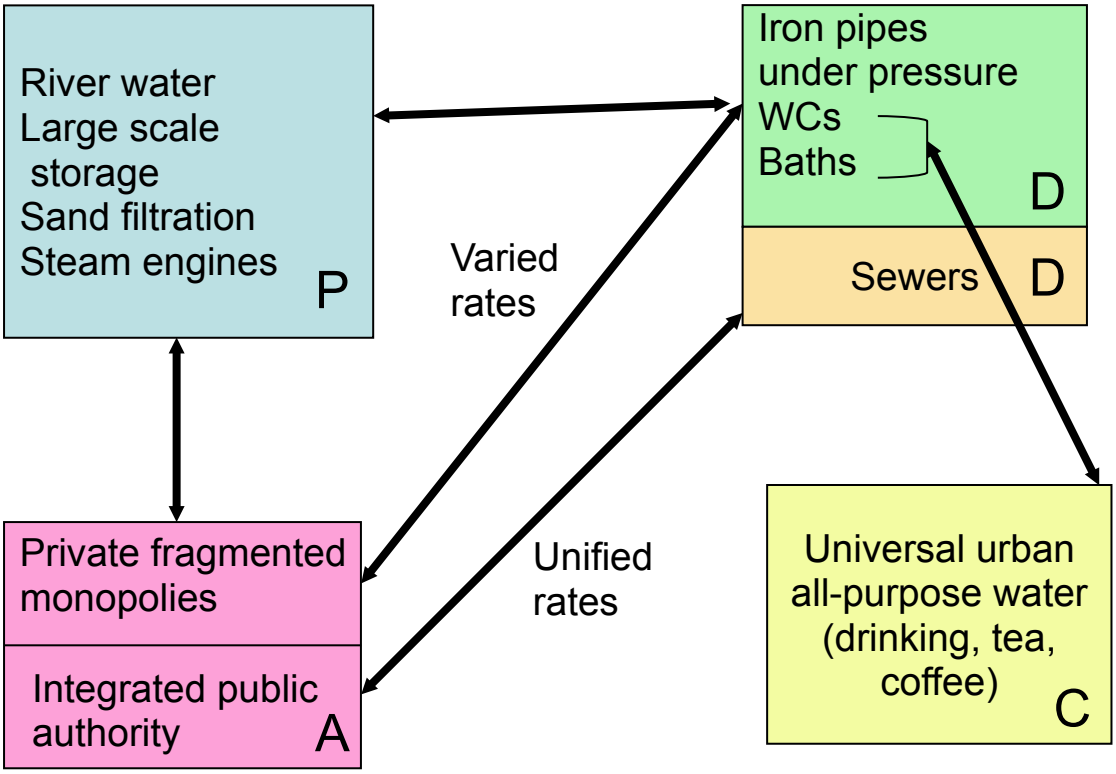

Figure 3: The post-crisis, late 19th century water sewerage configuration

2.4 Municipalisation and chlorination: the pre-reprivatisation twentieth century configuration

By 1904, the previous configuration had developed to an almost population-wide scale, with 97% of households connected to mains supply and sewage, in contrast to Paris at that time with 17.5% (Goubert, 1985). An even starker contrast in sewage systems, where under 20% of towns, and fewer households, were connected to sewer systems before the First World War, a contrast that continued for many decades and well into the second half of the twentieth century. If the pasteurisation of France can be construed from the discourse and network analysis of a handful of medical journals (Latour, 1993), in contrast to England, this did not 'translate' into a generalised 'pasteurised' economy of water and sewage until the 1970s.

Again, continuities, both technological and economic, can be seen in the transition to the final configuration under consideration. But there was a developing tension and instability of the previous configuration, in particular between the fragmented and divisive private monopoly sphere of water provision and the integrated sewage public economy. This tension was brought to prominence by consumer movements especially in the face of successive droughts, and led to a significant shift, with the municipalisation of water provision in 1903. The new public economy achieved integration under the Metropolitan Water Board, now responsible for both water and sewers. One of the most significant aspects of the new political economy of water was the standardisation of rates for both water and sewage across the capital. The municipalisation of water, however, was certainly part of a much wider process of expanding public ownership, and London was relatively late compared with major cities of Liverpool, Leeds, and Manchester (Hassan, 1985, 1998; Millward, 2000, 2007). Many utilities had come under municipal ownership and control, and across all political parties, there was a view that destructive competition over major infrastructures or, conversely, private monopoly power over 'essential' services, was better replaced by a rationalised, publicly accountable, integrated organisation: for many liberals and conservatives, including Neville Chamberlain as Mayor of Birmingham, public ownership did not equate to socialism. There was a widespread concept of a natural – by which was meant man-made physical infrastructural – monopoly, for which public ownership was appropriate. Moreover given the interdependence between water provision and sewage disposal, with the latter no longer able to operate on a market basis, at

that time public ownership was the only form of organisation that could economically integrate the two under a single system.

Quite contingently, chlorination of water was discovered to prevent bacterial infections in cattle, and quite rapidly the technology was adapted to the human water supply, from 1905 onwards, both in England and the USA. In the USA, the most immediate impact, significant for the problematisation of drinking water, chlorination virtually destroyed the burgeoning market economy of bottled spring water for drinking (Back et al. 1995). Safe potable public tapwater undermined commercial bottled dedicated drinking-water. In the United Kingdom, the process of developing and diffusing the technology of chlorination took almost a further 50 years, with various intermediate stages combining chlorine with ammonia, delivering chlorine through gas rather than liquid, before the fully ready-to-use tapwater became established from the 1950s (Chevalier, 1953). Interestingly in this comparative study, experiments arising from its application under the colonial water regime in India, led to a modification of the technology, which was then in reverse applied to the United Kingdom water supply. As a bactericide, chlorination was and is a technology of sterilisation, with the dominant design of making water safe for multiple purposes, of which drinking directly from the tap, was but one. It was water rendered safe to drink – but clearly not produced for aesthetic qualities of taste.

So, as a final element, this configuration witnessed the development of dedicated bottled water, quite distinctively arriving much later in the United Kingdom than many European countries, and still generally on a smaller scale (Eurobarometer, 2010). In configurational terms, from the long durée historical perspective, bottled water can be seen as the most purely market – as well as the most 'pure', unprocessed – water to emerge, with major international companies operating in a competitive market. As with most markets, it is also highly regulated, and in Europe strict distinctions are made between spring and mineral water, with prescriptions on quality and process. Nonetheless, the irony remains that bottled water, as a purely commercial product, is licensed by public authorities to extract 'public' groundwater, appropriate it, and market it with all the blandishments of branding. Carrying around bottles of water, drinking water on the move, became a new consumer practice. So, although bottled water, especially in the UK, represents a tiny fraction of water consumed, even of water drunk in its various forms (raw, boiled for tea, coffee, etc.), it emerged, pre-privatisation, when water in general had been established as a public good for three-quarters of a century. As such, bottled water constituted a new system of appropriation, as well as of distribution, going through supermarket systems of regional distribution centres, transferring spring water from Scotland or Wales to South East England. Whereas tapwater in the UK is still predominantly priced by rates, and even post-privatisation in ways differing little from taxes especially for sewage rates (Bakker, 2003a, b), for the first time, bottled water displays the extravagant range of prices, qualities and brands, with a multiple of 20 to 30 times from cheapest to most expensive per volume, characteristic of market differentiation. In configurational terms, however, and in ways that will become clearer by comparison, bottled water finds a particular and distinctive place only within the overall configuration, and is best understood in terms of this relationality.

