
The Human in the Water-cycle

L'intervention de l'homme dans le cycle de l'eau

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RÉSUMÉ

La compréhension détaillée des relations entre la société, les technologies et la nature est une étape nécessaire vers la re-configuration des infrastructures actuelles en vue d'élaborer des systèmes durables de gestion de l'eau. Le schéma acteur-réseau est un cadre qui permet d'explorer ces phénomènes naturels et culturels sur les mêmes bases. Grâce à cette théorie, il est possible d'appréhender un cycle de l'eau créé collectivement par des facteurs humains et non-humains qui interagissent et qui évoluent de façon constante et simultanée. Le cas étudié ici se situe sur le bassin versant inférieur de la rivière Lea à Londres. Les personnes qui vivent et travaillent dans ce bassin versant ont été interrogées sur le rôle qu'elles jouent dans le cycle de l'eau et leurs interactions avec les facteurs non-humains ont été enregistrées par le biais d'un journal photographique de l'eau. Cette étude confirme que les changements apportés pour préserver l'utilisation de l'eau potable dépendent à la fois de la détermination à changer les habitudes et de l'évolution-même de l'infrastructure qui doit rappeler à la population la nécessité d'économiser ou de recycler l'eau et leur permettre de le faire.

MOTS CLÉS

Théorie acteur-réseau, adaptation, stratégie intégrée, participation publique, rivière Lea, Londres, utilisation durable de l'eau

ABSTRACT

Developing detailed understandings of the relationships between society, technologies and nature is a necessary step towards reconfiguring current water infrastructures to form sustainable systems. Actor-network-theory is a framework that allows these natural and cultural phenomena to be explored on equal terms. This theory makes it possible to situate and understand a water-cycle that is collectively created by both human and nonhuman actants affecting one another and always co-evolving. The case study for this analysis is situated in the lower Lea watershed in London. People who live and work in the watershed were interviewed about the role that they played in the water-cycle and recorded their interactions with nonhuman actants through an photographic water diary. This study confirms that changes made in order to conserve drinking-water use are dependent on both a determination to change habits and a co-evolved infrastructure that continues to enable and remind people to save or recycle water.

KEYWORDS

Actor-network-theory, adaptation, integrated strategy, public participation, Lea river, London, sustainable, water use

1 INTRODUCTION

Access to a continuous supply of clean water is a feature of modern urban life that is taken for granted by most citizens in well developed cities such as London. The connections between everyday water habits, water infrastructure and the natural environment are usually invisible to people living and working in modern cities.

Popular understandings of the water-cycle usually centre on a natural hydrological system of precipitation, runoff and evaporation, with no acknowledgement of the role of humans in the water-cycle. Engineering models of the water-cycle conventionally focus on managing infrastructure and resources to meet demand, with little understanding of the details of everyday water use. This 'predict and provide' model of water provision is reaching its limits in London and other cities because the scope for expanding water resources to meet demand from a growing population is constrained by local hydrology and climate change. More sustainable models of water provision and consumption are required in order to maintain public health and urban lifestyles, while protecting and restoring aquatic and terrestrial ecosystems.

A clearer understanding of the role of humans in the water-cycle is essential for designing sustainable urban water systems. This is made difficult by the conventional division between the knowledge of social, technological and natural systems. This paper shows how actor-network-theory can be used to explore the relationships between technological, social and natural elements of the water-cycle. Actor-network-theory is used to tract the effects of humans and technologies to describe four different personal water-cycles in London. The study shows that these water-cycles are held in place by infrastructures and technology, as well as individual and group values.

The paper first defines the concepts of a water-cycle and the key ideas of actor-network-theory. It then gives a brief description of the methodology of the research process, before describing the results of the study, which show how four different people create alternative water-cycles in an urban area. These results are then compared in relation to other studies that have been done about human water use and infrastructures. The paper then concludes with further questions that arise from this study.

2 DEFINITIONS

2.1 Water-cycle

The water-cycle is also known as the hydrologic cycle. These two terms are used to describe a commonly accepted concept about the changing state, location and quality of water as it flows around the globe, in the atmosphere, on and under the ground. The water-cycle is mostly driven by direct energy from the sun, which causes the water to change state and thus move. The circulation of the water-cycle is also influenced by variations in the landform and the metabolism and actions of biota. The idea of the water-cycle is that despite the changing state and chemical content of water, there is no net loss of water from the system. The water circulates in a closed loop.

