

## CASE

# Revival of Amani Doddakere tank (Bangalore, India)

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## Supporting case for Business Model 21

Location:	Hoskote <sup>1</sup> , Bangalore, India
Waste input type:	Urban sewage (diluted with storm water)
Value offer:	Treated wastewater for irrigation, domestic use and restoration of ecosystem services
Organization type:	Public
Status of organization:	Fully operational: 2011
Scale of businesses:	Medium
Major partners:	Karnataka Department of Water Resources (Minor Irrigation); farmers at the Amani Doddakere tank. Indirectly: farmers along the lift irrigation transfer and the Hoskote Municipality

## Executive summary

This business case describes the transformation of urban wastewater into an asset for peri-urban farmers and households through inter-sectorial water transfer for groundwater recharge. Excess water from Bangalore's highly polluted Yelemallappa Shetty tank<sup>2</sup> (YMST) is redirected over about 6.2 km to the Amani Doddakere tank (ADT) at Hoskote, reducing pressure on the sewage-fed YMST while partially restoring the ADT, a tank that was for over 18 years dried up.

The lift irrigation system was planned in the late nineties but only realized a decade later. The original idea was to directly feed the water in the irrigation channels at the ADT. Due to illegal tapping into the transfer canal and pipe, the water arriving at the ADT is however insufficient for this objective and most farmers benefitting from the transfer can be found between the YMST and ADT. However, through aquifer recharge, groundwater tables which had dropped below 1,000 feet (ca. 305m) in ADT vicinity, can now be accessed again, providing farmers and households quality water, either directly from wells or through water vendors with well access. The Hoskote Municipality started almost a 24/7 water supply after mandatory water treatment (chlorination). Before this, piped water was only available for short periods all few days. Capital and operational costs, the latter mostly for pumping (lifting) the water out of the YMST are moderate given the achieved benefits. Although the project might present primarily a social business model with still unvalued, social and environmental costs and benefits, operational cost recovery of up to 25% from farmers appears possible, while options on how to charge private water tankers remain to be explored. Although in this case, the recharged groundwater appeared to be of excellent quality and public perception very positive, for any replication of the model care has to be taken that the characteristics of the receiving

aquifer are known, and a well-defined institutional and legal framework provides capacity for dedicated environmental impact assessments (EIA) and water quality monitoring in view of long-term impacts.

#### KEY PERFORMANCE INDICATORS (2014/15)

Land use:	20 km of wastewater pipeline / open canal					
Water requirements:	Lifting capacity of 0.26m <sup>3</sup> per second					
Capital investment:	USD 674,000					
Labor requirements:	Low in public sector, but high among benefiting farmers and private sector					
O&M:	USD 3000–3500 per month (mostly for pumping)					
Output:	5–6 MCM per year for up to 171 ha under irrigation					
Potential social and/or environmental impact:	200–500 farmers between the YMST and ADT. Direct and indirect supply also for several thousand households without well via piped and tanker water supply. Improved ecosystem services through biodiversity increase after lake restoration					
Financial viability indicators:	Payback period:	Not available (N.A.)	Post-tax IRR:	N.A.	Gross margin:	N.A.

### Context and background

Bangalore (Bengaluru), the capital city of India's Karnataka state, is with a total population of over 11.5 million people, the third most populous city of India. Bangalore's water demand-supply gap was estimated to be 750 million litres a day (MLD) in 2013, and is expected to increase to 1,300 million litres a day by 2026 (McKinsey and CII, 2014). The escalating water demands resulted in unsustainable groundwater extraction and correspondingly high wastewater generation. Although Bangalore is one of the most advanced cities in India with 3610 km of sewage lines and 14 sewage treatment plants, the sewer network is outdated, and less than half of the generated wastewater is captured and/or gets treated. The mix of untreated and treated wastewater pollutes local streams and [cascades of] freshwater reservoirs in and around the city. One of the largest tanks, the Yelemallappa Shetty tank (YMST) in north-eastern Bangalore, is such an example of an ecologically dying lake, increasingly filled up with city run-off, garbage and construction debris. Like 17 other (originally irrigation) tanks on the city outskirts, the YMST is under the management of the Minor Irrigation Department.

