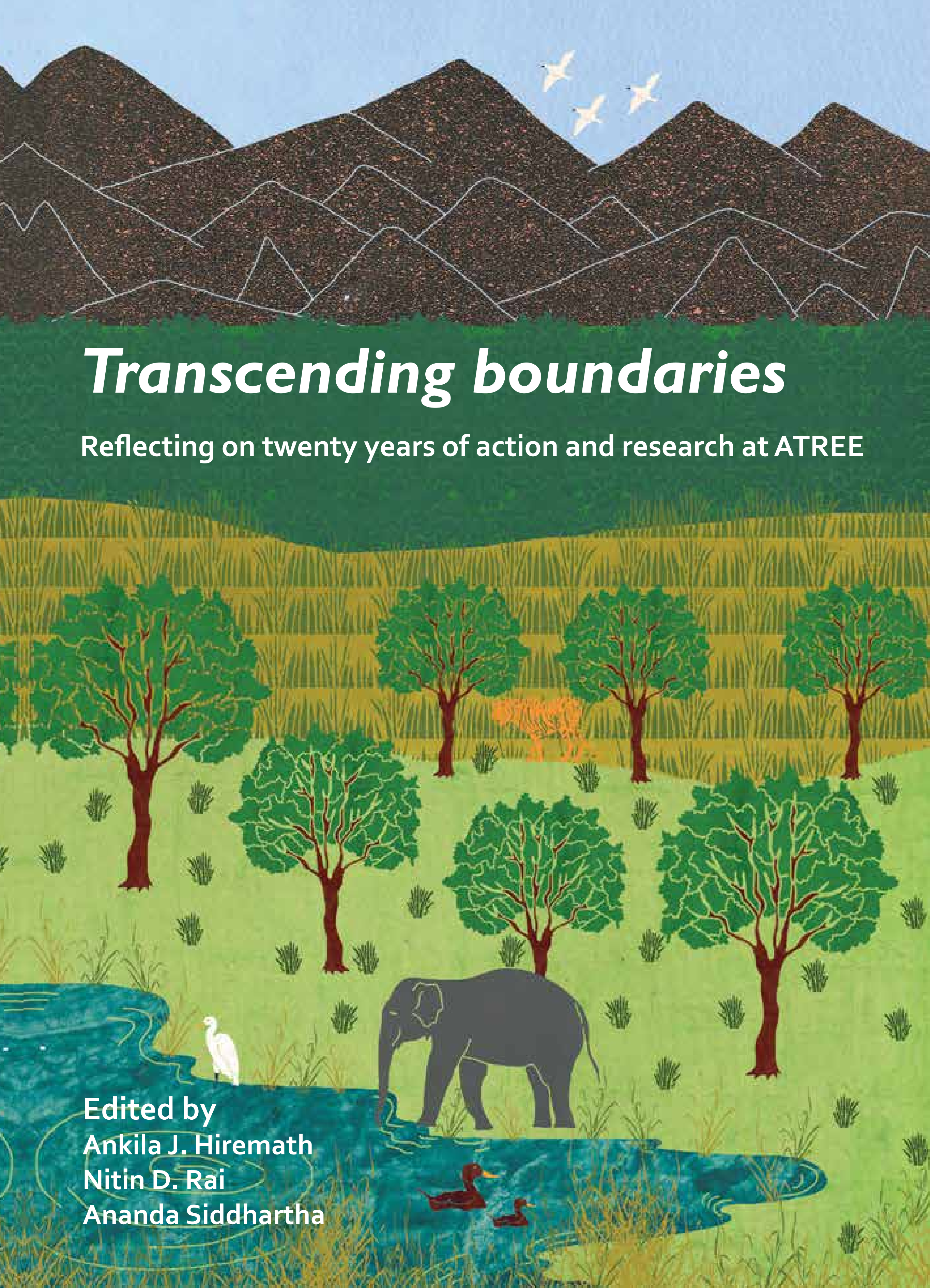

Transcending boundaries

Reflecting on twenty years of action and research at ATREE

Edited by
Ankila J. Hiremath
Nitin D. Rai
Ananda Siddhartha

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Ashoka Trust for Research in Ecology and the Environment (ATREE),
Royal Enclave, Srirampura, Jakkur PO.
Bangalore - 560064, Karnataka, India.
Website: www.atree.org
Tel: 91-80-23635555 | Fax: 91-80- 23530070