This generalised scheme is made up of local water-cycles, which the focus of this paper. Local water-cycles are formed by water transfers that occur in the interactions between, precipitation, soil, ground-water, surface-water, plants, animals, technologies and so on and so forth. These interactions make a multitude of complicated cycles in which water takes multiple paths and supports many life forms. People are essential actants in these local water-cycles. Individuals consume water to meet their basic biological and cultural needs. Collectively, humans are responsible for infrastructure systems that abstract, store, move and treat water, altering its flow and quality. These water-cycles depend on individual and collective values, social networks, physical settings, and infrastructure options.

2.2 Actor-network-theory

The full complexity of the range of actants and relationships that comprise local water-cycles is rarely understood. This is partly due to the conventional divisions between academic and professional disciplines, which separate knowledge of social, technical and natural systems. Actor-network-theory (a-n-t) provides a useful conceptual framework to place humans and their individual and collective values, social networks, physical settings, and infrastructure in the water-cycle. This is an approach that has been developed in science and technology studies since the late 1970s and considers humans,

technology, and nature on equal terms, rather than maintaining divisions between science and society (Latour 2005).

A-n-t concentrates on tracing the relationships between human and nonhuman actants, rather than understanding the world according to disciplinary divisions between the natural, technical and social sciences. The a-n-t approach has been applied in empirical studies to clearly show that scientific facts, medical diagnoses and commonly used technologies can be understood as assemblages of interactions within networks of human and nonhuman actants (Callon 1986; Law 2004; Latour 2000). The significance of the a-n-t approach is that it makes clear the contingencies of effects that support our knowledge and behaviour. By using a-n-t to trace the effects between humans and nonhumans in creating water-cycles instigated by individuals living in London, it is possible to reveal the tension, stabilisation and co-evolution effects between individual and collective values, social networks, physical settings, and infrastructure.

3 METHODS

To formulate the water-cycle using a-n-t the relationships between water, humans and nonhumans are traced by following the flow of the water through the everyday lives of people who live and work in the lower Lea watershed. Seven self identified environmentally aware citizens and sixteen water professionals were individually interviewed about their current water practices. They were then asked to complete a photographic water diary to document how they use water over the course of a day thus recording the objects that facilitate their water use. The participants were chosen for their particular knowledge of water and environmental issues, and are not intended to be representative of the population of the study area. For the purposes of this paper, the water-cycles of four participants are analysed for comparison between actions, infrastructures, water knowledge, and social support.

Environmentally aware citizens were identified as an appropriate group of people to target for this research because they have a moral position about the state of the natural environment and are presumably aware of the impacts their individual behaviour have on the world around them. They were also selected as a relevant group because these people are most likely to have knowledge about issues surrounding water and techniques for its conservation and reuse. It was also assumed that this group of people had probably modified their behaviour and their physical environment to mitigate their perceived negative outcomes, and improve their perceived positive outcomes on the environment.

Water professionals were also deemed a significant group to interview as their decisions and actions are focused on affecting larger volumes of water than the domestic consumer. They also have greater access to specialist water knowledge ranging from environmental effects, planning, and technologies that may change their personal concepts of water.

The participants in this study were recruited through environmental and professional networks. The four participants in this analysis were motivated to make changes to water use habits either professionally or personally. Three participants affect water professionally and one had no professional impact on water. These four people were chosen because they illustrate the contrasting effects of networks of nonhumans and humans have on personal water-cycles in either aiding or constraining the enactment of their stated goals of being environmentally responsible about their water use.

The interview was semi-structured and the participants were asked to list how they used or interacted with water on an average day, on a weekly, monthly or annual basis, and then on holiday. They were also then asked to describe any aspects of their daily professional life that had any impact on water. All four people could easily list how they used water, its value to them personally and how they felt their values were reflected in other people.

The water diary was completed with a disposable camera with twenty-seven exposures and a flash over the course of twenty-four hours. The diary also required people to fill out a small booklet with a description of what they had photographed and to categorise it as a typical (daily use), unusual (weekly, monthly or annual use), or meaningful (benefits other than utility). Meaningful photographs could be unique or incorporated within items that were typical or unusual water uses. Some participants found that twenty-seven exposures captured all their water use over the course of a day, others found that less than twenty exposures were needed. Many people felt that their water uses were entirely typical and repetitive and thus stopped taking photos before the end of the twenty-four hour period.