Further away from Bangalore, dried-up lakes are common. Despite an average of 800–900mm rain, many irrigation tanks have disappeared and their land was transformed for other use. In the case of Hoskote, a large county with 333 villages in Bangalore's vicinity, the local Amani Doddakere tank (ADT) dried up about 20 years ago, with groundwater levels dropping<sup>3</sup> over the same period by several hundred feet to a depth of more than 1,000 feet (Scharnowski, 2013). In the Hoskote municipality, the extracted 3.36 MLD of drinking water were by far not adequate to meet the 9.37 MLD water demand by Hoskote's ca. 60,000 inhabitants. To support all citizens, the government introduced a scheduled water supply, and made the process of getting permission to sink new borewells (bore holes) difficult.<sup>4</sup> However, under increasing water demand, owners of existing borewells started selling water to tanker companies.

With their livelihoods threatened, farmers from Hoskote requested in the late nineties from the Government of Karnataka to lift water from the YMST to the ADT in support of irrigation, a plan which was drafted in 1999, but only realized a decade later. By that time, the YMST had become a highly polluted water body. End of 2011, the scheme started transferring about 5–6 million cubic meter (MCM) of water from the YMST towards Hoskote. The original estimated cost was USD 579,000 which rose to USD 674,000 due to delays in completion. The ADT had an original capacity of 22.6MCM, with a command area of 940 ha and max. water surface area of 1,100–1,300 ha. The aim of the YMST lift irrigation scheme was to revive the ADT, support its irrigation channels and to recharge groundwater

and wells in the area. The wastewater which flows from the YMST to the ADT in part through a pipeline, in part through an open channel, attracted farmers to illegally tap at four to five locations into the resource to fill their tanks and enable ground water recharge for drinking and irrigation, fish rearing and cattle feeding. This resulted in significantly less water eventually arriving in the Doddakere tank, in particular not enough to supply the irrigation channels.<sup>5</sup> Still a part of the ADT got filled with about six feet of water, improving noticeably the groundwater table in lake vicinity from recently 1,000–1,200 feet to 800 feet or much higher. Based on the expected inflow of polluted water, authorities banned direct water use from the ADT, while indirect use via the aquifer provided water fit for irrigation.

### Market environment

Under the common water scarcity and dependency on dwindling groundwater, demand for water, water transfers and groundwater replenishment are very high in Karnataka and beyond, and more lift irrigation projects of similar nature are under discussion (see below). Aside supporting agriculture, the 'new' water is also replenishing groundwater for domestic use, making the local water supplying agency as well as private water vendors key customers of any water transfer. All actual as well as potential beneficiaries expressed a high willingness to pay for water (Scharnowski, 2013) as all alternatives are more expensive, from buying water or motor pumps to borewell construction. Well construction is in fact farmers' main cost item as farmers enjoy a broad spectrum of subsidies such as free electricity (pumping), subsidized fertilizer and seeds (The World Bank, 2012). Farmers who lost access to water either had to buy it from other farmers, change their cropping to only rainfed systems or abandon agriculture.

### Macro-economic environment

Although some governmental statistics might indicate a large number of households connected to piped water supply, water pressure, for example in Bangalore, is usually very low and access sporadic. A similar mismatch of statistics and reality is found in the sanitation sector where installed treatment capacities are not supported by the sewer network which is outdated and large amounts of wastewater end in streams and lakes. Thus, water supply remains a key challenge, and water transfer and reuse remain high on the policy agenda, also as lake restoration is strongly promoted in Karnataka.

