

Framing the Debate about Sustainable Scales for Water Systems in the UK

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Abstract

There is currently debate around what is the most appropriate scale of water system in the UK context. There has been an increasing level of enthusiasm for decentralised and small scale approaches such as rainwater harvesting to complement the traditional “mains” supply and sewerage systems. However, with additional systems come additional impacts; environmental, social and technical, which are not necessarily negated by the reduced burden on the existing infrastructure. Before entering into an adversarial comparison of the “business as usual” versus “alternative” strategies, there needs to be an improved understanding of the problem situation. This paper seeks to frame the debate by defining the root problem, outlining the characteristics of an ideal solution, and exploring the complex web of issues between the two.

Keywords

Alternative water systems; decision making; rainwater harvesting

INTRODUCTION

Water systems in the UK are currently undergoing a phase of scrutiny not seen since the privatisation of the water industry in 1989. Small or micro-scale water systems are growing in popularity, but there are tensions between these building-level systems and the macro ‘mains’ systems. There are questions being asked about the environmental credentials of, for example, rainwater harvesting (Clarke et al. 2009, Thornton 2008), as additional systems raise the environmental impact of the building, while not necessarily reducing the environmental impact of the mains networks, which typically remain in place.

This paper outlines what is driving change in the building industry and water industry, before considering fundamentally what the problem situation is. There is then discussion of what the characteristics of an ideal solution might be. Akin to a requirement specification, this is not seeking to provide answers, but to visualise what should be aimed for. Finally, the complex landscape to be navigated when moving from the existing situation to an ideal is explored. This highlights some of the key issues and tensions which need to be resolved, accommodated or exploited in order to move forwards.

CURRENT STATE

This section is focused on what the root cause is that is forcing our hand. Why are there moves to change the existing system, which on the whole provides a good service at a price the majority of customers find acceptable (MORI 2002, WaterUK 2010a)?

Drivers for change in the building industry

The UK market for rainwater harvesting systems has grown from around £1M to £10M in the past 7 years (Johnen 2010). This relatively recent enthusiasm has been driven strongly by the support for

such systems in building rating systems such as The Code for Sustainable Homes (CLG 2008) and the Building Research Establishment Environmental Assessment Method (BREEAM 2009). These rating systems require significant water savings from a baseline case, which at higher levels can only reasonably be achieved through use of alternative water sources for lower grade uses such as toilet flushing. Typically rainwater harvesting (RWH) systems are being used to meet this need, although there is also interest in the use of treated greywater and blackwater. This has led to RWH becoming part of the suite of technology indicators of an eco-development. Along with elements such as green roofs, timber construction, and solar-thermal panels, it is becoming intrinsically connected with the idea of a 'green building' (Cutler 2009). However, it is mostly the public sector which is being incentivised to adopt the higher levels of these rating schemes, as there is a cost implication to meeting the Code (Mann 2009), which private homeowners may be reluctant to meet.

Community developments such as the new Ecotowns (CLG 2010) are seeking community scale solutions such as combined heat and power and district heating, and there is pressure to consider the applicability of similar scale water systems.

End users are beginning to look at how to reduce water use, if only, for those on meters, for financial reasons. Those not on meters may be seeking to reduce use as part of a wider environmental consciousness (Stern 2005).

This all indicates a rising consciousness of demand management in the building industry and among end users. Reducing resource consumption at point of use is something largely within their sphere of control. Supply management has not been incentivised in recent history, and if anything has been discouraged through, for example, copious regulatory constraints on private water supplies, and making the 'mains' systems convenient and affordable.

Drivers for change in the water industry

There are four main drivers:

1. Pressure to reduce resource use in the macro system.

The water industry's energy use and greenhouse gas emissions are increasing, largely in response to increased demand and quality requirements (WaterUK 2009). Carbon is becoming a significant factor to be aware of with the introduction of the Climate Change Act (UK Govt 2008), and the carbon impacts of the water industry are coming under scrutiny. There is a tendency for "supply side" schemes to meet rising demand to result in an increase in carbon emissions (EA 2008).