Both the interview and water diary can only be considered a semi-reliable record of how people use water because it depends on people faithfully recalling and recording their water use, both of which could be partial or misleading. However by combining both elements together a fuller water-cycle understanding can be achieved. In particular, the photographic water diary captured both the physical implements and environment of water use and allowed participants to provide additional water uses they may have forgotten or felt uncomfortable to mention verbally.

4 RESULTS

The research shows that water-cycles are cemented in the particular worlds of four people by the types of infrastructures that are already in place or those that they choose to modify. All four people are served by the same drinking and waste-water provider, which provides household connections to a pressurized piped drinking-water supply from several reservoirs to the west and north of London and gravity sewer connections that collect both surface-water and foul-water for treatment except in heavy rain. The source of their drinking-water is from the upstream areas of the catchment they reside in. All three people also have access to a garden area; live in an urban area in the same watershed; and are home owners.

The water-cycles that are described reflect both the interview and the water diary that these participants completed about their daily lives and reflects what they remember and see as their most important, but not necessarily total, interactions with water.

4.1 Rose's water-cycle

Rose is a ground floor owner of a semi detached house converted into a flat located in London. She lives on her own. Rose is an environmentally aware citizen who has modified her behaviour to conserve her use of drinking-water. Rose has attempted to make two changes to her infrastructure in order to improve her water conservation efforts, but neither of these have been successful.

Rose's first water interaction of the day is to go to the toilet, which she may or may not flush, depending on how she feels. The most unique aspect to Rose's water-cycle is the amount of effort she goes through to reuse water from bathing. She bathes (either a shower or bath) every other day with a strip wash between. This water is collected in her bath, which she reuses with a bucket to flush the toilet, hand wash clothes, wash the floor, general cleaning and watering the garden. The collection of water in the bath tub gives her direct feedback as to how much water she has used and how much she has recycled.

Rose attempted to improve the system of bath water reuse for her garden with a siphon purchased from a catalogue, but the water pressure from the gravity feed was insufficient to be effective as there was not enough difference in level between her bathroom and the garden. She was motivated to try the siphon because of the heavy work required to carry buckets of water from her bath to her garden. If she is feeling particularly tired, she is unable to do this labour and her grey-water goes to waste.

Rose also tried to receive additional feedback about her water use and make a saving on her water bill by requesting a water meter for her flat from the water service provider. Nevertheless, this was not possible due to the configuration of water distribution in her building. Thus she does not have a measured volume for her water use. This has led her to be as frugal as possible in her habits using the existing technologies available to her.

Rose also noted that using the water diary made her even more conscious of her use of drinking-water. *"I noticed that when I had to photograph each time I used water, I would try and avoid it by reusing bath water and not having to use new water."*

4.2 Tom's water-cycle

Tom is an owner of a semi detached house located in a flood prone area of London where he lives with his wife. Tom is an environmentally aware citizen and professional who has refurbished his house to be an eco-house. This involved modifications to the water systems as well as building a full height basement into the water table. Tom is not yet satisfied with the water system he has put in place as he feels there is scope for additional water reuse to improve biodiversity.

Tom's first water interaction of the day is to drink the glass of water he keeps standing by his bed. The biggest change to Tom's personal water-cycle with the house renovation is the addition of a grey-water recycling system that collects water from all wash basins and showers for reuse to flush the toilets, cleaning and gardening. The grey-water recycling system was included in his refurbishment because it was a very easy piece of technology to use, source and purchase from Germany. It was not as easy to install as he had hoped because the piped connections assumed that it would be installed in a standard German home, which varied greatly from those in his house. This has meant that an additional pump is required to drain excess water into the general waste-water infrastructure. After its successful installation the tank has not needed any additional modifications and the only maintenance required is the need to be cleaned every few years. There is no feedback on the system to let users know how much water contained in the tank is used. Tom therefore has no idea if there is a balance between the volume grey-water collected and that which is used. There is just a small screen at the front of the system that constantly reads 'OK', which is both reassuring and uninformative. This lack of feedback is not helped by the fact that the water meter was installed incorrectly by the drinking-water service provider and constantly reads zero.