However, implementation of water transfers is not straight forward. Although governmental programs and policies call for wastewater reuse, treatment at the right (reuse) location is seldom, and (untreated) informal wastewater irrigation remains most common (Amerasinghe et al., 2013; Gupta et al., 2016). Also aquifer recharge with wastewater falls in a grey area. Karnataka's first groundwater law, which came into effect in 2011, introduced regulations to monitor the number of bore wells and groundwater use, and that commercial bore wells could be subject to tariffs and caps on water withdrawal. However, law implementation and registrations remained limited (Borthakur, 2015), partly due to missing incentives to register as well as lack of clarity over the exact mandates of different authorities (Bangalore Water Supply and Sewerage Board, Department of Mines and Geology, Department of Water Resources), not to mention water quality issues where freshwater lakes turned into sewage ponds, or options for charging for water abstraction. Moreover, recent suggestions for lift irrigation schemes in Karnataka (e.g. the replenishment of 29 minor tanks around Hoskote and Chikkaballapur) got stalled due to objections raised by the neighboring state of Tamil Nadu fearing that these projects will affect Tamil Nadu's access to water in the shared Dakshina Pinakini River basin. Competition for water, independently of its quality, is high in the region.<sup>6</sup>

### Business model

This is primarily a social business model with a potentially high pay off. The city is trying to reduce pressure on lakes with high sewage and storm water inflows in support of groundwater recharge in the water-scarce hinterland, allowing indirect (waste)water reuse for irrigation, household and environmental needs with ecological, economic and social benefits.

Revenues are theoretically collected by the Department of Irrigation, charging farmers per hectare, while households connected to meters pay for drinking water supply. Field surveys showed that farmers between the YMST and ADT would be willing to pay significantly above the current water rates if they could rely on the wastewater flow. The amounts would allow to cover about 25% of the operational and maintenance cost of the lift scheme (Scharnowski, 2013).<sup>7</sup>

The originally unintended primary beneficiaries of the water transfer are those institutions whose obligatory functions as per the Constitution of India is to provide drinking water to the people. However, there are no systems (yet) in place to fund the lift irrigation from revenues accruing in other sectors, like charging water vendors (or farmers) for abstracting replenished groundwater for sale.<sup>8</sup> Changes in tariffs for water use or electricity (pumping) are being discussed, also in light of regulating water abstraction than only revenue generation. Given the low water tariffs, the project is unlikely to financially break even, while the expected economic returns in terms of environmental and livelihood benefits are probably surpassing both, the investment and running costs of the lift irrigation scheme which easily justifies the social character of the business model (Qadir et al., 2014).

Due to immense water demand around cities, and the success of the Hoskote case, the social business concept has a strong replication potential, especially if water access between source and target can be considered in the project design. For the business model to be sustainable, it has to be based on principles of integrated water resources management (IWRM) with full stakeholder participation beyond the irrigation sector, and geo-hydrological assessments including continuous groundwater quality monitoring. Figure 256 shows the business model canvas.