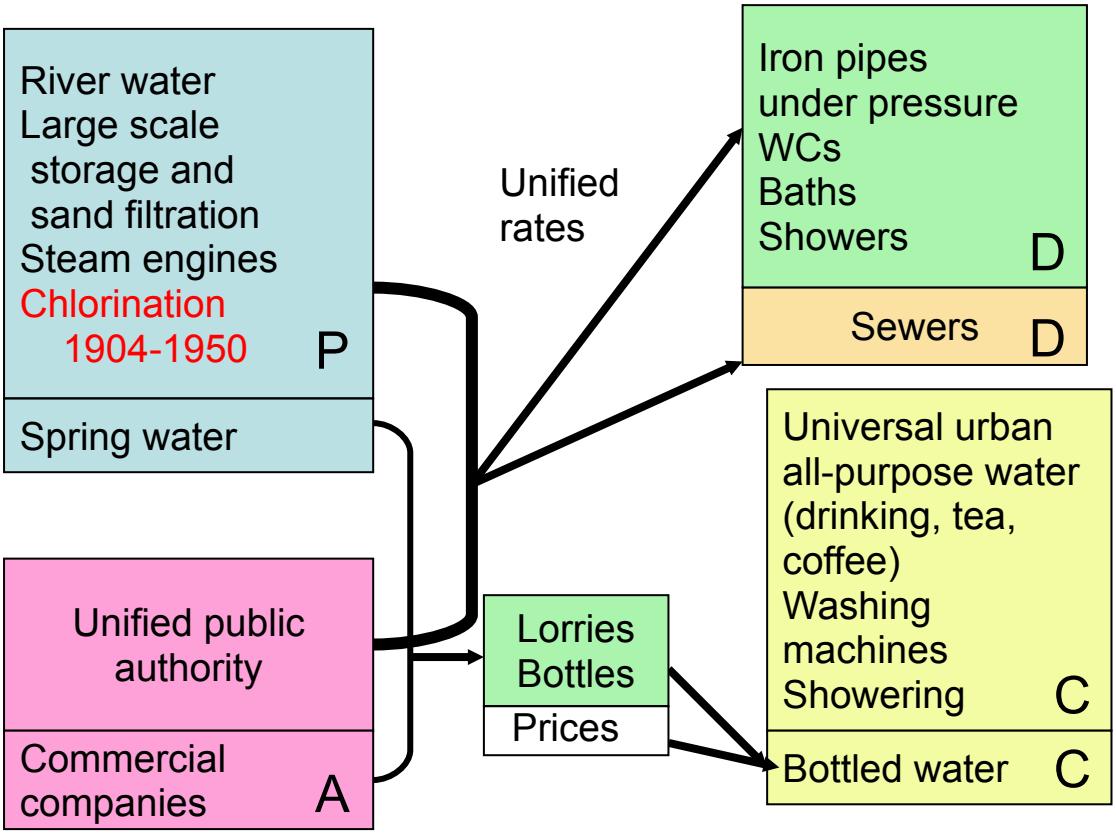

Figure 4: The pre-privatisation 20th century water-sewerage configuration

2.5 Endogenous transitions

The historical approach to successive transitions provides some material for analysis. Unquestionably urbanisation and industrialisation, including adoption of technologies such as steam power and iron-casting of pipes, produced a major rupture from-pre-industrial periods. Yet, even there we can see the industrial system pre-figured in the wooden pipe system of the New River and other water companies, as well as the remarkable endurance of the water rate system until the recent introduction of metering for private domestic units. Transitions are always transformations of previous configurations, with elements of continuity, modified by the new relational dynamics of new configurations. In this analysis, therefore, it makes more sense to understand the emergence of new consumption practices always as both transformations of previous practices, and in the relational context of a given historical configuration. There is co-emergence, co-evolution of new production, distribution, appropriation *and* consumption processes. In this respect, consumption work, work necessary for consumption after the point of final delivery and appropriation, is integral both to consumption practices themselves, and to the division of labour upstream of final delivery. Domestic water storage and treatment (filtering, boiling, alcoholisation, flavouring, etc.), domestic distribution through plumbing systems, disposal and treatment of waste water, and practices of defecation,[5] are integral to the nature of the water delivered, and systems of production, exchange and distribution. New processes of preparation for final consumption, and novel coordination with other consumption activities – e.g. carrying bottled water for sports training – is integral to the emergence of new consumption practices.

Secondly, the comparison between successive transitions demonstrates both the persistence and variation of some of the economic dynamics, in interaction with both political initiatives

[5] In drawing attention to a contrast between England and France, squat toilets persisted in the latter until the late 20th century, in contrast to the established domination of the seated WC in the UK, and there remain many distinctive designs of toilets conditioning the 'embodied practice' of defecating and urinating. A converse contrasts lies in the diffusion of bidets in France, and, until recently, their virtual absence in the United Kingdom.

and responses. Long term expansion of urban population and the dynamically growing demand for higher and higher standards of water quality are examples of persistence: London boasted the purest water in 1840 through its regulated quality of reservoirs and slow-sand filters, and again in 1905, with the additional treatment of chlorination. The elimination of cholera and typhoid were major achievements in progressive improvements of water quality.

Thirdly, there were distinctively contrasting characteristics between the different transitions: no one model type of transition. The anthropogenic sustainability crisis of mid-century stands out as a consequence of the first industrial configuration and a cause of the second industrial configuration. The particular tensions between private water systems and public sewerage systems again demonstrate how a previous configuration provide the dynamic context of their own demise and replacement, in this case by a fully integrated, municipalised water-sewage organisation, stimulated and in part driven by consumer movements, as well as wider political strategies towards economic rationalisation. A given configuration expanded, driven often by economic and commercial growth, only to develop contradictions and tensions that paved the way for further transformation. The dynamics of a given configuration constitute immanent and emergent causalities within that configuration, as well as generating new interactions with the environment, political processes and culture, which in turn contribute to configurational transformation.

