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Public Affairs Centre (PAC) is a not-for-profit organization, established in 1994 that is dedicated to improving the quality of governance in India. The focus of PAC is primarily in areas where citizens and civil society organizations can play a proactive role in improving governance. In this regard, PAC undertakes and supports research, disseminates research findings, facilitates collective citizen action through awareness raising and capacity building activities, and provides advisory services to state and non-state agencies.

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Thinking about Urban Resilience: The Case of Water Scarcity and Wastewater Reuse in Bengaluru*

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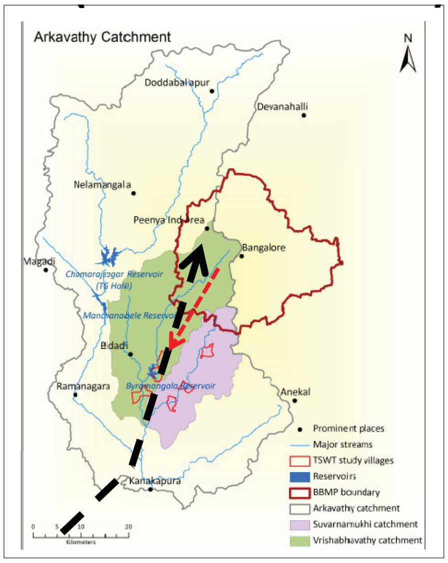
WITH ORIGINS in the ecological sciences, the concept of resilience gained currency in the context of climate change. The 'classical' ecological notions of resilience emphasize recovery to a prior state in the aftermath of stress or shock. The broader social-ecological notion of resilience focuses on learning, innovation, adaptive capacity and transformation (Folke, 2006: 259). The literature on urban resilience (Leichenko, 2011; Romero Lankao and Qin, 2011: 145-6) discusses systems bouncing back to 'equilibrium' in the aftermath of shocks, such as natural disasters (drawing from the classical literature), as well as the adaptive capacities of systems to long-term stressors or shifts such as climate change. The argument that, the classical, equilibrium centric thinking about resilience may be inappropriate in the case of cities of the developing country, which face multiple stressors, including climate induced ones, which are not separable or independent of each other (Srinivasan et al, 2013). On the other hand, the long-term view confuses resilience with ideas of sustainability and adaptation. He suggests that one must not lose sight of the broader normative concerns, while discussing resilience to climate change. It can be illustrated this taking the case of water stress in Bengaluru city and the feasibility of waste water reuse (WWRU) as an option to make the city resilient to climate change.

The context

Much of Arkavathy basin (Figure 1) which used to supply water for Bengaluru earlier is currently dry, with upper parts of the basin experiencing rapid decline in groundwater levels (Lele et al, 2013). Bengaluru meets its current water requirement by importing water from Cauvery river and relying on groundwater. One of the areas in the Arkavathy basin which is still water abundant is the Vrishabhavathy catchment, which is primarily fed by return flows from Bengaluru. Vrishabhavathy river carries the city's domestic and industrial waste, and the water is stored in a reservoir at Byramangala, which is used by farmers downstream for irrigation through a canal system. It is against this backdrop that WWRU as an option is explored to reduce Bengaluru's water stress.

Figure 1: Arkavathy Basin



Source: Ecoinformatics lab, ATREE

Challenges in Waste Water Reuse

Waste Water Reuse (WWRU), both recycling upstream in cities and use downstream in peri-urban agriculture, has been promoted as a climate change adaptation strategy. In fact, WWRU is a stated objective of Bengaluru Water Supply and Sewerage Board (BWSSB),

*The research reported here draws substantially from Jamwal et al (2014) and forms part of ongoing projects supported by International Development Research Centre (IDRC), Canada, and Sir Dorabji Tata Trust and the Allied Trusts.

the city's water management agency, which could buffer Bengaluru against over-dependence on imports from Cauvery river and groundwater.

However, it is easier said than done particularly in developing country cities, where many challenges exist with managing and reusing wastewater. This becomes even more complex when one takes a basin-level perspective. Based on ATREE's ongoing research in the Arkavathy basin, three major challenges are identified for WWRU in Bengaluru - technical, institutional and political (Jamwal et al, 2014).

Technical challenge: There are serious inadequacies in the physical infrastructure and the technical operation of this infrastructure impacting on the efficiency of wastewater treatment. Bengaluru's wastewater treatment systems have not kept pace with the city's growth in water use. The city generates about 1100 MLD of wastewater. There are 14 centralized sewage treatment plants (STPs) with treatment capacity of about 720 MLD, but only about 300 MLD gets treated. Lack of an underground drainage system (UGD) has led to underutilization of treatment capacity. Of the treated wastewater, only a small portion (about 4 MLD) is reused. One of the largest wastewater treatment plants in Bengaluru, the Vrishabhavathy valley treatment plant (VVTP), was studied in detail. It was found that the plant operates far below capacity because of inadequate UGD, clogged drains and power shortages, and that the percentage reduction in biological oxygen demand is low indicating lower efficiency at which VVTP operates.