### Value chain and position

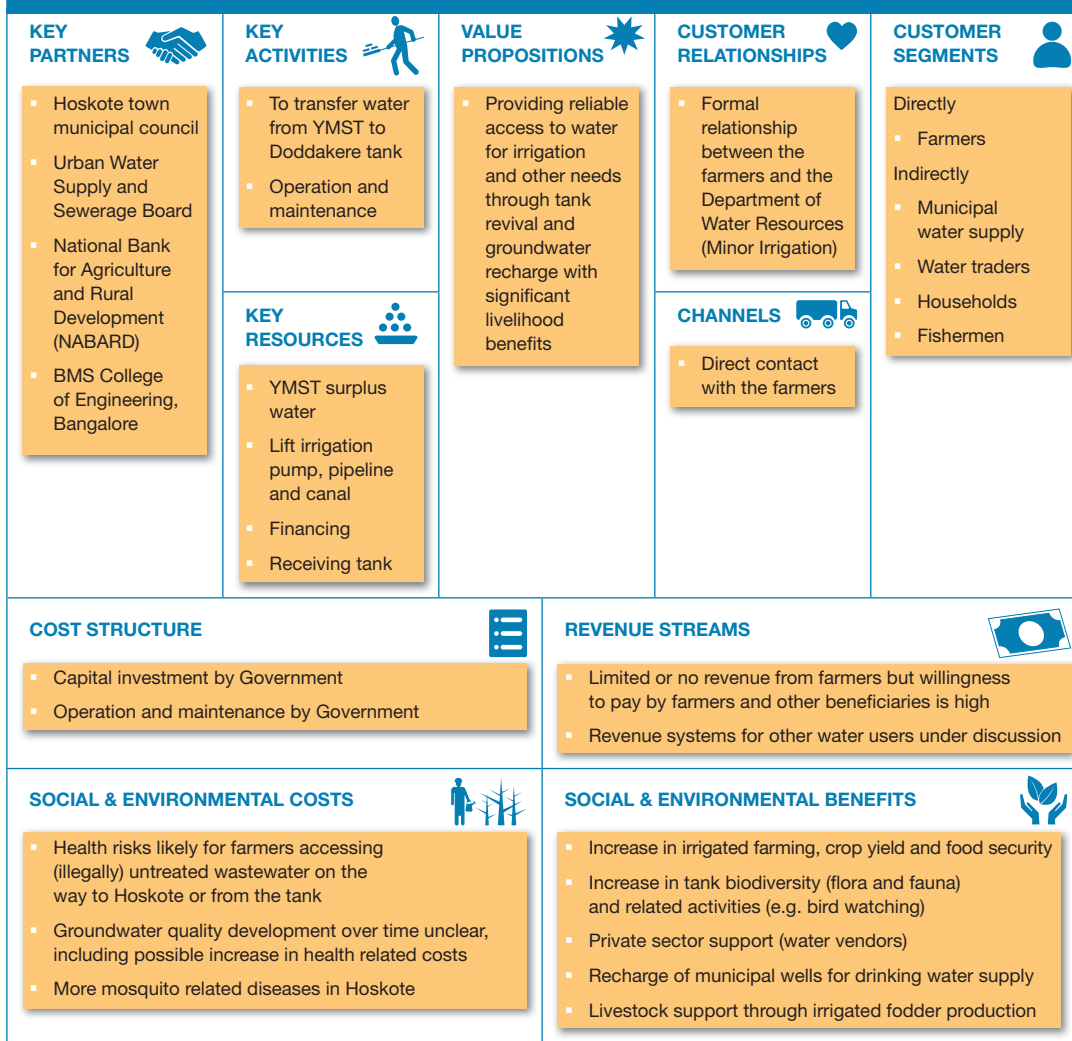
The value chain (Figure 257) shows current services as well as actually possible and potential (dotted line) revenue streams.

### Institutional environment

What was originally planned as a simple transfer of normal irrigation water (and correspondingly did not involve other stakeholders) became much more complex when the system eventually started, and the lift irrigation scheme evolved into a complex system of wastewater use, lake rehabilitation, groundwater recharge and drinking water extraction, elements which concerns a range of departments, authorities, and initiatives in the state of Karnataka. Overlap in responsibilities as well as reassignment of responsibilities are common features. The construction, maintenance and monitoring of minor irrigation projects, i.e. those with a 'culturable command area' of 2,000 ha or less are under the purview of the Minor Irrigation Department. Most of the Department's projects focus on surface water schemes while ground water schemes are dealt with in collaboration with the Department Mines & Geology (Groundwater Wing). The Minister for Minor Irrigation is also the chairperson of the governing council of the new (2015) Lake Conservation and Development Authority, which has members from several departments.

The Bangalore Water Supply and Sewerage Board (BWSSB) is responsible for providing drinking water supply to Bangalore City. The Karnataka Urban Water Supply and Sewerage Board is responsible for providing drinking water supply to urban areas throughout the state of Karnataka.