ATREE regional offices
Eastern Himalaya Office
C/o Theyzong Heem, Near Brahmakumari's
Development Area, Gangtok 737101, India
Tel: 91-3592-206403

New Delhi (Liaison and Development)
C-86, 2nd floor, B.K. Dutt Colony
New Delhi 110003, India.
Tel: 011-24603134

W.Q. Judge Press,
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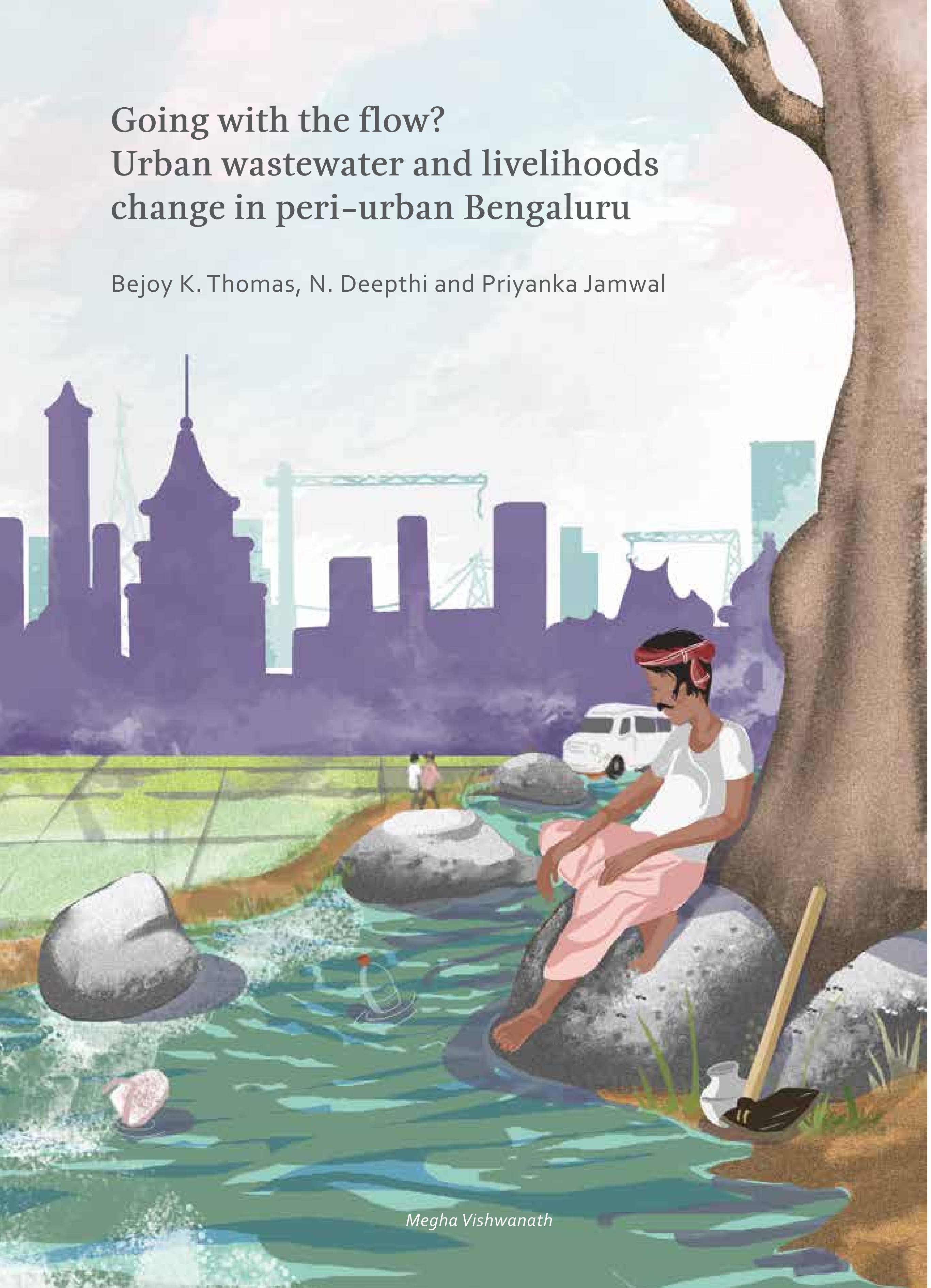
Bejoy K. Thomas, N. Deepthi and Priyanka Jamwal