Reducing water wastage through leakage is a perennial problem, and will increasingly need addressing as the asset base ages. Money is another resource, and the industry is under pressure to do more with less (WaterUK 2009). OFWAT (the Water Services Regulation Authority) has a remit to keep prices 'affordable' meaning that financial efficiency is important.

2. Pressure to respond to changing conditions.

The weather is becoming increasingly variable under the effects of climate change. The water industry is at the forefront of dealing with these effects, as they are felt predominantly through impacts on the hydrological cycle (EA2009, Water UK 2008). Extreme weather events such as droughts and floods are becoming increasingly common, along with predictions of sea level rise, and seasonal weather variation. These all change the flows the existing infrastructure was designed for, and there are issues of capacity and resilience. Following on from this, the physical asset base is aging, and much of it is coming to the end of its useful life (EA 2009, WaterUK 2009). This means decisions need to be made whether to regenerate, remove or replace.

3. Pressure to respond to changing demands.

This significant driver relates to water quality. The EU Water Framework Directive (EU 2000) is requiring stringent standards of discharge to the aquatic environment, and meeting these needs changes to the current system. This in turn will mean higher costs, higher energy use, and additional facilities. Water quantity demands are also changing. There is less demand from industry, and more from the domestic sector, and potentially more from agriculture (DEFRA 2008). The population is not only growing, but aging and migrating within the country. There is net counter-urbanisation and the rural population is growing, mostly due to people moving out of cities. Younger age groups (19-35yrs) are moving into urban areas, while older age groups (families with young children and the 44-64yrs group) are moving into rural areas. There is also migration from overseas, which is increasingly into rural areas, and not exclusively into cities (CRC 2008). These changes will all impact on demand profiles, along with the increase of single occupancy households.

4. Requirement for advance planning

Currently water companies have to follow a cyclic five yearly asset management process, which sets up strong, hard-to-change frameworks once they are agreed. Water companies also have to set out statutory 25 year resources management plans (DEFRA 2008) meaning that decisions are being made with long term impacts, so there is pressure to get it right now, and to be seen to be acting with an environmental consciousness.

This all indicates an acute awareness of supply management, unsurprising seeing as it is the core role of the water industry to supply a constant service to its customers. Demand management is arguably not incentivised, other than as a public relations exercise or to reduce pressure on existing infrastructure.

WHAT IS THE PROBLEM?

The building industry is largely focused on demand management, and in trying to reduce use of potable water has started looking at alternative sources of supply, thus becoming involved in supply management. Utility companies are no longer the only legitimate managers of energy, water and waste. Organisations such as housing associations and local authorities are negotiating and delivering new energy water and waste services for their tenants (Van Vliet et al 2005), forcing consideration of supply management approaches. However, there is little evidence that decisions are being made which are informed by the wider environmental impacts of additional systems, or that consider the complexities involved.

Climate change and a prolonged lack of investment in maintenance are forcing the water industry to respond to a change in the historically stable state. It is however making positive moves to address these issues (DEFRA 2008, EA 2009, WaterUK 2010a), which raises the question of whether this undermines the argument for small scale systems being 'better' from an environmental perspective. What role do they play in future resource management?

There is a feel that household and community scale (several hundred homes) systems may have benefits for reducing overall energy usage and lowering carbon emissions (EA 2008) but it is still very much a 'feel'. There needs to be an improved understanding of when different scales make sense from a demand and supply perspective. In order to frame this, the following section considers a 'castle in the sky' situation of what the characteristics of an ideal water system might be. Overlooking the barriers to change this is a kind of requirement specification 'think piece'.

CHARACTERISTICS OF AN IDEAL SOLUTION

These points come in part from reviewing the literature, and in part from interviews with informed experts in the field. These interviews are being done as part of ongoing research into perceptions around sustainable water systems, and a section of them focuses on how experts construe the ‘ideal’ situation.

In order to structure the argument, they have been loosely ordered around key principles, but given the interconnected nature of many of the characteristics, some points may be interpreted as fitting under several headings.