Fourthly, water developed, changed is characteristics, as both a private and a public good, indeed, can be seen as contributing to the co-evolution of the differentiation and interdependence between 'the private-market', 'private-domestic', and public goods, a reconstitution of the economically 'private' and 'public'. This was, throughout, an intensely political process, and in that respect, the successive transitions demonstrate the interaction between different processes of instituting economic organisation, both private and public. The Bazalgette technological sewer system co-evolved with the development of both the political organisation of the capital and the organisation of the public economy. Political tensions and conflicts run as a strand through the successive transitions, lobbying behind the monopolist water companies countered by the lobbying of anti-monopoly property interests, and later, consumer defence associations. A dynamic mix of the instituting of novel commercial economic organisation, politically instituted market organisation, market regulation of price and quality, as well as the instituting of radically new forms of public economy, are a testimony to the complexity of transitions from configuration to configuration.

Fifth, and finally, water is not only distinctive as an economic good, but, and inextricably involved, distinctive as a material entity, environmentally and biologically, in ways that conditioned the interactions between polity and economy. The sources and geographies of water are not only the continuing lifeline of urban development in this narrative, but also the bearers of bacteria and viruses pathogenic to human biology. However much humans were responsible for pollution and the spread of diseases, the diseases were responsible for the deaths. Water presents particular challenges, to distribution and purification, but also, as the different transitions demonstrate, continuing tensions and conflicts around appropriation: who, what and how does any social organisation 'own', 'control' a river, an aquifer or rainfall (my water in my water butt?), as they are naturally given. In that respect, the natural properties of various natural waters, independent of human constructions, continuously condition, constrain, and stimulate those water constructions: political, economic, or cultural (including epistemic). The transitions analysed above are of London, in its physical dependence on the Thames, the Lea, and other rivers; on the particular aquifers and rainfalls; on the floods and droughts; and on the organisms that thrive in this environment. London may share many environmental characteristics with other cities in the United Kingdom, and hence similar nature-economy-polity interactions. But all this changes when going from historical to geographical comparison.

3 NEW DELHI: A CASE OF FAILED TRANSITIONS?[6]

In this section, a brief account will be given of the preceding history of Indian water provisioning, again selectively focusing on Delhi, before turning to an examination of some major configurations of water economies in the contemporary city. In contrast to the endogenous transitions characterised by the emergence of industrial capitalism in the UK, India can be seen as layered by two major exogenous transitions, the Moghul and then British Empires, followed by the post-colonial period of endogenous change, coping with historical legacies.

The Moghul Empire was renowned for its extensive engineering of water, and for the cultures of water that were introduced, overlaying historical Hindu traditions of water practices, religious and secular (Hosagrahar, 2010; Sharma, 2009; Sharan, 2011). The geography and natural water environment, the uses of different types of water, and the engineering of water storage and supply struck an English traveller in the 1680s in the following terms:

> 'The Bannian seldom drinks of the common water of the wells or rivers, only what falls from heaven in the time of the mussuouns, which is preserved in large tanques and cisterns made on purpose to receive it, and keep it for their use the following year….He confines his drinking to those heavenly showers, which he esteems a more pure and ethereal liquor for descending from above.' (cit. Sharma, 2009, 70).

The reservoirs (tanks and cisterns) were constructed in stone, as large as a kilometre in length, half a kilometre wide. Conduits from reservoirs distributed water to various parts of buildings, and for different uses. In Delhi, reservoir water was complemented by the Yumana River, primarily, and wells for washing clothes, cooking, and for ritual ablutions. In contrast to the England of the time, where baths once a year were the norm, washing before eating, and a daily total bodily submersion were powerful cultural norms (Hosagrahar, 2010). Moreover, a particular construction of water wells, the *baoli*, were large buildings, descending in flights of stairs 100 or more metres deep, surrounded by covered cloisters, where washing and socialising together created a significant cultural combination. Within the city of Delhi, extensive systems of canals, covered to prevent evaporation, distributed water to different parts of the city.

The transition from the Moghul to the British colonial water economies was one that combined decline and decay of a dying empire, followed by destruction, and, by the time of British Imperial Rule, introduction of an industrial transplant from 19th century England (D'Souza, 2006; Broich, 2007). There were also continuities for much of the population. British colonial water economies, both water provision and sewage, was sharply segregated and primarily dedicated to supplying the white colonial regime and its army, whilst attempting to ensure security from 'pollution' from the spread of disease from the colonised population: it was a sharply divided water economy, one that never promised generalisation to the population as a whole (Mann, 2007; Prashad, 2001). Attempts were made to ensure that there was not even mixing between white and Indian sewage, whilst at the same time, as in London, Indian nightsoil was sold to Indian farmers on the periphery of the city (Prashad, 2001). The continuity of caste, with nightsoil collectors clearing the streets of Delhi in the Old City to this day, reveals not so much a failed transition, as a deeply segregated and divided population in terms of rights over water resources and hygienic systems of waste disposal.

It is more difficult to interpret contemporary Delhi in terms of the exogenous imposition of a divided water economy whose inequalities of rights were part of the fabric of empire, given that the presumed rights and responsibilities of a modern democratic state are to a whole population, within its capital city. The legacy of inequality and division, including the bureaucracy of the state apparatus, may certainly contribute and weigh heavily on the present

[6] I wish to thank my co-researcher, Aviram Sharma, a doctoral student at the Jawaharlal Nehru University, for his indispensable collaboration, creativity and initiatives, in researching water provision and consumption in New Delhi. I also wish to thank Dr Saradindu Bhaduri of the Centre for the Study of Science Policy, JNU, for his continuing and generous support. This research was in part supported by the ESRC Sustainable Practices Research Group, in part by University of Essex research funds. Over 50 interviews have been conducted with key actors, slum-dwellers, water tanker contractors, water street vendors, NGOs, the World Bank, Delhi Jal (Water) Board, Delhi Municipal Authorities, and academic experts. The fieldwork was conducted between April and November, 2011.

organisation of the water economy in the city. But legacy can only account for so much, for a nation capable of devoting the skill, resources, and organisation to the launching of satellite missiles into space, or to developing stealth fighters with Russia in a $10 billion project (The Hindu, August 18, 2011), but incapable of supplying piped water to more than 1 in 10 of the population of the capital, or sewage pipes to 1 in 25 households (interviews, Chief Engineer, Delhi Jal Board, NGOs, World Bank). In this context, the concept of failed transition appears worthy of consideration, and to do so we turn to an IEP analysis of contemporary Delhi configurations of water economies. Interviews, indeed the process of getting interviews, at the principal governance organisations revealed major impediments, ultimately political, to the renovation of bureaucratic administration. Quite startlingly, a senior official and expert in the Delhi water system, declared that, in the absence of any competent organisation with which they could co-operate, the World Bank had 'given up on Delhi', following a failed Public Private finance initiative.