Megha Vishwanath

INTRODUCTION

As cities grow, peri-urban areas and surrounding villages undergo rapid changes in land use, environment and livelihoods. The conventional view on change in peri-urban areas is one of shifts in livelihoods away from agriculture towards urban jobs, as well as keeping lands fallow, to be taken up by real estate or industries. Further, people in peri-urban areas experience huge changes in the nature of and control over local natural resources. This is particularly so in the case of water resources. The demand for water from expanding cities is often met by sourcing it from peri-urban areas. In addition, domestic sewage and industrial discharges from cities put pressure on lakes and rivers, and the impact of pollution is felt in surrounding landscapes. Planners and policymakers have been grappling with the implications of such transformations for both agricultural production and environmental sustainability. Here we examine the case of peri-urban Bengaluru to ask the questions: is abandoning agriculture inevitable in the wake of urbanisation or can there be other trajectories? How have peri-urban farmers been responding to water pollution and changes in irrigation water quality?

The growth of Bengaluru has been especially significant, with the city population increasing from 4 million in 1991 to 8 million in 2011 and the area from 226 km^2 in 1995 to 741 km^2 in 2007, due to a combination of factors such as natural growth, massive immigration and jurisdictional changes. The city has created opportunities for people in the neighbouring rural areas and there has been a steady movement out of agriculture to non-agricultural and city-based jobs. We studied the impact of Bengaluru's urbanisation on water resources and agriculture in the peri-urban areas taking the case of villages along two contrasting rivers downstream of Bengaluru viz., the Vrishabhavathy and Suvarnamukhi.

Vrishabhavathy and Suvarnamukhi catchments form part of the Arkavathy sub-basin, itself part of the larger Cauvery basin. A large portion of the Arkavathy sub-basin (with a catchment area of 4,169 km^2), from which Bengaluru city used to draw its water previously, is currently dry, primarily due to declining groundwater levels and cultivation of plantations, particularly eucalyptus, upstream (see Srinivasan *et al*, this volume). Bengaluru's current water requirement, domestic as well as industrial, is met by groundwater and by pumping water from the Cauvery river. This results in a return flow, which keeps Vrishabhavathy perennial. Vrishabhavathy (catchment area 561 km^2), which originates inside the city, carries the city's domestic waste as well as industrial waste from Peenya and Bidadi industrial areas (see Jamwal and Lele, this volume). The reservoir at Byramangala on the Vrishabhavathy stores this water which is used by farmers downstream for irrigation through a canal system. Suvarnamukhi (catchment area 286 km^2), on the other hand, fed by streams from the Bannerghatta forest, is relatively unpolluted, and unlike most other streams in the Arkavathy basin, flows for most part of the year, except in peak summer.

We used a two-stage analysis to assess the extent of urbanisation and the impact on agrarian livelihoods and water resources in the two catchments. In the first stage, we analysed census data. In the second stage, we selected six villages lying along the river course, three each from the Vrishabhavathy and Suvarnamukhi catchments, for field research, conducted in 2013. Field research involved participatory rural appraisal tools, questionnaire surveys and water quality testing.

QUITTING OR STAYING IN AGRICULTURE?