Fairness

Stemming from the infamous Brundtland definition of sustainability (WCED 1987) there should be intergenerational fairness and consideration taken of future users. This is intrinsically related to the ‘polluter pays’ principle (OECD 1996) and means that customers as well as industry will have to pay for their part in water pollution and its subsequent treatment (EA 2009). Responsibility should fall equitably, and with water a critical human need, the poor and vulnerable should be protected. The environment is another key user, and systems should allow for environmental needs as well as human needs. Smaller communities should also not be discriminated against, with systems ‘getting away with’ poorer quality water or discharges (UKWIR 2004). An ideal water system would have minimal carbon emissions associated with it throughout its lifecycle to reduce the future impact on the environment. Similarly, chemical use should be minimised and avoided to prevent long term degradation to the environment.

Integration

Great gains could be made if energy, waste and water sectors could work closely together and have more integrated thinking (UKWIR 2004, EA 2009, WaterUK 2010a). This relates not only in terms of reducing CO₂e emissions, but to exploit efficiencies in the whole resource chain. This cross-boundary cooperation would need multi-skilled staff and regulatory support at a local level to allow flexible, responsive management.

Efficiency

Systems should follow the ethos of source control. Primarily of pollutants; cleaning water after contamination has much greater environmental impacts than preventing contamination in the first place (EA 2009). Also with regard to stormwater management, not letting stormwater get into sewers in the first place significantly mitigates flood risk and reduces the need for pumping and treatment. Systems should retain water on-site as far as possible and then allow controlled use or discharge.

Users should be helped to be water efficient through intrinsic good design. Leak detection measures will prevent unnecessary water loss, in line with the principle of waste minimisation, relative to all resources. Following minimisation, unavoidable waste should be seen as a resource, for example with sewage sludge being used as an energy source.

Systems should be gravity-fed where possible to minimise energy use. Although not all energy use is ‘bad’, it does depend on where the energy is coming from, the demand should be reduced as far as possible in the first instance. Through efficient network design, total infrastructure length could be reduced, with an associated reduction in the embodied energy of the system.

Responsibility

This is a key component. Ownership, responsibility and accountability are not only in line with the ethos of sustainable development, but critical in maintaining ongoing support and performance of systems. Users should be able to know how much they are using, and be in touch with the system, through things like meters or intelligent building management systems.

Effectiveness

Systems should be functional, and work effectively. They should do what they are designed to do, with minimal maintenance requirements. Simplicity is good for maintenance, and good for resilience. Noise and odour are critical factors and should be minimised or eliminated where possible.

Stability

The system should predominantly be low risk, reliable and functional to ensure a consistent protection of public health and the environment. The main asset of the existing system is its stability (WaterUK 2010a)). There needs to be security of supply and long term support of systems, as, for example, communities can't be abandoned a few years after installation, as this would jeopardise the ongoing safety of the users should something go technically wrong.

Flexibility

Flexibility is a fundamental characteristic of a future-proof system (EA 2009). This is not acting at cross-purposes with stability characteristics, but cooperatively to help maintain the stability of the system. Resilience is important and the system needs to flex to adapt to the variability in the weather, demand patterns, regulation and so on.

Different quality characteristics are suited to different functions. For example, soft water prevents limescale build-up and prolongs the life of household appliances, and this should be exploited.

Locality

Systems should be locally adapted (WaterUK 2010b). There are many benefits to a local perspective, such as enabling a tailored approach to managing greenhouse gas emissions and local water quality and quantity requirements, and allowing an effective use of local resources. This ranges from staff managing smaller catchments having less travel associated with their work, to the possibility of utilising previously unused water sources which may be too small to be an economic part of a larger system (EA 2009). It also allows for place specific solutions. This is something which has long been identified in the wastewater sector: 'There is no best method of sewage disposal which can be universally adopted regardless of local conditions' (Kershaw, 1911). There is also scope to improve local biodiversity and the aesthetic environment.