The city of Delhi faced a scale and rapidity of unplanned population growth surpassing any experience of urbanisation during the industrial revolution in the United Kingdom: from 1.4 million in 1951 to 13 million in 2001, and then 18-19 million by 2010, truly one of the global mega-cities (Davis, 2007). The supply of fixed infrastructure water and sewage to unauthorised expansion of settlements, and dwellings whose fabric could not support any normal plumbing, demonstrates how water provision is intimately connected with the development of the wider built environment. Over half of the city exists outside any planning framework. Yet, many of the settlements, so-called authorised and unauthorised colonies, have been established for decades. Moreover, many of the districts of regularised colonies have existed for decades, and the process of regularisation, the conversion of unauthorised into authorised colonies, remains erratic and politically sensitive. The main public water authority, which combined the responsibility for water provision and sewerage under the Delhi Jal Board only in 1998, is only required to provide services to authorised colonies, in spite of a Supreme Court order of the right for all citizens for water supply.

However, even for the one in ten of Delhi households connected to piped water, supply is intermittent, the irregular water pressure resulting in leaks-in as well as leaks-out, so also in contamination. Even wealthy households, therefore, have no reliable access to a public resource of potable water: there is no ready-to-use, all purpose, drinkable tapwater in Delhi. Consequently, there are, as in pre-industrial England, multiple alternative sources of water for alternative purposes, different systems of distribution; diverse forms of bottled water and distribution systems, water tankers, street vendors, standpipes, borewells, and the river Yumana running through the centre of Delhi. There are also diverse forms of disposing of human waste for the 80% of the population not connected to sewers: private toilets in the vicinity of slums, public spaces, streets, ditches, domestic open sewers, open streams, and so on. In striking parallel with Thomas Cubitt's description of the River Thames in 1840, the Chief Engineer of the Delhi Water Board (DJB) said of the Yumana 'We call it a sewer not a river.' (Interview, 2011, November).

Within this context, two contrasting economies of water can be identified, which by no means exhaust the full range of emergent economic organisation surrounding water provisioning and consumption, but which reveal some of the key dynamics of emergent configurations, and their limitations. Given the absence of integrated, scaled-up, and generalised systems of provision, both configurations, to different degrees, display characteristics of what might be called 'bricolage' economies of water, that is, economies that are composed of diverse elements that are put together to provide a range of water types for a range of consumer practices, but in ad hoc, often temporary combinations (Maria, 2008a, b; Levasseur and Maria, 2005). Bricolage involves an inventive 'cobbling together' of bits and pieces. A key aspect of these bricolage configurations of water is consequently the extensive reliance on consumption work, as consumers in various social groups and categories, develop the combinations, and put together the pieces, to meet their overall water needs. The consumption work of coordination – often time-consuming and labour-intensive – is combined with consumption work of transport, storage, treatment and preparation of water prior to use for each of the water elements constituting the bricolage water economy. In this respect, one of the strengths of the IEP approach is that it enables analysis of distinctive modes of appropriation, distribution, production, and use of water, in complex combinations, and at various social and geographical scales.

3.1 The upper-middle and middle class economy of water configuration

The bricolage economy of the wealthier inhabitants of Delhi, living in authorised and planned urban built environments, exemplify a bricolage economy at the top end of the scale, enabled by sufficient levels of income. In the first place, a significant element of their water is provided by piped tapwater, as a public service, using technologies of sand filtration and chemical treatment typical of any advanced economy, drawing water from the River Yumana. Given intermittent and contaminated supply, this water is generally boiled, in large quantities, prior to use for cooking or drinking, whether as water, tea or other flavouring. Only 40% of those supplied with tapwater pay any water bills, and little or no enforcement for the non-payers (interview, DJB principal legal officer) – in short, there is a failure to generate a reliable revenue stream. In turn, inevitably this affects the scaling up of a public piped water supply system (DJB Chief Engineer, interview).

A further typical water element is derived from private-domestic borewells, of which there are now approximately two million in the city. From an IEP perspective, borewells are a combination firstly of a significant market for borewell construction and maintenance. But, secondly, they are also a private-domestic appropriation of a putatively public good, the groundwater aquifer. In that respect, all borewells are legally required to be registered with the separate Central Groundwater Commission,[7] but over 99% of borewells are unregistered (interviews with the NGOs Centre for Science and Environment and Delhi Science Forum, and DJB legal officer). Hence, in effect, there is a substantial middle class illegal appropriation of a public good. Furthermore, in many areas of Delhi, a tragedy of the commons has arisen, as groundwater resources are depleted, forcing borewells to be drilled deeper and deeper, to an extent that in some cases they are abandoned altogether as a source of water. Moreover, the purity of the groundwater is by no means guaranteed, and given the private-domestic nature of appropriation, there is no quality regulation or monitoring, unlike DJB water in piped public provision. So, borewells also generate both more consumption work for filtering the water, as well as markets for water filters. No survey data is available to identify the use of borewell water, but it is less likely to be used for drinking than for other domestic purposes. A further water 'element', only for special occasions, such as weddings, when there is exceptional household demand, is provided by DJB water tankers, which can be hired for the occasion.

Finally, there is a significant use of bottled water, and in Delhi, this primarily means 'packaged water', processed spring or river water, much the same as piped water, but further filtered and processed to eliminate residual chemicals. Bottled water purchases by individuals can reach levels of 60 litres per month, much higher than found in the United Kingdom or many European countries (Sharma and Bhaduri, 2012, World Bank interview). Packaged water is generally, and on a large scale, produced by commercial enterprises drawing on licensed sources of groundwater, the largest provider being Bisleri (an Indian company), followed by Kinsley (Coca-Cola), Aquafina (Pepsi-Cola), and more recently the Indian multi-national, Tata, under the Himalaya brand. But this is only affordable by the wealthy, and only the relatively very wealthy purchase the imported, largely European, mineral and spring waters, although Indian mineral and spring water is growing as a small niche product. Finally, and still on a very small and non-dynamic scale, the DJB itself sells bottled water in Water Convenience Stores (Jal Suvidha Kendra) mostly in 20 litre bottles, and from seven outlets in middle- to lower-middle class areas. There is thus the peculiar phenomenon, although quite marginal, of the co-existence of public and commercial bottled water, both exchanged at a price-per-unit, but with public bottled water sold in large quantities at a much lower cost.

The Figure 5 below schematically summarises the upper-middle and middle class water configuration, demonstrating the bricolage combinations of public, private-domestic, and private commercial forms of appropriation and distribution, the use of multiple waters for multiple purposes, and the considerable involvement of consumers in the division of labour involved in delivering water fit for consumption, whether for drinking, cooking, washing, or gardening. It demonstrates also the peculiar significance of packaged bottled water as a key element for dedicated drinking water, intelligible within this distinctive configuration. Bottled

[7] A typical feature of the bureaucratic boundaries to development of water provisioning resides in the current division of responsibilities between groundwater and other water resources, paralleled until 1998 and the formation of the DJB, by the separation of responsibilities for sewers and water supply.

water in Delhi is not the bottled water of the United Kingdom or Europe. Based on a small survey taken in five locations in Delhi, Sharma and Bhaduri have argued that necessity rather than any normal concept of market consumer choice underpins the purchase and consumption of bottled water. And, although it is frequently consumed when on the move, outside the home, bottled water is the only trusted source of drinking water, when untreated by the range of consumption work undertaken in the domestic context (Sharma and Bhaduri, 2012).