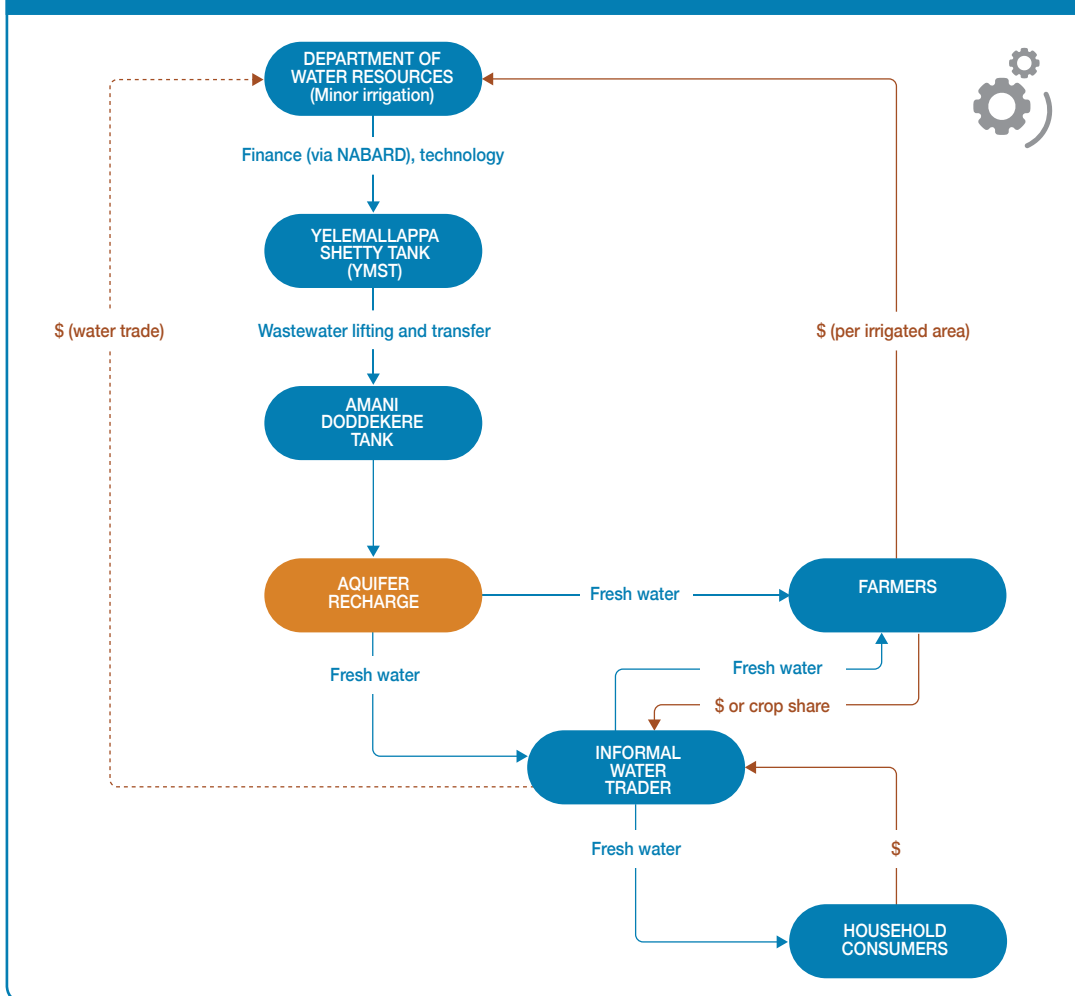
The legal framework influencing the extraction of groundwater are the Karnataka Groundwater (Regulation and Control of Development and Management) Bill (2009) and Act (2011) which basically lay down the application procedure for new borewells, process of registering and costs involved. Groundwater is considered the property of the government, and the drilling of borewells requires in the Hoskote area, like in several others harshly affected by groundwater depletion, official approval from the district committee. This resulted in a ban on new drilling of deep borewells in the area.<sup>9</sup>

**FIGURE 256. BUSINESS MODEL CANVAS FROM THE PERSPECTIVE OF THE WATER PROVIDING DEPARTMENT OF WATER RESOURCES**

Although water reuse is encouraged, questions around the ownership of the wastewater vis-à-vis the recharged groundwater, and the modalities for institutions to charge for groundwater abstraction remain subjects of discussion. The situation is complex as small farmers who are charged per irrigated area take advantage of their aquifers for selling water to tanker operators. Also in Bangalore and its vicinity private water supply is rampant filling gaps in the public supply system, while legislations to limit groundwater abstraction are hard to implement, especially where farmers can make easier money from selling water than via irrigation.