Smaller communities also lend themselves to greater participation in decision making process (UKWIR 2004)

Value

An ideal system would not only enable business value, but also instil in its users a realistic sense of the value of the resource. It should also provide a good, affordable service. There is also an element of trust required – faith that the service will be provided as required.

An ideal system would support people to live lives with low environmental impact, while protecting public health, within a regulatory regime that ensures costs are recovered.

THE COMPLEX WEB

Given the problem of the building industry getting into supply side solutions to demand reduction, and the water industry requiring more flexibility while maintaining service, and the idea of aiming for solutions with the characteristics outlined above, what are the features of the landscape which need to be navigated to achieve this?

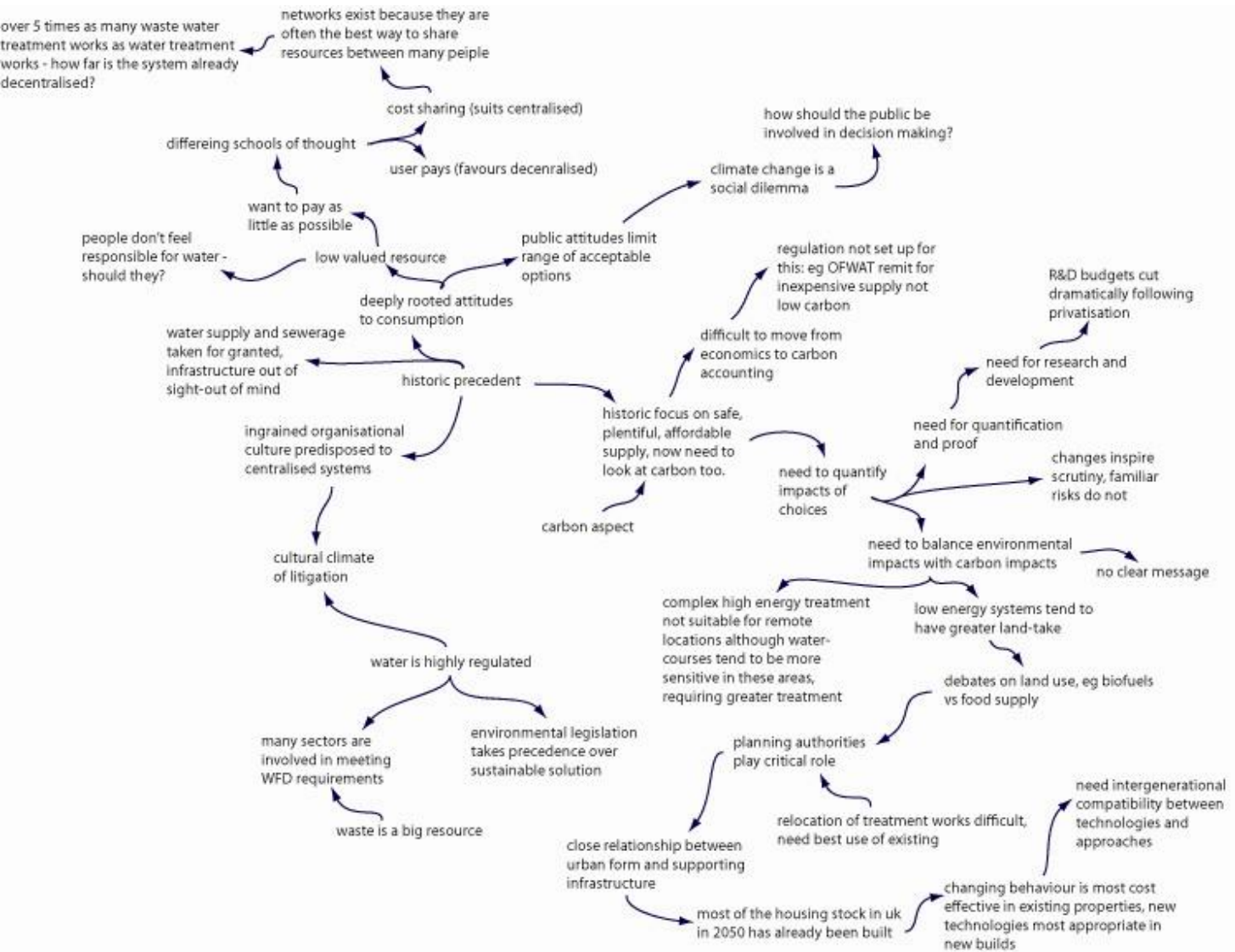


Figure 1. The complex web of issues around water systems

Key Tensions

The historic focus of the water industry has been on providing safe, plentiful, affordable water (EA 2009). There is now ever increasing pressure to additionally consider carbon impacts and stricter discharge qualities. This is tied in with a broader move towards carbon accounting, which regulation is currently not set up to accommodate. The shadow price of carbon is currently too low to incentivise major change, and regulation has traditionally been divided between economics (OFWAT) and quality (Drinking Water Inspectorate, Environment Agency). How the balancing will be done between cost/ quality/ quantity/ carbon without conflict is not clear with existing legislation and funding mechanisms.

The complexities and uncertainties associated with this sort of environmental problem make scientific input and technical knowledge a cornerstone of the decision making process (Larson et al 2009). There is a need to quantify the impacts of various types of water system, and whilst WaterUK provides a balanced framework for the mains supply and sewerage systems through its sustainability indicators (WaterUK 2009) there isn't such a cohesive approach for alternative systems. Work has been done on this (eg Jeffrey 1999, Hellström 2000, Ashley et al 2004, Makropoulos et al 2008) but few studies seem to be comprehensive across all aspects. Several focus on the poor carbon emission performance of (for example) rainwater harvesting in comparison to the mains (Crettaz et al 1999, Hallmann et al 2003, EA 2009b), but carbon related issues are only one part of analysis of water systems, and the broader issues should not be overlooked. It is however the modern predicament to try to measure everything in terms of its carbon footprint.