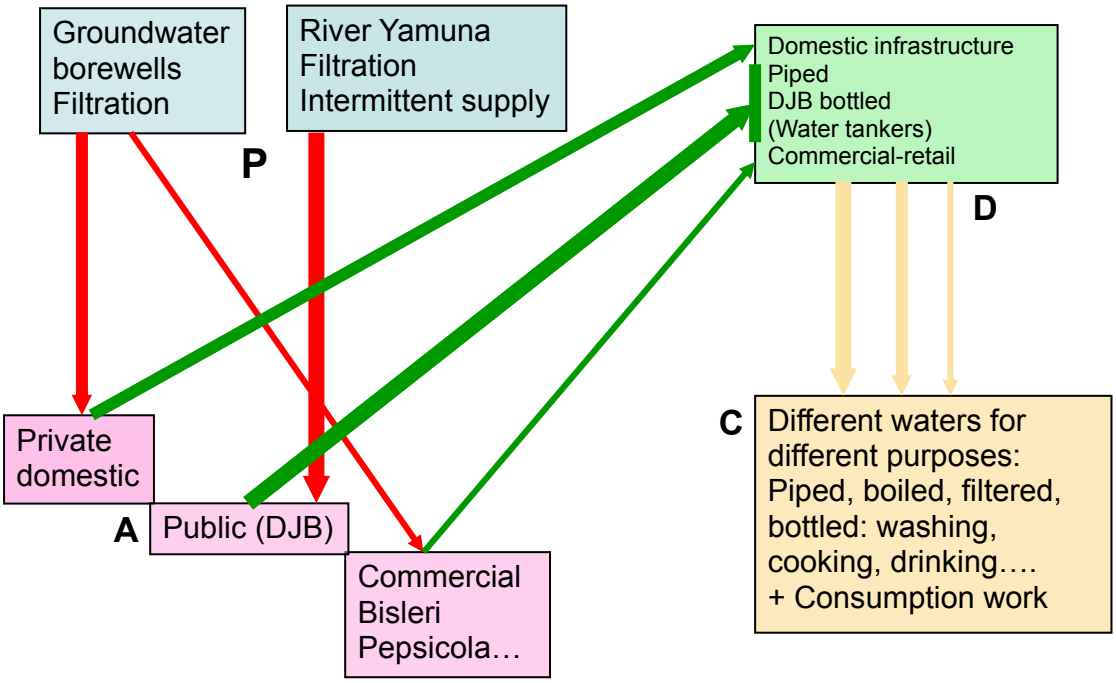

Figure 5: The upper-middle and middle class economy of water configuration

3.2 The unauthorised colonies economy of water configuration

The research undertaken to support this analysis was undertaken by multiple informal interviews in two different Delhi slums – unauthorised colonies, or Jughi Jhopdi, and cannot be taken to be representative of every Jughi Jhopdi in the city. Nonetheless, it is supported by other case studies and analyses (Maria, 2008a, b; Baud et al. 2008; Banerji, 2005). As already indicated, there is no official piped water in unauthorised dwellings, and the fabric of the buildings prohibit normal domestic plumbing systems. Indeed, on entering the slums, one of the most conspicuous sights is the huge number of 50-100 litre plastic drums for storing water. Nonetheless, in parallel to the middle class illegal appropriation of groundwater with borewells, both slums had standpipe access to illegally diverted DJB piped water, although at very low pressure, and with intermittent supply. In one colony, one standpipe fed 25 households, and access and use of water from the standpipes were collectively regulated, allowing each household to take just 40 litres of water once every 7 to 10 days. This was an example of private collective appropriation of an illegal source of water. In the other colony, the water was illegally appropriated via diversion of public supply by another colony, and then sold to the colony in question, an informal secondary 'market' for water. Even visual inspection of the water could detect high levels of contamination. In this colony, pressure was so low that it could only be scooped up from ground-level pipes by plastic bottles, and women were working at this 'distribution' of water by filling up the plastic drums, again for a collective grouping of households. In both colonies, there were a few legitimate, but inadequate number of DJB installed groundwater borewells, so public borewells accessing public groundwater.

These two components of the water economy was then supplemented by child labour fetching and carrying water from public standpipes at some distance from the colony, twice a day, once at 3-4am in the morning, once at 8-9pm at night. A further component of water supply was provided by DJB water tankers, distributing water free-of-charge, regularly but not daily, and to which there was unequal access within the colonies. Much of this water was fit for drinking

purposes without further treatment, boiling being the only one possibly available in the slum context. Apart from the multiplicity of plastic drums, the other striking impression of the resilience of the slum population was the display of drying clothing from lines strung between every available point, with clothes washing carried out by women in cut-away plastic containers.

A final component, quite marginal in terms of overall consumption, was dedicated drinking water purchased from the ubiquitous street vendors, found in highly populated areas such as street markets, bus or railway and bus stations. This in turn shows a distinctive economic organisation in terms of appropriation and distribution: the water originated from the DJB public water supply, was sold to contractors, who in turn employed the vendor watercart pushers. Typically, each watercart had to be licensed by the Delhi Municipal Council, who supposedly checked the water contractors' facilities to ensure proper filtration and cooling systems. Each cart had strictly prescribed physical dimensions, making the carts a standardised feature of Delhi street life. To give the economy its final twist, it is prohibited to sell the water with slices of lemon as these might be a potential source of contamination. But lemons were the only source of profit for the water vendors, and so the rules were never enforced (interviews with the licensing officials at the Delhi Municipal Council). Lemons are on every cart, for all to see, providing drinking water at a lower cost than bottled water for those on the move.

In the absence of sewers, in both colonies men used open squat toilets directly discharging into open drains or streams running through or beside the colonies, and women were obliged to walk up to a kilometre to 'sulabh souchalya' or 'easy-access toilets' where they had to pay a small fee for each visit, in one case in a private company toilet that was both squalid and lacked any privacy.