Tom also decided that it was worthwhile to spend money on the grey-water recycler because it was cheaper to install in the basement during the refurbishment work in comparison to photovoltaic cells which do not cost significantly more to add at a later date. Tom was also aware that the supply of water is likely to become scarce in the future. By using grey-water he would help mitigate this and also ensure that he is buffered against any rise in the cost of drinking-water in the future.

The quality of the grey-water from this system is very high. The kitchen installers made a misconnection to the grey-water pipe to the kitchen tap, so for the first three months of living in his newly renovated home Tom and his wife were using the grey-water for cooking with no ill effects. It was Tom's wife who relies on her sense of smell to cook, who identified that the water from the kitchen tap smelt slightly different from other taps in the house and thus the misconnection was discovered and rectified. This unintended mistake has changed Tom's perception of the quality of the recycled grey-water *"...colourwise it was totally transparent. There were no solids in there or anything. But basically they say it isn't legally potable...but yeah, we drank it for three months and we were completely fine."* This has meant that if there was an extreme water shortage, Tom would feel confident of taking the risk of using his recycled grey-water for drinking.

4.3 Frank's water-cycle

Frank is an owner of a semi detached house located in an area just beyond the borders of London. He lives with his wife and two children. Frank's work directly involves the improvement of the natural environment and thus he is an environmentally educated citizen, but this knowledge has not transferred to changes in his home life.

Frank's first water interaction of the day is to clean his teeth. Frank uses a power shower (a shower with an additional pump to produce greater water pressure and therefore uses more water than an ordinary shower at any time) and has not made any water conservation modifications to his water technologies. However, he does have a water butt to collect rain water for his garden and like all the participants in my interviews, he notes that he rarely washes his car, which somewhat mitigates this water use.

Living with an active family doing lots of sporting activities means that the washing machine is in constant use, with two to three loads being done a day. Frank's wife does the majority of the laundry and therefore there are no details as to whether these were on a water economy cycle, however Frank thought that it was most likely the standard cycle.

Sometimes Frank makes presentations about the necessity of conserving water to school children, this will result in a short lived burst of water conservation and consciousness to his own water use habits.

Frank's actions are influenced by the values of water use by his wife, children and his own perception of the acceptability of his own water use patterns as being normal. *"Being absolutely honest, we like our power shower, we like using, I don't want a dribble coming out of the tap, I want a lot of water coming out of the tap. I think a lot of people are the same actually, if they're honest. You know, that's just how it is."*

4.4 Samuel's water-cycle

Samuel is an owner of a semi detached house located in London where he lives in a four person household with his partner, child and friend. He is an environmentally aware citizen whose job also entails improving the quality and quantity of water in the natural environment. Samuel is extremely knowledgeable about the effects of his water use and existing technologies to enable him to reduce his water use and thus his water abstraction. He was one of the few interviewees that knew and monitored the water consumption of his household and actively intervened to promote a change in behaviour as well as modifying the fittings in his home.

Samuel's first water interaction of the day is to boil the kettle for a cup of coffee. His shower is an ecosaver model which means that it uses less water per minute than a typical shower. His taps are also fitted with aerators and his toilets are dual flush. However his household does not flush the toilet unless they defecate. This measure of water restriction was contentious within his household and was debated before it was implemented.

Samuel has a water meter that he had fitted by the water service provider which has meant that *"we discuss our water consumption as a household"* because there is a yardstick to compare against. For example, given that his daughter and friend are not always in residence, they are able to determine with the water meter that his daughter is not a big water consumer while his friend is. Furthermore he was able to identify the habits that consumed more water *"She takes baths and very long showers and has long hair. So you know, if it's 3mins for that product, and it's 3mins for that product, and 3mins for the next product, you're already in there for 9mins and actually she has about 20mins showers, which we have discussed. But, there's no movement on that. And she also works in the water industry...she's an environmental consultant specialising in water."*

Samuel has tried to implement a grey-water recycling system for his garden, but his partner is not supportive of this action. However, he is going to persist *"We did it at our last place and my partner wasn't too happy with it. We were using shower water. Well, she felt that it was not very nice to use on the garden, but we're going to get around that because what I think I need to do is just to fit a filter on the system, so then she'll see it's not a problem."*

This suite of water conservation efforts has resulted in a water consumption of 70L/person/day, which is less than half the average domestic water consumer (150L/person/day) reported by this water service provider. This is one of the few instances where the water meter readings were used to argue for behaviour modification to reduce the water consumption of his friend. Despite the volumetric evidence and his friend's environmental knowledge, his arguments were unsuccessful. Due to the knowledge from the water meter that the household consumption is already very low makes it more difficult for Samuel to implement further water-cycle changes.