There is a deeply rooted historic precedent for our current water systems and attitude towards their management and consumption. Centralised water supply systems grew out of a need to provide for increasingly localised and large populations. These became so large that the structures and practices demanded were beyond the capacity of individuals, leading to municipal authorities taking responsibility. This meant public policies developed a paternalistic character, a 'leave it to the experts' approach, and removed the burden of responsibility from the end user.

However, people have become comfortable not being responsible for water, and will tend to distance themselves from water scarcity problems (Askew & McGuirk 2004). This leads to tension when there are attempts to return some of this responsibility. Reports often talk of engaging with the consumer or the public, and assigning greater responsibility to them for the protection of the resource, suggesting co-management between consumers and providers (EU 2000, Van Vliet et al 2005, EA 2009), but do they actually want it? And what if they don't? Putting in additional systems means responsibility for the user. However, while they may not want responsibility, the deferential society of the past has gone, and there is public interrogation of the water industry's motives, approach and actions.

Water is one of the most highly regulated industries in the UK, and this policy structure can be very constrictive and forms significant regulatory resistance. 'It is not a question of technical capability, but rather economic and regulatory incentives and constraints' (EA 2009). UKWIR (2004) considers environmental legislation to be the key driver, even going so far as to say 'it must take precedence in situations where there is a potential conflict between complying with legislation and achieving a sustainable solution'. There is also a call for greater competition in the water industry, but this is almost impossible with it being such a tightly controlled natural monopoly (most consumers do not have a choice of supplier, and it would be unfeasible to duplicate the existing infrastructure).

There is a cultural climate of litigation in tandem with a strategy of failure avoidance. There has been a move from avoiding threats to public health by using historically rooted experience, to 'speculative improvements based in the mathematics of risk assessments' (EA 2009). This often leads to plants being over-designed (UKWIR 2004) and a reluctance to pare things down. We have created tightly coupled systems (Perrow 1984) where a problem in one component rapidly affects others. Loosely coupled systems, with redundancy, have more flexibility of response, but rules and norms must be exercised to create reliability.