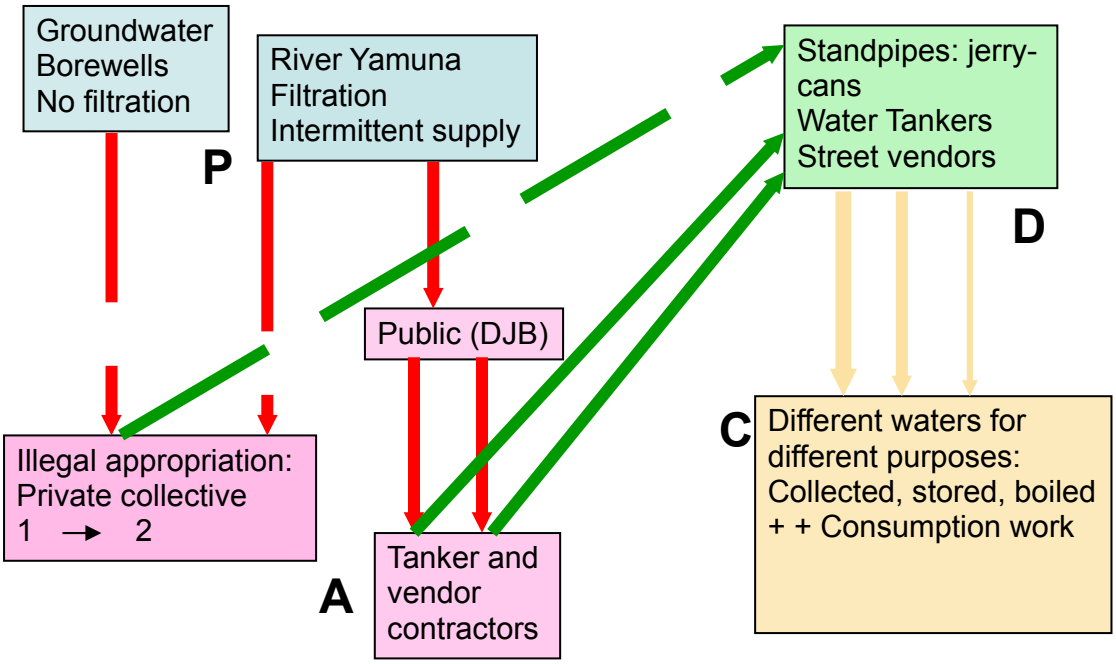

Figure 6: The unauthorised colony economy of water configuration

The contrast between the upper-middle and middle class water economy configuration and that of the unauthorised is demonstrated by Figures 5 and 6. For the latter, a much more restricted range of water quality and supply resulted in even higher levels of consumption work. In both colonies, everyone interviewed insisted with great vigour that water was the biggest problem of their lives. Women and children clearly carried much of the burden of this water consumption work.

3.3 Partial systems, failed transitions

The above analysis, both of consumption work and consumption itself, suggests the power of a relational analysis within economic configurations of production, appropriation, distribution and consumption. Bottled water finds a place within the wealthier of Delhi, but is almost absent in the context of a slum. Its place in the former is intelligible only in the context of failed systems

of piped provision, even where households are connected. The two bricolage economies of water, different combinations for different segments of society, both incredibly resourceful, manifest the failure of any system to scale-up and provide potable water to a general population, sufficiently or continuously. The technologies are all present and available. The DJB deputy CEO argued that in the absence of urban planning, and control over the expansion of the Delhi population, it was neither a plausible responsibility nor a technical possibility, for his organisation to provide water for the whole population (Interview, November 2011).

Undoubtedly, water provision cannot be seen in isolation from wider economies of urban infrastructures and the built environment. Yet, as with the historical development of water and sewage provision in the UK, it is clear that the possibilities of breaking through the multiple barriers, including bureaucractic ones, to viable water and sewerage provision, is primarily a political issue, or rather a political economy issue. Before elections, in order to obtain new voting constituencies, unauthorised colonies regularly are offered authorisation, and thereby the possibility of piped water provision, in exchange for their suffrage. Social movements and trades unions have been, and are, engaged in campaigns against privatisation, and for the protection and reconstitution of groundwater as a public good against both private-domestic and commercial appropriation, while NGOs recognise that the organisation of the DJB is itself as much a source of the problem as a solution (interviews with DJB Trades Union representative, Centre for Science and Environment, Delhi Science Forum). Yet, whether in the current perspectives of the World Bank, leaders of social movements for public water provision, or, perhaps most significantly, inhabitants of Delhi slums, there is a profound pessimism about the immobilism and inertia of current bureaucratic and political formations.

4 A 'DEVELOPMENTAL STATE' ECONOMY OF WATER: TAIWAN[8]

With a current population of 23 million, now largely urbanised with 77% living in cities,[9] in an island 394 km (245 miles) long and 144 kilometres (89 mile) wide, Taiwan presents a totally different scale and environmental context and condition for water provisioning than a mega-city like Delhi. Its capital Taipei, with a population of 2.3 million is roughly an eighth of the population of Delhi. With 131 rivers, 21 of which are large, and a monsoon supply of rainwater, the island is naturally well endowed with water. However, for socio-economic comparison, at least as significant is the very different trajectory of development and legacy, when compared with British Imperial rule, which, as we have seen, left a water provisioning system sharply divided by socio-economic status and ethnicity. Taiwan also experienced a significant exogenous transition, with Japanese colonisation from 1898 to 1945, during which road, education, housing and, water infrastructures were introduced, in the Westernised industrialising and modernising model of the Meiji Restoration. So, during their rule, most of the current 109 mountain dams were built, providing gravity-fed water into the cities, and Western technologies of slow-sand filter beds and chlorination provided similar quality of water, this water provisioning system replacing predominantly pre-industrial wells and river sources prior to colonisation. However, even prior to Japanese occupation, public water authorities had been introduced in cities such as Tamsui, where technologies of purification and distribution were introduced by the British engineer, William Kinnimond Burton. The Japanese legacy was provision for the urban population, not exclusively or predominantly for the colonising elite, the significant exception being the almost genocidal suppression of indigenous mountain people that occurred during the construction of mountain roads and dams.

Thus, when considering the contemporary economy of water configuration, as with the comparator cases of the England and Delhi, the transitions involved a transformation of this pre-existing Japanese introduced water economy. Table 1 below demonstrates the broad picture of the extension of tapwater provisioning, in conjunction with urbanisation in post-war Taiwan, going from under 50% in 1970 to over 90% in 1990.

[8] The research into water provisioning in Taiwan has been made possible by my collaboration with Dr William Li, Department of Sociology and Social Policy, National University of Dong Hwa, Hualien, Taiwan. The research reported here is at a preliminary stage, but I am most grateful to Dr Li for all his assistance.

[9] http://www.taichung.fcu.edu.tw/%A5x%C6W%B3%A3%A5%AB%B5o%AEi%A5v2004.pdf

	Coverage %	Total population (million)	Urban population / total population %	Tap Water system	Simplified System built
1905	1.4	3.02	3.82	2	
1910	5.6	3.2	4.94	6	
1915	8.1	3.4	4.97	18	
1920	9.8	3.6	6.97	22	
1925	13.1			45	
1930	16.9	4.56	11.27	72	
1935	10.9			91	
1940	14.6	5.89(1939)	14.9(1939)	123	
1945	17.89			88	
1950	26.77	7.87(1951)	27.61(1951)	88	77
1955	27.52			116	
1960	29.67	10.79	34.07	132	11
1965	38.32			133	100
1970	43.26	14.68	45.11	132	330
1975	58.5	16.14		246	270
1980	78.6	17.80	59.16	211	96
1985	85			222	
1990	90.1	20.35	66.44	232	
1995	90+				
2000	90+	22.21	67.99		
2005	90+				
2010	90+				

Table 1: Public Tap Water Coverage in Taiwan, 1905-2010ea excluded

Source: Tap water: from 台灣自來水誌 p.44-100.