4.5 Actor-network-theory water-cycle

Each of these water-cycles reveal that there are many subtle mediations between infrastructures and people's water use resulting in the enactment of varied water-cycles in this urban area. It also shows that the water-cycles are dependent on how people interpret the feedback or lack of feedback from the infrastructure, the values they would like to achieve, and the social support to behave as their values would dictate.

Rose, Tom and Samuel all lived in socially supportive environments that permitted them to explore the use of grey-water recycling. Rose and Tom were the only two households to achieve this, but in very different ways. Rose uses a simple system of storage and distribution (bath and bucket), which maximised the visual feedback of whether or not her grey-water use was equal to her bath water use. Moreover on days when she is too tired to physically transfer water, she has an idea of how much drinking-water she consumed for uses that would otherwise use grey-water. Tom uses a high-tech system that is completely opaque and may just be an expensive treatment of the grey-water before it is pumped to the general waste-water infrastructure, but there is no sure way he could know this. All three people had ideas about how their grey-water systems could be improved to either allow for more convenient use of the water, greater use of the water, or to convince other people that grey-water recycling was worthwhile.

Samuel was the only participant to have knowledge of his volume of household water consumption from a working water meter. The feedback from the meter was positive in informing him that his water saving strategies are effective, but negative in persuading the people around him to innovate further.

Roses' lack of a quantitative volume of water consumed and a visual understanding of bath water consumption led her to continue to conceive of new grey-water uses. Tom's lack of a water meter on either his drinking or grey-water has led to a slow paced development as there is no material sense of the water flowing through his life and thus no urgency to innovate more alternative water-cycles.

Water clarity, smell, and illness were the ways these people determined water quality. In the case of Tom's misconnection, it was the sensitive nose of his wife that persistently informed her that this was not drinking-water from the mains, despite no ill health and good water clarity. This has led to greater trust in the quality of the water from the recycler. On the other hand, Samuel's partner felt that the grey-water at their previous house could not be good for the plants because there were too many suspended solids in it. This has led to Samuel to formulate new ways the grey-water can be made clearer to convince his partner of its integrity for use on the garden.

Frank used off-the-shelf fittings for water use in his house because these fittings were easy to obtain and install, his feedback from his infrastructure was that this is the typical and desired way to use water, thus he was not overly concerned about his consumption habits and did not see a need to persuade his household to change their patterns of water use. Tom's research to source a grey-water system and his initial difficulty installing it in his property was a clear signal that his system was not usual in England.

Frank and Samuel's friend are examples where knowledge about the environmental impacts of water use made no difference to daily behaviour. In Frank's case, he saw that his water use fitted within the norms of society and hence was not convinced he needed to change the level of consumption of his family. Instead he chose to concentrate his efforts on making a change to the broader public value of water. Samuel's friend could see that the household water consumption was low and therefore did not feel any additional conservation measures were necessary, especially as these measures would impact on her sense of cleanliness and health.

All four people had the access and responsibility for looking after their own private garden. Without the garden and its water retaining soils and transpiring vegetation grey-water recycling habits are more difficult to form. This is particularly complicated if the household only has a shower cubicle where there is nowhere to easily store a volume of grey-water; or if it has a separate toilet and bathroom where the simple use of a bucket to flush the toilet is obstructed.

These four people have shown that there are numerous water-cycles that they enact with an interplay between their values, available infrastructures, the infrastructure feedback, their translation of this feedback, their further actions, and the interactions from other people living in their households. They also reveal that there are many local water-cycle possibilities being co-evolved in the changing habits and technologies of water reuse by these environmentally aware citizens.

5 DISCUSSION

Environmentally aware citizens are at the forefront of changing interactions between humans and their water because they value water for its environmental use as well as for personal use. This has driven action to alter their water-cycles to fit with these values given the material situation they currently live in, their scope to alter it and their interpretation of what this means. This results in a tension between their desired water-cycle and their habitual water-cycle that has been stabilised materially in the form of taps, machines, toilets and other fittings. These four people show a co-evolution in their infrastructure and behaviour as they move towards stabilising their desired water-cycle of greater water conservation and reuse, aligned with their environmental values.