Our analysis of census data (1991, 2001 and 2011) showed that on the whole, there has been a clear shift from agriculture to non-ag-

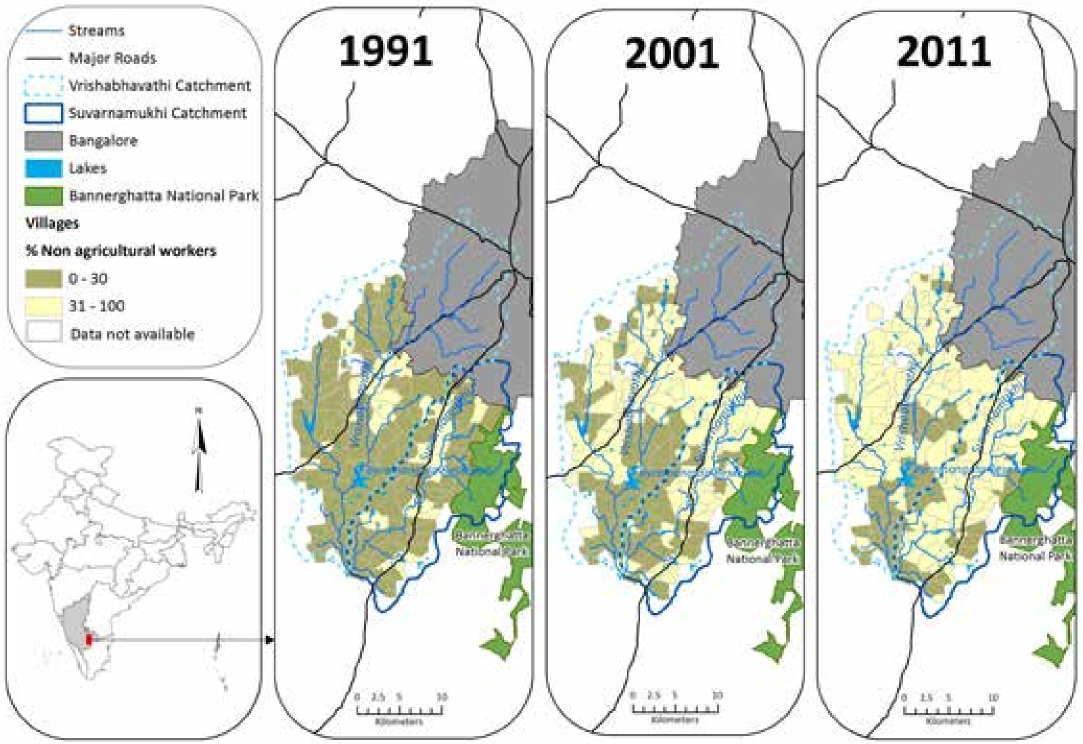


Figure 1: Trends in the proportion of agricultural cf non-agricultural employment in Vrishabhavathy and Suvarnamukhi river catchments (based on an analysis of census data from 1991-2011). Agricultural employment included farming, farm-labour, dairying and sericulture; non-agricultural employment included jobs in the city, or in nearby industrial areas. (Source: Village boundaries and classification are based on census data for respective years, mapped at the Ecoinformatics Lab, ATREE)

ricultural employment in villages falling in both the Vrishabhavathy and Suvarnamukhi catchments during the last two decades. Contrary to this trend, livelihoods in the villages along the course of the Vrishabhavathy river, and in the command area of Byramangala reservoir, still centred around agriculture. While it is natural to point to availability of water for irrigation as the reason for this, a similar preference for agriculture was not evident in villages along the Suvarnamukhi river just a few kilometres away, which were not as water abundant, but were by no means water scarce. We explored this issue in detail.

We examined the trend in 'extent of urbanisation' in Vrishabhavathy and Suvarnamukhi catchments in census villages downstream of the points where Vrishabhavathy and Suvarnamukhi exit the Bruhat Bengaluru Mahanagara Palike (BBMP) area (figure 1). We defined 'extent of urbanisation' as the proportion of non-agricultural workforce to total workforce, classifying villages where more than 30% of the workforce is employed in non-agricultural occupations as urbanised. We included farming, farm-labour, dairying and sericulture in agricultural work. Other jobs, whether city-based, or in industrial areas close by, were considered non-agricultural. We drew upon census data for the years 1991, 2001 and 2011 to create the maps. As the figure shows, over the period 1991–2011, there is a sharp increase in the number of villages across both catchments where more than 30% of the working population is engaged in non-agricultural employment. Interestingly, the villages where agriculture is still the mainstay are concentrated around the Vrishabhavathy, especially in the Byramangala command area.