During the period of Kuomintang (KMT) dictatorship, industrialisation and modernisation of water supply, particularly following severe outbreaks of cholera in the 1960s, resulted in the Water Supply Act 1966, followed by the establishment of the Taiwanese Water Corporation in 1973. From that period onwards, the basis of a fully integrated, national public water supply system was established. At the same time, partly funded by the UN, the so-called 'simplified system' of groundwater extraction in borewells, also under governmental control and monitoring by the TWC, established a relatively modernised water provision to rural areas.

The contemporary configuration, in schematic terms, reflects this transition process. Dominating the configuration is the public supply of tapwater by the Taiwanese Water Corporation, supplying tapwater to urban populations at a price half that of the United Kingdom.[10] In terms of distribution and exchange, there is a uniform water charge for public water across the country, a price-per-volume institution enabled by metering. It is a national, integrated system, with water institutionalised by law and economic organisation as a national public good. Even the groundwater of the 'simplified system' in rural areas, comes under governmental control and responsibility, combined with collective community control.

In rural areas especially, there is continuing reliance on borewells, although modernised pumping systems enable the domestic installation of plumbing, water tanks, and WCs. In the rural Southwest, including the city of Kaoshiung, where problems of water pollution have been most severe until recently, private contractor water tankers provide a commercial delivery service. A distinctive feature of Taiwanese town- and city-scapes are the water tanks on every roof, reflecting the significance of gravity feeding in domestic plumbing systems.

Given the now widespread provision of industrial-quality tapwater to the majority of the

[10] http://www9.water.gov.tw/ch/files/waterch/水價合理調整_03.doc

population, one of the most striking contrasts with the United Kingdom, however, involves the consumption work and consumption practices for drinking water. In fact, tapwater is not used by consumers as a 'ready-to-use' all purpose water. The practice of filtering tapwater in the domestic context is widespread, so supporting a large water-filter industry and market on a much greater scale than the UK. But, even more significantly, tapwater, even when filtered, is then boiled, to be drunk as hot water, or, more generally tea, with virtually no-one drinking 'raw' tapwater.

Domestic filtering, however, finds a market counterpart in this configuration with water vending machines, also a distinctive Taiwanese phenomenon to be seen on many city streets, with their elaborate filtering mechanisms, flashing and glowing blue lights, distributing water through pumps similar to petrol pumps for consumers to fill their plastic jerry cans and carry back home. These water vending machines are connected to the public water supply, with the commercial enterprise paying public water rates, but then marketing the filtered water at market prices. In many machines, there are three levels of quality of filtered water, at three price levels from 20 cents a litre to 40 cents a litre, for example. Thus, these water vending machines involve a distinctive sub-component of the overall water configuration, involving combined public and private appropriation, commercial market exchange and distribution, consumption work and consumption.

Given this particular context of water consumption, the growing bottled drink market also exhibits a distinctive Taiwanese flavour. The dominant way of drinking water in bottles is through drinking bottled tea, with bottled 'pure' water – here mostly spring, mountain, or deep ocean – only constituting a minor part of the market. So here too, the emergence of a consumption practice of drinking bottled water needs to be analysed in relational terms, within the particular water provisioning configuration (Table 2). More than two and a half times more bottled tea is purchased than bottled water, a statistic reflected in supermarket shelf space with the variety and quantity of bottled teas on sale. Moreover, the emergence of this market is closely linked to the explosion of convenience stores, growing from 2,000 in the early 1990s, to 20,000 in 2006.

Total Sales (1,000 Litres)	2006	2007	2008	2009	2010
Fruit/Veg. Juice	226,557	208,806	280,701	296,042	260,259
Soft Drinks	269,488	281,547	270,060	377,050	294,938
Tea	727,151	677,296	710,570	851,698	926,035
Water	312,160	307,612	320,710	361,095	364,087
Others	375,966	352,829	351,811	364,537	377,364
Total	1,911,323	1,828,093	1,933,853	2,250,424	2,222,684

Table 2: Drink Consumption in Taiwan 2006-2010 unit: litre

Schematically representing the contemporary economy of water configuration in Taiwan, therefore, Figure 7 displays the dominance of the public water provisioning system in part a reflection of the strong centralising state both pre- and post- Second World War, complemented by the private domestic filtration market and consumption work. There is a distinctive Taiwanese configurational complementary between public, public-commercial, domestic-private, and commercial bottled water provision and consumption, resulting from successive configurational transitions, and the emergence of ancillary market phenomena (domestic filters, bottled tea).

As yet it is difficult to interpret the consumption work and consumption practice of boiling water, and the absence of the use of tapwater for drinking 'raw'. Japanese colonisation involved a powerful inculcation of the habit of boiling water, both in primary and secondary schooling but also in what amounted to a 'hygiene' police, with intrusive inspections of domestic hygiene practices, no doubt in part a response to outbreaks of cholera and typhoid fever. Overlaying Chinese cultures of drinking hot water and tea, persistence of the boiled water practice can be seen to be a reinforcement of cultural norms with a modernising 'scientific' hygiene regime,

rather than in terms of an antithesis between scientific discipline and traditional culture. This 'water' culture is also complemented in the Taiwanese food cooking culture, where almost all food is fast-fried, steamed or boiled: raw vegetables (even washed) are virtually absent from the cuisine. Safe food and water is cooked food and water, as well as constructing the distinctive aesthetic of taste and consistencies.