The planning authorities also play a critical role (UKWIR 2004). There are ongoing debates on land-use, regarding flooding or bio-fuels versus sustainable food supply for the UK (EA 2009, Wheeler and Evans 2009) and the local planning authority are a crucial determinant of what

happens in a particular area. Relocation of existing water treatment sites is difficult and uneconomic due to planning constraints, and so there is not free reign to re-jig the system. Best use must be made of existing sites and their infrastructure (EA 2009)

The following diagram illustrates the complexity of policy mechanisms relating to smaller scale water systems:

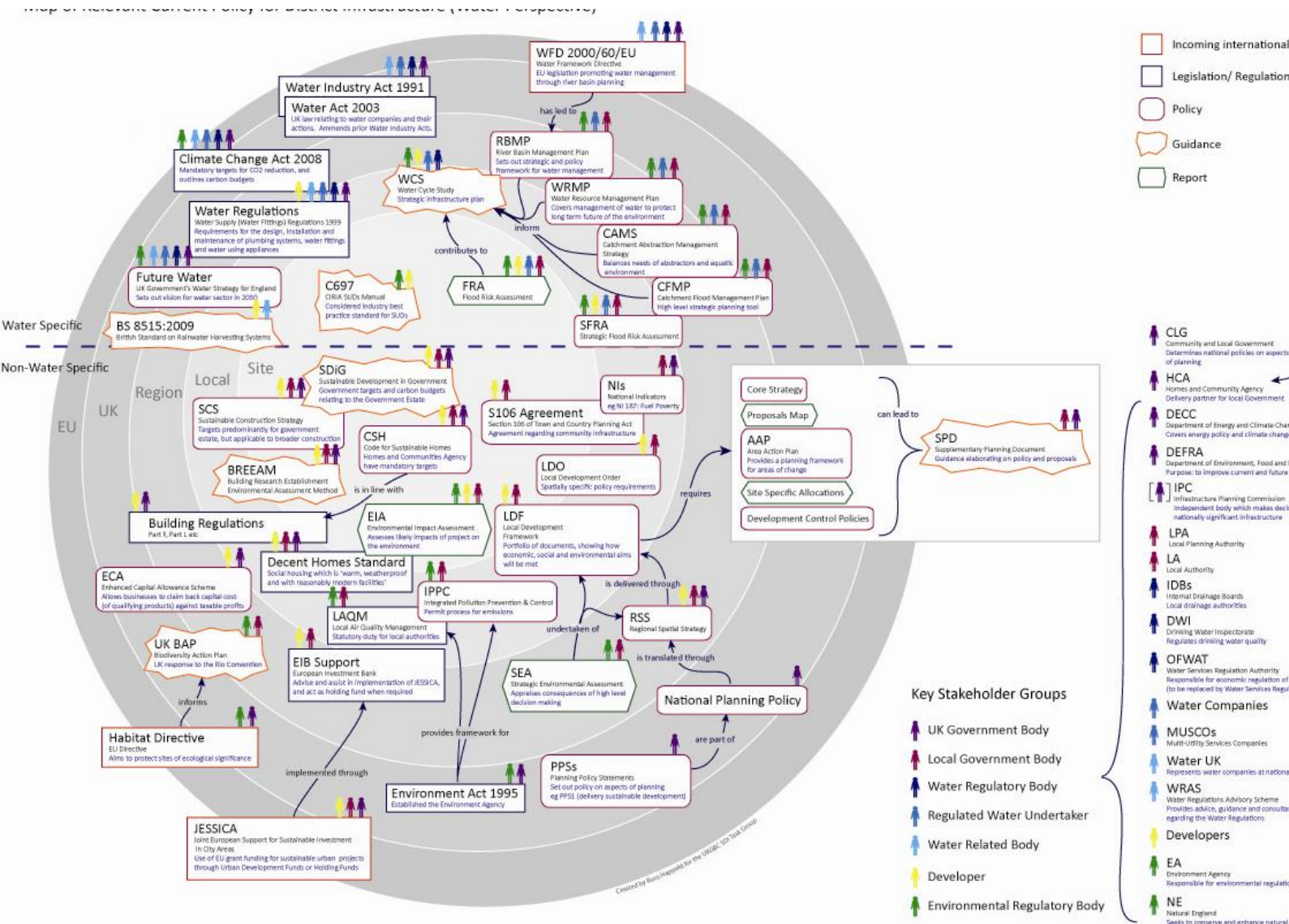


Figure 2. Policies relating to community level water systems

Climate change is a social dilemma (Leff 2005), and if the public perceives little action being taken by others, it acts as a further disincentive to individual action (Whitmarsh 2009). This not only puts added pressure on the water industry to be seen to be doing something, but calls to question how much alternative water systems should be hidden away to look as ‘normal’ as possible. To what extent should they be a visible ‘statement’ reassuring others that it is something-that-is-being-done?

There is tension in how far the public should be involved in decision making. The general public is known to have a relatively low awareness and concern for their water and sewerage services (MORI 2002) and public attitudes can limit the range of possible management choices. People rarely make rational decisions (Reed 2009, Sutherland 2008, Routhe et al 2005), so at what point do experts need to dictate what is best for the greater good? This is a sensitive area, as people become fiercely

protective over things that may affect their homes (As typified by the well-worn saying “An Englishman’s home is his castle”).

There is a social reluctance to change habits and routines, which combined with the physical inertia of systems, means that change happens slowly and incrementally, and can be understood as a process of reconfiguration as old and new interact (Van Vliet et al 2005). This ties in to the idea of progressive retro-fitting; systems need intergenerational compatibility. However, there is pressure to change quickly, stressing the various social and physical systems.

Research and development (R&D) is required for technical solutions, but R&D has been the big casualty of privatisation as companies focus more on short term returns (EA 2009). Regulators need this technical information about alternatives such as softer engineering solutions and sustainable approaches in order to make informed decisions and overcome the tendency to prefer traditional hard engineering solutions. (UKWIR 2004)