A 'larger' institutional challenge of the water transfer is that the river basin is shared by the states of Karnataka and Tamil Nadu. There are strong objections by the state of Tamil Nadu over Karnataka building permanent structure to divert water for its own needs while Tamil Nadu continues suffering from water scarcity. Thus, initiating any project even to utilize the wastewater for any existing tank command area needs clearance from the Central Water Commission.

FIGURE 257. BUSINESS PROCESS FLOW (WATER RELATED)



The YMST lift irrigation scheme is one of several planned lake-to-lake inter-sectorial water transfers around Bangalore, for which models for institutional collaboration and ownership have been described (ICRA, 2012).

### Technology and processes

Aside the initial lift pumping, the technology is based on physical, chemical and biological processes of natural water treatment (sedimentation, filtration, sun exposure, etc.) above and below ground along the 20 km water passage into the YMST, and between YMST and Hoskote. The potential of natural water treatment should in this context neither be over- nor underestimated. In the current case, the 6.2 km long wastewater overland transfer after leaving the YMST occurs partly piped, partly open, before the water enters the Amani Doddekere tank and gets filtered while percolating through 200 meters of rock to reach the groundwater table. About half of the passage requires pumping, half follows gravity flow. The water is not running continuously as pumping is sometimes stopped over hours or days. While the recharged groundwater at Hoskote appears to be of excellent (potable) quality, as tested by the BMS College of Engineering, Bangalore, any change in transport distance, groundwater table, type

of rock, etc. can influence the final water quality. Therefore, water quality monitoring is important, also as there are no data how the natural treatment will continue over the years. To minimize health risks, other planned water transfer schemes around Bangalore recommend wastewater treatment before the final reservoir (ICRA, 2012).

### Funding and financial outlook

The financial cost estimate for the YMST lift irrigation system was USD 579,000 with financing from National Bank for Agriculture and Rural Development (NABARD). The actual cost incurred, including additional works was USD 674,000. Charges for irrigation are marginal, about USD 2.6/season/ha for horticulture and floriculture, with free electricity for pumping groundwater.

The Department bears the operation and maintenance cost of at least USD 3,000 per month. Current irrigation water charges for horticultural crops (ca. USD 5.4/ha/yr) generate maximal USD 930 per year, or 2–3% of the annual O&M costs if all transferred water will end on farms which are charged and not be lost/redirectioned on the way to Hoskote. These charges are much lower than what farmers are willing to pay, which could cover up to 25% of the ongoing operation and maintenance costs as shown by IWMI in the Hoskote area (Scharnowski, 2013). Applying water charges to other users, especially water vendors, will be difficult as the market is informal and hard to monitor. However, for the success of the project, the present policy framework (the 2003 guidelines for lift irrigation) estimates the project benefits through the achieved agricultural yield increase, not through financial cost recovery.

### Socio-economic, health and environmental impact

Due to surface water scarcity, groundwater access is most crucial around Bangalore. Nearly 99% of all farmers in rural Bangalore depend on tube wells. The water transfer allows farmers now to cultivate more land or more than one crop per year, or crops with a higher return on the urban market. According to local media, the water table in about 30 villages surrounding Hoskote has increased to the benefit of up to 500 farmers.<sup>10</sup>

The situation also improved water supply to households in Hoskote Municipality which had before the scheme only water for once a day to once in ten days for few hours. Now, up to 60,000 inhabitants are reported as beneficiaries, either directly via own borewells or indirectly via local water vendors (tankers). Improved water access is in particular helping women, given the gendered nature of water collection (Borthakur, 2015).