Of the three villages that we had selected for detailed study along the Vrishabhavathy, none had moved away from agriculture (using the 30% cut off, based on census data) during the period 1991–2001, and just one moved to non-agricultural employment during the period 2001–2011. On the contrary, along the Suvarnamukhi river, just one village of the three was urbanised in 1991, and over the next decade (1991–2001), all three had more than 30% of working population employed in non-agricultural jobs. Our survey data showed a similar trend, with the number of households engaged in non-agricultural jobs increasing from 11% to 27% in Vrishabhavathy villages, and 4% to 38% in Suvarnamukhi villages during the period between the early 1990s to the present.

A possible 'biophysical' explanation for the movement out of agriculture in the Suvarnamukhi catchment would be lack of availability or access to water. However, even as we found increased groundwater dependence (largely a 1990s trend), gradual increase in depth at which water was first sighted in borewells, and several instances of failed borewells in the 1990–2013 period, both the Vrishabhavathy and Suvarnamukhi catchments are better endowed with irrigation water compared to the rest of the Arkavathy sub-basin.

Census (village amenities) figures showed that the total irrigated area increased from 17% to 28% in Suvarnamukhi catchment and from 19% to 28% in Vrishabhavathy catchment, during 1991–2001 (data from 2011 census was not available). Of the total irrigated area, surface water (river) irrigated area constituted 42% in the Suvarnamukhi catchment in 1991, declining to 35% in 2001. In the Vrishabhavathy catchment, there was a marginal decline in surface-water irrigated area from 57% in 1991 to 54% in 2001. Our survey data also showed a similar picture as the census with respect to irrigation. Irrigated area constituted 86.5% of the total area cultivated by households we surveyed in the three Vrishabhavathy villages in 2013, and the corresponding figure for the three Suvarnamukhi villages was 68%. Of the total irrigated area, 66% in the Vrishabhavathy villages and 38.5% in the Suvarnamukhi villages used surface water.

There is apparently little variation in irrigation water availability between villages in the two catchments that we surveyed. Our household surveys showed that the depth at which water was found in recently drilled borewells (drilled between 2008 and 2013) for agricultural households was in the range of 36.5 to 121 m (120 to 400 ft) in the Vrishabhavathy villages and 38 to 121 m (125 to 400 ft) in the Suvarnamukhi villages. Most Vrishabhavathy villages, especially the ones in the command area of Byramangala reservoir, cultivate monsoon and summer crops, as do some in the Suvarnamukhi catchment, particularly the downstream villages.

Interestingly then, households have been gradually quitting agriculture post-1990 in the Suvarnamukhi catchment, although there has not been a drastic decline in water availability. On the other hand, the Vrishabhavathy villages saw households largely staying in agriculture, despite being more or less similar to the Suvarnamukhi villages in proximity and exposure to the city. What might explain this difference in trajectories and responses to urbanisation?

Wastewater irrigation in the Byramangala command area. (Photo: Nakul Heble)

CROPPING PATTERN IN VRISHABHAVATHY VILLAGES, 1990–2013

Cropping pattern in both Vrishabhavathy and Suvarnamukhi villages were comparable till the 1990s. From our households' survey, we found that in 1990, *ragi* (finger millet) and paddy used to be grown in 70% of the area under cultivation in Vrishabhavathy villages and 79% in Suvarnamukhi villages. The quality of water in Vrishabhavathy began eroding steadily during the 1990s with the expansion of Bengaluru and the establishment of new industrial areas upstream in the Vrishabhavathy catchment. Surface water, as well as groundwater, were affected. There was substantial reduction in returns from crops such as paddy and sugarcane cultivated in poor quality water, compared to good quality water. Studies have also established heavy metal contamination in water in Byramangala reservoir and command area, resulting from the mixing of industrial waste with domestic sewage (see Jamwal & Lele, this volume).