Things are changing. WaterUK is calling for a new business model based around enabling water companies to work more closely with other infrastructure and service sectors, and reforming regulation to create more responsive business (WaterUK 2010a). It recognises that ‘water companies cannot deliver long-term sustainable water services along...they need support from and partnerships with, regulators, policy makers, customers and communities’ (WaterUK 2009). The Environment Agency recognises the need to deliver flexible solutions that adapt to climate change as it happens. This will mostly be through changing abstraction licenses to time-limited status (WaterUK 2010c), but they are also looking for increased efficiencies and are considering moving towards a system of self monitoring, with relevant parties monitoring their discharges, and with the EA just doing audit monitoring (UKWIR 2004). The UKWIR will publish its carbon accounting methodology in 2010 which will be used for scheme appraisal once endorsed by OFWAT. OFWAT has itself developed its own Sustainability Principles stemming from the Government’s five principles (OFWAT 2009). However there are some moves in a direction which may forestall attempts at decentralisation of parts of the mains system. The imminent Flood and Water Management Bill (DEFRA 2009) currently going through Parliament contains legislation regarding transferring drains and sewers currently under private ownership, to the water companies, doubling some companies’ sewer networks (Hopkinson 2009).

CONCLUSIONS

This is clearly a complex field, but there is potential for radical change in the way the UK water systems operate and are managed. Existing systems can be organised and managed in different ways, and be complemented and enhanced by newer smaller scale additions. The water industry of 2050 could be enormously different from the industry of today.

There needs to be clarity in what needs to be achieved, and informed consensus in how to approach it. It is not obvious that the interface between the building side demand management, and supply (and removal) biased water industry is being addressed. The two industries are tackling different aspects of water stress, and seeing the problem from different viewpoints. The debate around the application of small scale systems has brought this to light as they are located in this gap. The roles and responsibilities of each side are not always clear, and this disconnect needs to be resolved.

Traditionally, the building industry has dealt with buildings, the energy industry with energy provision, the water industry with supply and disposal of water and so on. Moving from this clearly delineated approach to an integrated resource network will inevitably be a wicked, messy problem

(Jackson 1993).

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