Also dairy development is among the benefits of the project due to the increased availability of fodder from the wastewater reuse. The 'new' water in the tank revived local fish farming and lured various species of birds to the revived wetland, creating a regional hot spot for birding.<sup>11</sup>

The positive impacts could also extend to the YMST if the lifting of larger water volumes for Hoskote and other lakes could be realized. However, aside some initial groundwater testing, neither, soil, water, crop or fish quality is being monitored, and health risks are high, especially as farmers (without well) might use the wastewater directly, and not via groundwater as seen at other polluted lakes. Safeguards are also needed to ensure that possible negative long-term impacts are under control.

### Scalability and replicability considerations

The key drivers for the business model are:

- Water scarcity and high water demand catalyzing public investments.
- Strong policy support for lake conservation and development.

As both drivers are omnipresent in the region, already other lift irrigation schemes for water transfer are under discussion such as for replenishing 29 minor tanks around Chikkaballapur and Hoskote towns, using in this case treated wastewater. As part of an IWRM strategy for Bangalore, McKinzie and CII (2014) proposed a programme of lake regeneration to improve urban groundwater supply. Starting with 38 lakes, each one should be linked to a sewage treatment plant to clean lake inflow. These 38 lakes could increase Bangalore's water availability by an estimated 180 MLD. A comprehensive tank rejuvenation project was undertaken for example for the Jakkur Lake in the northern part of Bangalore at the cost of Indian Rupees 215 million (USD 3.37 million). The lake was dewatered, de-silted and all sewage inflows were diverted to a 10 MLD sewage treatment plant. The treated wastewater flows then through a constructed wetland before entering the lake itself. The result has been an increase in biodiversity, fishing and groundwater recharge (Evans, 2016).

While the use of wastewater for lake regeneration and aquifer recharge has been accepted in the case of Hoskote and shows favorable environmental and economic benefits, this does not have to be the case in other locations as water quality varies significantly and so the risks and public acceptance of indirect wastewater use is also not universal. Therefore, full stakeholder participation and information appear as important as water quality monitoring. Stakeholder inclusion is also needed for the discussion of options for cost recovery from the various beneficiaries, and modalities on how to address illegal water abstraction from the transfer canals.

For any replication of the reuse model, in particular in Karnataka, a legal and institutional framework with clear responsibilities would be beneficial. The same will be an institutional challenge in many other regions, given that such a water transfer links multiple sectors, i.e. urban and rural authorities in charge of surface and groundwater, sanitation, health, drinking water and agriculture. Regulations are also required to prevent that lift irrigation schemes eventually harm agriculture because of farmers becoming water vendors. In recent years, there has been a surge in the conversion of agricultural wells on the outskirts of Bangalore to supply urban consumers because agriculture is less profitable than selling water (and businesses can profit from the subsidized electricity afforded to rural landowners).

The resulting water loop appears to reflect an increasing reality of the circular economy between urban and rural areas in India, where the urban hinterland functions as a 'kidney' for urban water reuse.

### Summary assessment – SWOT analysis

The business case focuses on mitigating the economic impact of water scarcity by providing water to farmers for irrigation through the use of (waste)water for groundwater recharge. Additional benefits were observed for household water supply and ecosystem services. Taking advantage of natural water treatment processes, the city saves on treatment and disposal cost for wastewater while farmers and others benefit from 'new' water for their economic activities. There are also substantial benefits for the informal water market through the sale of groundwater to farmers, industry and households. The observed and largely praised success of the project could have even been larger as a significant water volume got lost due to illegal wastewater extraction before the water reached the targeted ADT. There are various options for revenue generation from different beneficiaries who would pay for a reliable water supply. However, already the significant welfare benefits and their downstream impacts on regional economic performance make this social business highly worthwhile.

A long term impact on groundwater quality can be expected, and close water quality monitoring is highly recommended. A better alternative would be to treat all water entering the YMST. Another challenge will be to steer the right hydrological balance between formal aquifer recharge and formal and informal water extraction. Figure 258 shows the SWOT analysis for this business case example.