While water quality deteriorated and made cultivation of sugarcane and paddy difficult, farmers adapted by trying out other crops that could withstand and gain from the nutrient-rich wastewater. Baby corn, a high value commercial crop, proved successful, catering to the growing demand in the Bengaluru metropolis and elsewhere, and bringing in steady returns to the farmers. The production and procurement of baby corn in Vrishabhavathy villages was facilitated by private agencies such as the Namdhari Seeds Group, which owns the Namdhari's Fresh supermarket chain. Baby corn is a post-2000 phenomenon, with the earliest baby corn farmer in our sample reporting having started cultivation in 2002. In 2013, baby corn occupied as much as 20% of the area cultivated by our respondents in Vrishabhavathy catchment (nil in 1990), and another commercial crop, mulberry, used for sericulture, occupied 22% (6% in 1990). With water not suitable for cultivation, many farmers resorted to growing fodder, which occupied close to 9% of cultivated area in 2013. Between 1990 and 2013, the area under ragi and paddy registered a massive decline from 70% to 27%. As we noted earlier, the crops are irrigated, largely by surface water. The nutrient-rich and perennial Vrishabhavathy, along with a steady and growing market for commercial crops, has kept the villages in the Vrishabhavathy catchment in agriculture.

Suvarnamukhi villages have also seen a move away from ragi and paddy, the area of which declined from 79% to 45% during 1990–2013, but not as much as in Vrishabhavathy catchment. The decline has been made up by crops including coconut (nil in 1990 and 17% in 2013) and mulberry (2% in 1990 and 12% in 2013). Ragi and paddy require high labour input and are grown nowadays mostly for their own consumption. Agriculture is a viable option in Suvarnamukhi villages, but not as attractive as non-agricultural employment in the city or in the industrial areas close by. Over time, the region has witnessed a shift towards less labour-intensive crops, and in general, a move out of agriculture as we noted earlier. Of our sample households, 55% in the three Vrishabhavathy villages, and 28% in the Suvarnamukhi villages, attributed the reason for crop change to better income, while the responses did not vary much with regards to water availability as a factor leading to crop change (14% in Vrishabhavathy and 15% in Suvarnamukhi). Paddy (54%) was seen to be the most adversely impacted by deteriorating water quality amongst respondents in the Vrishabhavathy villages. On the other hand, fodder (44%), input for dairying, which has become a major activity in the region during the past several years, and baby corn (37%), were viewed as having benefitted from wastewater irrigation.

IMPACT OF WASTEWATER AGRICULTURE

Deteriorating water quality in the Byramangala reservoir and Vrishabhavathy river has been a topic of discussion in the popular press and civil society circles for some time now. Our research looked at the reasons for this and the extent of contamination. Results from our assessment of the Vrishabhavathy valley wastewater treatment plant showed that there was no positive impact of treated effluent discharge on river water quality. Thus, the wastewater being used for irrigation largely consists of untreated sewage. One third of all farm households that we surveyed in the Vrishabhavathy villages reported skin ailments (and unsurprisingly, none in the Suvarnamukhi villages), which could be attributed to the contaminated water they use for cultivation. While the farmers and residents in the villages are concerned about the visibly bad water, the never-ending stink, and mosquito menace, they seem to be oblivious to a more serious threat that is lurking in the background. We tested for heavy metal concentrations in milk, vegetables, groundwater (used for drinking), and irrigation water, in the villages where we carried out the household survey, and found that 98% of irrigation water samples, 68% of drinking water samples, 77% of vegetable samples, and 85% of milk samples exceeded limits prescribed by existing standards. The impact of industrial waste and heavy metal contamination on human health will not be visible as skin ailments are, but will be apparent only in the long term. Even when the levels of heavy metals may not be above the standards in all the sites and for all the samples, there are multiple channels through which they enter the human body, such as water, vegetables, and milk, all consumed by the same person, which can have a cumulative impact.

Heavy metal contamination may have already entered the food chain, thereby posing a health risk to consumers of vegetables, and milk produced by cows feeding on fodder grown in contaminated water. It is important to conduct a systematic assessment of health risk to farmers in the region, and to urban consumers of farm produce. Epidemiological studies can throw light on the severity of the problem and make clear the impact of wastewater irrigation on human health.