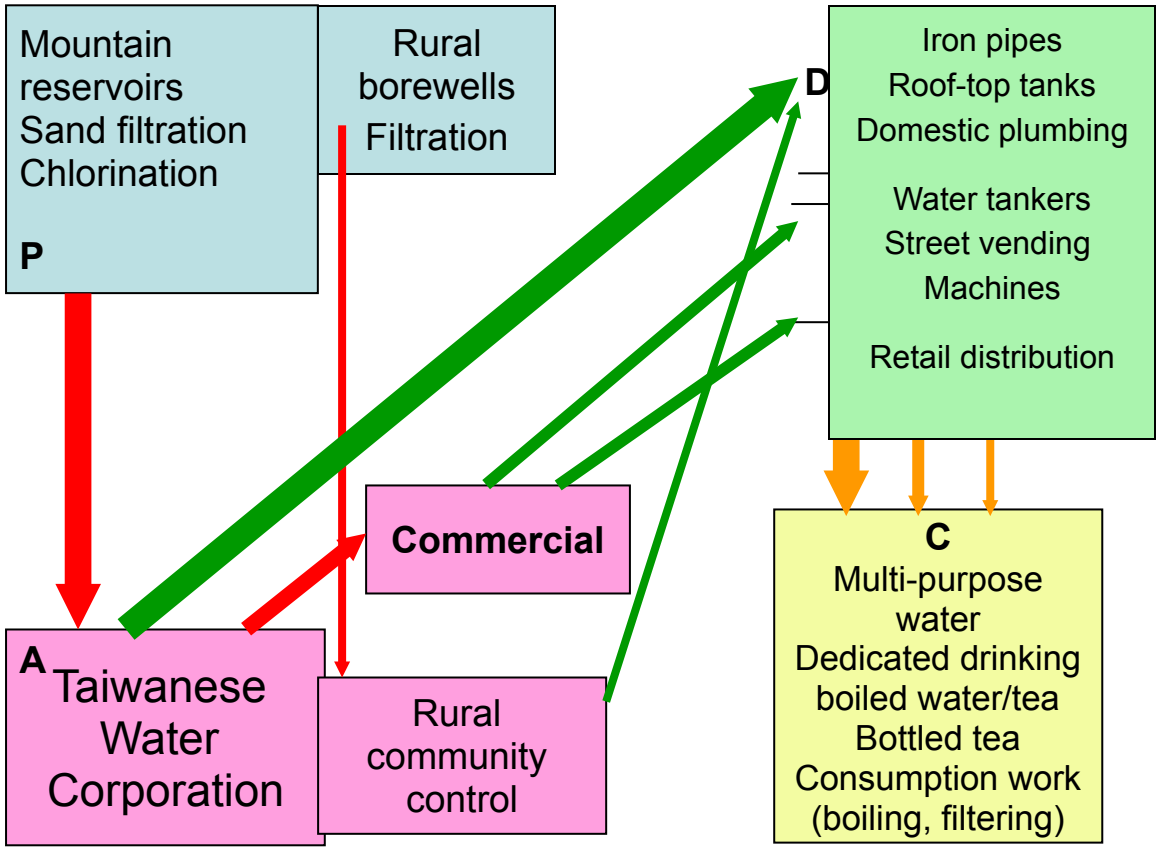

Figure 7: The Taiwanese developmental state economy of water configuration

5 TRANSITIONS, CONFIGURATIONS, AND CHANGES IN CONSUMPTION PRACTICES

Water is a most peculiar good, assuming multiple characters, centrally involved in the historical constitution and re-constitution of public economies, market economies, and the differentiation and interdependencies between them. Its natural properties, and geographical distribution and availability, pre-condition and condition its human appropriation and use. How it is produced for human use, and then how economies of water are instituted, de-instituted and re-instituted mark water out as a distinctive good: highly politicised in all the contexts examined in this comparative and historical exercise, water is difficult to commodify like any other commodity, and appears as such in bottles at the margins of all the configurations examined. It escapes domination by globalisation – for the most part, and in spite of the presence of Pepsi-Cola and Coca-Cola bottled water. It resists neoliberalisation, in spite of water privatisations which fail to institute fully-fledged, self-regulating, competitive markets, even in the USA, where public water still dominates water configurations, including in New York City and Washington DC. Even when privatised, piped water is not a commodity like any other.

But equally, the comparative configurational analysis also demonstrates just how slippery water is in the institution of public economies of water. The establishment of public control over rivers and groundwater is quite different from public control over roads or railways, human artefacts. The example of Delhi with its 2 million private domestic borewells, or the historical uses and abuses of river water, illustrate the problematic and contingent emergence of these water resources as public goods. Moreover, although often ignored when considering public water supply, in all cases examined here, distribution of public water connects to domestic,

privately-owned, plumbing infrastructures, where compatibility and divisions of responsibility are potential sources of tension. Only in the epoch of widespread socialised housing in the United Kingdom was the local state responsible for internal domestic infrastructures as well as public water supply.

The IEP approach to the instituted configurations of economies of water has demonstrated both the interdependence and specificity of processes of production, distribution, appropriation and consumption of water. Focusing on consumption work and consumption practices, for example, the consumption of bottled water finds distinctive places within the different configurations, yet involves activities of consumption work and processes of consumption to develop in ways that cannot be understood as determined by the technologies of distribution, for example, or the qualities of the water produced by different processes. The contrast between the all-purpose ready-to-use tapwater in post 1950s England, for example, and the near equivalent in contemporary Taiwan suggests the specific dynamics of the evolution of consumption practices, themselves the transformation of previous consumption practices in the two contrasting trajectories of development. This underscores the analytical point of an instituted process account, historical configurations as transformations of previous configurations.

When considering both the comparative and historical approach, therefore, transitions from one configuration to another have been analysed in terms of the immanent dynamics of emergent configurations. If one compares the endogenous transitions of the English example, the dynamics that led to a reconfiguration following the Great Stink contrast with the dynamics that led to the transition between the private-monopoly to integrated public water-sewerage configuration at the turn of the twentieth century. The dynamics of growth and scale-formation of any given configuration suggest the immanent causality for transition within the contingent, historical formation. However, when comparing this endogenous growth with the examples of Delhi and Taiwan, it becomes clear that configurations instituted at any one place or time are not closed, internally bounded, systems but always open to 'invasion', colonisation, and external transformation. In both the Delhi and Taiwanese examples, contemporary configurations bear the marks and legacies of previous colonial regimes, if in quite contrasting ways. In both cases, moreover, it can be seen that the transitions cannot be interpreted in terms of technology transfer – of the pressurised, chemically treated, tapwater technologies, for example. The economic organisation of the configurations and the place of the piped infrastructures, are sharply contrasted and distinctive. In the case of the bricolage economies of water in Delhi, notably, the blockage of the piped water system, the failure to scale-up and generalise the technology to a population-wide system of provision, were seen to be the outcome of politico-economic paralysis, placing huge burdens on the different populations to cobble together their economies of water from different resources and sources. The immanent dynamics of different configurations, therefore, have no implacable internal logic to grow, scale up, and generalise. It could be argued in the United Kingdom of today, for example, that the unequal distribution of water in different regions in circumstances of overall plenty in a natural resource, betray an inheritance of the frozen scales from earlier periods of instituted economies, first of the private monopoly water companies, and then of the local and regional public water authorities. It is a scale legacy of earlier economic organisation, contrasting notably with the centralised and nationally integrated economy of water characteristic of Taiwan as a developmental state.

To conclude, an IEP approach to economies of water supports a radically historical and spatial account of the specificity of consumption practices within emergent economic configurations. Moreover, whilst insisting on the specificity of economic processes in their relational configurational organisation, these economies of water are in turn shaped and dynamically affected by their interactions with 'nature', human biological, biological and physical environmental, as well as by distinctive developments of political and cultural processes. This analysis of instituted economies of water is hence illustrative of a wider and necessary reconceptualisation of the economy *within* society and its natural environment.

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