This research of contemporary water-cycles of environmentally aware citizens in the Lea watershed in London, exhibits the same co-evolution qualities as those revealed by sociologists studying the long-term historical changes in water use and water technologies around the world. Geels (Geels 2005) documents how the piped infrastructure of the Netherlands from the 1850s–1930s co-evolved with new social norms of cleanliness and technologies to achieve these new values. Shove (2004) looks specifically at how a sense of comfort, cleanliness and convenience co-evolves what are considered 'normal' bathroom and laundry technology and behaviour in the UK today. In Australia, Allon and Sofoulis (2006) found that contemporary water practices and technologies are deeply intertwined, and that assumptions about the endless supply of water was 'baked in' to existing water systems and infrastructures, providing material constraints on efforts to reduce demand and improve efficiency. Individuals found themselves fighting their technologies to achieve the water conservation demands of

the water company and themselves.

These studies give a clear indication of how practices and material configurations (humans and nonhumans) have co-evolved in the past. Nonetheless their conclusions reflect the same phenomena of tension and stabilisation that eventually results in a co-evolution that are exhibited in the four individual water-cycles analysed in this study. These four water-cycles of environmentally aware citizens give some indication towards how sustainable water-cycles maybe assembled in the future. Nevertheless their efforts are hindered by a lack of information about what water qualities are needed for what uses, how to measure this quality, and what quantity of water is an appropriate use for each person.

Historical co-evolution shows that the answers to these questions of acceptability can only be agreed in dialogue with other people: scientists, environmentalists, ordinary citizens, economists, etc; and the material environment: pipes, siphons, pumps, gardens, rivers and so on. At present, these four water-cycles are formed by people expressing their values individually, within their own properties, with support from their families. It shows that there are no mid-scale collectives that respond beyond the property boundary to the local conditions where these people live. Their actions are materially and socially limited to the networks of large scale water transfers and individual use.

This potential mid-scale of local community action is not addressed within the paradigms of integrated water resource management (IWRM) (Calder 1999) that has been developed and adopted by UK land and water managers (Department for Environment, Food and Rural Affairs 2008) to achieve a balance between environmental quality and human needs within surface-water catchments. IWRM looks at the broader scale of land use: rural, urban, forest, pasture, etc, and thus misses the potential for local watersheds and water cycles within urban communities. This is in part due to the co-evolved urban form of impermeable surfaces for vehicular and pedestrian movement that is typical where urban runoff is centrally collected and managed. This urban form obscures sub-watersheds. However, the individual co-evolution of water reuse shows that there are possibilities for new water-cycles to develop within urban areas whose potential should not be ignored.

These individual water-cycles also show that public participation for IWRM could develop new forms based on the emerging practices of values by the public. Existing forums of public participation in the lower Lea watershed include public consultations about large developments that have been prepared by experts and professionals that presume that individuals in these developments will behave in a historically average way. These assumptions result in infrastructure provision that encourages the continuation of unsustainable patterns of water use. However, changes towards sustainable water use could be developed in collaboration with people who are trying to alter their water-cycles for these values. Through these collaborations, individuals, governments, and professionals would co-evolve more sophisticated and socially accepted forms of water sustainability.

6 CONCLUSION

Humans are a part of the water-cycle. Actor-network-theory is a framework that allows this analysis by looking at the effects of individual humans and nonhumans within networks of relationships between actants. People create their own water-cycles depending on their values towards water. Situating humans in the water-cycle allows us to conceptualise more nuanced ways of making sustainable water use a reality.

This research offers hope towards this eventuality because it reveals that people are constantly trying to reconfigure their practices and material relations to suit their values. We do not just co-evolve to greater comfort, cleanliness, convenience, and consumption, people will go to extra lengths to co-evolve with other desired values for the future.

The research also explores the role that technologies, knowledge, values, conventions and social support play in creating water-cycles. It shows that technologies enable different types of water reuse, and the importance of feedback within the system. The feedback both ensures that water conservation behaviour is stabilised and can also help the development of new behaviours to make water use sustainable.

It is also important to note that these sustainable water behaviours are very much at a nascent stage within the wider community. It requires collective action to aggregate effects to develop more sophisticated, diversified and sustainable water-cycles.

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