FINAL REMARKS

The contrasting experience of Vrishabhavathy and Suvarnamukhi villages offer some interesting pointers in conceptualising responses of peri-urban agrarian communities to urbanisation as well as in planning water

Byramangala reservoir, from where Bengaluru's wastewater flows downstream for irrigation through canals. Note the froth visible at the outlet of the reservoir. (Photo: T. Md. Zuhail)

management in such settings. While peri-urban areas are witnessing tremendous social and economic change, explanations for these changes are varied in the scholarly literature. A classical political economy approach would characterise the change in terms of changing agrarian relations (e.g., land ownership, tenure), whereas a development perspective would view it in terms of livelihoods change (e.g., migration, diversification). What has been overlooked in these approaches are the environmental factors that might have triggered the change. Even while they are acknowledged, they either do not figure prominently in the analytical schemes or get subsumed under other systemic factors. While the Suvarnamukhi villages followed the conventional narrative that urbanisation leads to abandoning of agriculture, the farmers in villages fed by Vrishabhavathy adapted to changes brought about by the expanding city and largely stayed in agriculture. What has made the difference is the availability of nutrient-rich urban wastewater. A fuller explanation of the transformation that peri-urban areas downstream of Vrishabhavathy and Suvarnamukhi rivers have undergone is possible by combining insights from the three modes of thinking—classical agrarian, livelihoods, and environmental—perhaps under the umbrella of political ecology.

The response of farmers in Vrishabhavathy villages raises questions of values, interests, and institutions. First, wastewater reuse has become a feature of peri-urban agriculture with many scholars and agencies actively advocating it. The framing of the problem seems to centre around the inevitability of urbanisation and the dependence of the peripheries on the urban core. The Vrishabhavathy farmers seem to have successfully adapted to the changes triggered by Bengaluru's growth, by experimenting with and eventually switching to different and more economically profitable crops. However, whose adaptation are we talking about if, as we saw, irrigation using heavy-metal-laden wastewater poses risk to the health of farmers and agricultural labourers who work in contaminated water, putting their well-being and sustainability of the practice in question? In addition, it is also possible that the urban consumers of farm produce, such as baby corn, are also not spared, and the contamination comes back to them through the food chain.

Second, planners need to be mindful of the multiple actors and competing interests at various scales, city/village and state, catchment/sub-basin and basin, while attempting to address issues of water management across the urban, peri-urban, and rural continuum. Wastewater reuse is a stated objective of many urban administrative and water supply bodies, including the Bengaluru Water Supply and Sewerage Board (BWSSB). Improvements in wastewater treatment infrastructure and supply may enhance the demand for treated water in urban centres. This, in turn, will deprive the peri-urban and rural users downstream of irrigation water. In the case of Bengaluru, wastewater reuse in the city will considerably reduce the flows in Vrishabhavathy, affecting agriculture, and thereby livelihoods, of farmers in the command area of the Byramangala reservoir. Reduced flows would also mean increased concentration of contaminants, aggravating health risk. Wastewater reuse upstream becomes especially complex when inter-state commitments and political interests are involved as in the case of Bengaluru. Vrishabhavathy is fed mostly by return flows of Cauvery supply, and in the event of massive recycling upstream, and reduced flows, Bengaluru may not be able to meet the obligations under the inter-state Cauvery Water Disputes Tribunal (CWDT).

Third, there are several institutional challenges to be addressed if wastewater reuse is to become a viable option for the future. Facilities for wastewater treatment in cities and newly emerging urban areas are grossly inadequate compared to the quantum of wastewater generated. There is often no separation between domestic and industrial wastewater and both get mixed as in the case of the Byramangala reservoir in the Vrishabhavathy stream. Cities are home to numerous small-scale industrial units, several of which do not end up in the official lists of pollution control agencies. Even when they do, it is not economically feasible for them to set up an in-house pollution control infrastructure. The idea of Common Effluent Treatment Plants (CETPs) initiated to address this problem has met with limited uptake. Wastewater irrigation would be viable only when cities are able to separate industrial effluents that cause health hazards, from sewage, which has potential benefits in irrigation.

Further reading

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