FIGURE 258. SWOT ANALYSIS OF BANGALORE GROUNDWATER RECHARGE, INDIA

	HELPFUL TO ACHIEVING THE OBJECTIVES	HARMFUL TO ACHIEVING THE OBJECTIVES
INTERNAL ORIGIN ATTRIBUTES OF THE ENTERPRISE	<b>STRENGTHS</b> <ul style="list-style-type: none"> <li>Strong policy support for tank rehabilitation and protection</li> <li>Governmental support of lift irrigation for groundwater recharge</li> <li>High demand for (waste)water</li> <li>Recharged ground water suitable for drinking purpose</li> <li>High economic and ecosystem service benefits, making the system worthwhile without cost recovery</li> </ul>	<b>WEAKNESSES</b> <ul style="list-style-type: none"> <li>User participation was limited to farmers</li> <li>Unexpected wastewater diversion along the water passage to Hoskote not covered in any EIA</li> <li>Insufficient water quality monitoring</li> <li>As the system is not designed for cost recovery, rigorous options to monitor and regulate water abstraction are missing</li> </ul>
EXTERNAL ORIGIN ATTRIBUTES OF THE ENVIRONMENT	<b>OPPORTUNITIES</b> <ul style="list-style-type: none"> <li>Potential to establish clientele/ revenue relationship with various water users, beyond farmers</li> <li>Value of wastewater (farmers, water suppliers through tankers and local bodies) 3 to 12 times higher than the current water charges</li> </ul>	<b>THREATS</b> <ul style="list-style-type: none"> <li>Conflicts with Tamil Nadu over water infrastructure could stall replication of the model</li> <li>Aquifer pollution risks resulting in health issues for farmers and other water users, unless YMST water gets treated</li> <li>Lift irrigation might serve more sale of drinking water than agriculture and eventually result in farmers stop farming</li> </ul>

## Contributors

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*Case descriptions are based on primary and secondary data provided by case operators, local insiders or other stakeholders, and reflect our best knowledge at the time of the assessments 2013–2015. As business operations are dynamic data are likely subject to change.*

## Notes

- 1 Also spelled Hosakote.
- 2 In South Asia, the term ‘tank’ is used for man-made water reservoirs (lakes) which are often centuries-old, constructed for rain/surface water storage, mostly for irrigation but also other community needs. Several tanks can be interconnected.
- 3 Groundwater overexploitation at Hoskote is reported as 144%. <http://timesofindia.indiatimes.com/city/bangalore/Water-table-in-Bangalore-South-drying-up/articleshow/7838020.cms?referral=PM> (accessed 4 Nov. 2017).
- 4 <http://reliefweb.int/report/india/drought-hit-karnataka-regulates-borewells> (accessed 4 Nov. 2017).
- 5 Observation during field work in 2012.
- 6 [www.deccanherald.com/content/244394/tn-now-lays-claim-city.html](http://www.deccanherald.com/content/244394/tn-now-lays-claim-city.html) (accessed 4 Nov. 2017).
- 7 This would require that those farmers who are illegally tapping into the water transfer will be charged. In fact, the Department of Minor Irrigation and Revenue Department are not charging farmers of the ADT, firstly as the tank was for nearly two decades dry and farmers invested big money on tube wells, and even the ‘new’ water pumped from YMST has not risen above the sluice level to carry water in the irrigation channels.
- 8 Tube well owners expressed their willingness to support the water transfer with a monthly rate, as they see a clear relation between tank water level and tube wells, usually with four to five days of delay. A revenue system for tanker operators could be based on number of tankers and their volumes (usually 4,000–6,000 liters), while neither actual pumping (tanker filling) nor water delivery are easy to monitor.
- 9 <http://timesofindia.indiatimes.com/city/bengaluru/Depleting-water-table-could-hit-city-outskirts-hard/articleshow/50665373.cms> (accessed 4 Nov. 2017).
- 10 [www.deccanherald.com/content/227529/hoskote-reuses-bangalores-refuse-ends.html](http://www.deccanherald.com/content/227529/hoskote-reuses-bangalores-refuse-ends.html) (accessed 4 Nov. 2017).
- 11 As the lake is, with its about 940 ha, rather large, the water inflow creates a patchwork of grassland and water bodies ideal for many kinds of birds.