Political challenge: It was observed that, there are multiple actors and competing interests around WWRU. As noted above, farmers downstream of Byramangala reservoir depend on Bengaluru's wastewater for irrigation. During the last 10-15 years, many of them have switched from rice and millets to high value crops like baby corn and mulberry, on account of water quality changes and availability of wastewater for agriculture. Massive recycling upstream in the city would substantially reduce water available for agriculture. Farmers could argue that they have customary rights over Bengaluru's wastewater. This also raises normative questions on what to privilege - urban consumption or agrarian livelihoods. Further, since the Vrishabhavathy is fed mostly by return flows of Cauvery supply, in the event of reuse upstream and reduced flows, Bengaluru/Karnataka may not be able to meet the obligations under the inter-state Cauvery Water Disputes Tribunal (CWDT).

Institutional challenge: The scale of WWRU, infrastructure and the social organization of WWRU poses additional challenges in Bengaluru. We could think of three scales of WWRU (Table I) - large scale, involving large volumes between20-100 MLD or more, neighborhood scale, involving 1-5 MLD, and apartment complex scale, involving <1MLD. BWSSB has invested heavily in building more STPs. However, the costs involved in transporting and delivering treated water may be huge. Even if there is substantial recycling and cost reduction, there exist no incentives for users, especially industries, to switch from groundwater or supplement this with treated water. The neighborhood-level STPs will result in cost reduction, but there is no proper UGD, nor clarity on who will use the water. The decentralized option, viz., the apartment-level reuse, has met with non-compliance. The few compliant ones might find that they cannot use all of the treated water. Thus, for WWRU to succeed, it requires a combination of sound infrastructure, co-ordination between different agencies, and attitudinal change among users.

Table 1: Three scales of waste water

Scale	Method	Implementer	Regulator	User	Challenge
100+ MLD (Large Scale)	Large-scale transport and in-stream treatment	BWSSB	KSPCB	Industry, urban consumers	Technical feasibility poor/unclear
20-100 MLD (Large Scale)	Large-scale treatment + local sale/ delivery	BWSSB	KSPCB	Industry	No disincentives to industry using groundwater
1-5 MLD (neighbourhood scale)	Treat and discharge in lakes	BWSSB	KSPCB	Lakeside residents (as environmental amenity users)	Environmental amenities goal differs from reuse goal
	Treat and supply/sale	BWSSB	KSPCB	Industrial parks, institutions	No links established with users, no disincentive to users using groundwater instead of treated water
<1 MLD (apartment complex scale)	Treat and reuse on their own	Large apartment complexes	KSPCB	Only complex itself	Too much treated water for apartments to reuse; poor regulation

Source: Authors' compilation (Jamwal et al, 2014)

Final remarks

Classical resilience thinking emphasizes the ability of cities to return to 'equilibrium' after climate change/hazard-induced calamities. However, this does not capture the 'dis-equilibrium' that cities in developing countries like Bengaluru are experiencing. They are impacted upon by multiple stressors such as global economic expansion, migration, land use change and water scarcity, in addition to climate change, the effects of which are inseparable. Cities are already water scarce and persistently water stressed. Climate impacts themselves are mediated by the infrastructure and institutions of water access, storage and distribution.

The long-term view of resilience, on the other hand, lacks conceptual clarity as it overlaps with ideas of sustainability and adaptation. Increasing reliance on groundwater may enhance the city's resilience but raises questions of sustainability. Upstream recycling of wastewater as an adaptation strategy limits downstream releases and poses questions of (basin-scale) equity. The policy emphasis on economic growth in countries like India further complicates matters. The argument that polluting industries reduce environmental quality of rivers or impact on water resources sustainability, may not be concerns of high priority in policy formulation in growing cities.

To sum up, while on the one hand, for systems in dis-equilibrium, resilience may be better thought of as adaptability; and broader notions of resilience nevertheless should not distract us from the need to address normative concerns of scarcity, fairness and sustainability in urban governance.

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Public Affairs Centre (PAC) is a non-profit, non-partisan, civil society-led think tank dedicated to improving the quality of governance in India through research, advocacy and action. The creation of PAC in 1994 was perhaps the first civil society-led institutional initiative to mobilize a demand for good governance in India. The Centre is globally known for its pioneering Citizen Report Cards (CRC), benchmarking studies used to improve public services. The other leading-edge monitoring tools designed by PAC to promote social accountability or governance organisations are Community Score Card (CSC), Social Audit Toolkit, Road Infrastructure Monitoring Toolkit and Climate Change Score Card (CCSC).

In 2010, PAC established a group on **Environmental Governance** (EnGG) with the vision to improve the quality of life of the poor and marginalized sections of the communities in the environmentally affected areas of India. The group aims to improve the security, ecological sustainability and climate resilience of various livelihoods and livelihood groups through its efforts. The group has worked with marginalized and highly vulnerable communities in coastal Tamil Nadu and highlands of Wayanad in Kerala. The CCSC, a social accountability tool was developed by EnGG with a focus on empowering the vulnerable communities affected by environmental issues such as Climate Change. The group has developed approaches and methods for developing Green Manifestoes for influencing the political parties and leaders for developing a sustainable environment. PAC has supported to join, India's first citizen weather network in Bengaluru - Know Your Climate.

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