Urban Canals and Peri-urban Agrarian Institutions

A Study of Budhera Village in Gurgaon

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The metabolisation of water to serve urban consumption through drinking and waste water canals is an important yet understudied aspect of urbanisation in Indian cities. The empirical evidence from fieldwork in Budhera village in peri-urban Gurgaon suggests that the surface water that flows in the canal systems is open to seepage, theft, waste water irrigation, and these processes have a profound impact on agricultural livelihoods in the vicinity. The structure of the canals in relation to the geographic conditions of land, social relations and technologies create differentiated risks and opportunities for farmers and produce complex distributional impacts that are unplanned and arbitrary. This article looks at different types of conflicts that emerge in this context while also focusing on new norms, institutions and practices that support the changing rural–urban flows of water and prevent conflicts of interest from emerging into outright conflicts.

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There is growing interest among peri-urban scholars on aspects of peri-urban water security; but relatively little is known about aspects of conflicts and cooperation around water resources in these contexts. Likewise, while there is growing interest on aspects of waste water use in peri-urban agriculture, little is known about the day-to-day dynamics and practices surrounding its use, including the role of different normative systems in shaping access to water. This article seeks to illustrate and discuss the context of a peri-urban village where socio-spatial transformations associated with the material and ecological footprints of the urban metropolis produce a distinct waterscape fraught with multiple claims and contestations. Budhera village in the periphery of Gurgaon city, is the site of various networked infrastructures that mediate resource flows and serve the urban metabolism of a growing city; this takes the form of the building of drinking water canals to carry water for the city's needs, a water treatment plant, a waste water canal and high tension power lines. Budhera is one among several villages that are conduits to networks of water and power feeding the city and the impact of the physical infrastructures on its predominantly agrarian economy is unplanned, arbitrary and significant. While the convergence of multiple urban metabolic infrastructures in Budhera make it an especially empirically rich peri-urban site for studying their impact, specific concerns and issues emerging in Budhera are shared across a large group of conduit villages that may only host a single urban drinking/waste water canal.

The locus of the study is around three canals, two drinking water and one sewage canals that pass through Budhera. These canals can be seen as physical manifestations of the flows of water between the rural and the urban. The raison d'etre for building these canals is to transfer drinking water and sewage water in and out of the city. Other unintended aspects of their utility in terms of direct irrigation, groundwater recharge, and occasional water theft operate within the proverbial backwaters of development, without active state action or regulation save the policing of drinking water flows and maintenance and clean-up of the canal structure. The absence of government here does not imply a corresponding absence of governance, as community norms and institutions provide a firm basis for cooperation in the sharing of water. The analysis of irrigation institutions and dynamics along these canals add new and valuable insights to the social irrigation literature, different from the head–tail dynamic, water user associations and management systems characteristic of traditional irrigation canals.

These canals constructed at different times traverse a landscape of varied topography and soil profiles within Budhera, and create new geographies of land productivity in comparison to what was before. While they are readily considered as a socially useful technology by the bureaucracy and policymakers who built them, their impact can be destructive to farmlands in certain stretches, from seepage or breaches, and they have profound secondary level impacts found in new institutions and cropping patterns developing in their wake, which may or may not leave farmers worse off. This article looks at the patterns of social interaction around these canals, to uncover emerging forms of conflict and cooperation.

Conceptual Framework

The mainstream literature on canal irrigation in India has traditionally been rural-centred, and has been confined to only canals specifically built to serve agriculture. The primary debates and shifts in focus have been around issues of participatory irrigation management (PIM), irrigation reforms and water pricing. The sites for research have generally been the large-scale, bureaucratically managed canal systems for agriculture (see Wade 1979; Mollinga 2003; Narain 2003 among others). In contrast, the dynamics of the canals that are built to transfer waste water from cities and provide drinking water remain a black box and we know little about the interface with their users, particularly peri-urban residents who often happen to be indirect or unintended users of these flows of water.

Inquiring into the impact of these canals on the peri-urban waterscape opens up new inroads and intersections with several important literatures concerning the geography of water marginalisation and urban metabolism, and we incorporate only some of these in our theoretical framework to give space to our empirical findings. The key literatures we engage with are the conflict and cooperation over natural resources literature and the urban political ecology (UPE) literature. That urban canal infrastructures as mediators of urban metabolism in the peri-urban could serve in the future as fertile research sites for theorising on peripherality, techniques of rule and place-making, is a prospect which excites us considerably.

The absence of state regulation push matters of management and sharing of canal water flows centrally into the realm of social negotiation and community institutions. Norms of cooperation develop to support mostly the legal (waste water canal flows, pumping water from land around the canals) and sometimes the illegal (drinking water canal theft) diversion of water from the canals. The existing practices around norms of water access are shot through with subtle exclusions and antagonisms, and together with the differential impact of the canals on different farmers, produce various overt and covert conflicts. We use a broadened definition of conflict to incorporate conflict of interests along with the traditional definition of conflict as quarrels or confrontation. Conflict of interests may or may not lead to confrontations, dependent upon the existing configurations of institutions and norms governing resource access (Bavinck et al 2014).

In formulating infrastructure as an "ethnographically graspable manifestation," Rodgers and O'Neill (2012) give importance to studying how relations of power or conflict play out concretely at the level of everyday practice. The emphasis on mundane everyday engagements with infrastructure is also emerging as an important theme within urban political ecology scholarship (Loftus 2012; Radonic and Kelly-Richards 2015). In line with this literature, we emphasise that Budhera's waterscape has been transformed not only through the state's action of constructing the canals but also through the everyday practices of accessing water that have developed in the wake of the canals. The specific physical structure of the canals in Budhera in relation to surrounding land topography and soil texture, land tenure systems and everyday practices of accessing water are central axes which

> shape the differentiated micro-geographies and temporalities of increased access on the one hand and deprivation on the other, as well as the spatial and temporal contours of conflicts. (Desai and Sanghvi 2017: 56)

As sociotechnical systems, networked infrastructures produce contingent and complex outcomes in their interrelation with natural environment and social practices. Jochen Monstadt (2009: 1933) mentions this empirically understudied dynamic when he states: "Networked infrastructures are material mediators which use natural resources and produce both intended infrastructural services and an unintended second nature by their emissions, waste and land-use." The canal systems are implicated in the production of a particular socio-nature where the physical characteristics of nature that are relevant to social practices in the villages have been reconstituted in intentional and unintentional ways. The transformed waterscape in context of the canals is unambiguously power-laden, which is not as apparent at the scale of everyday interactions between peri-urban farmers, but much more visible and violent in relation to the city's footprint upon the peri-urban. The flows embody a narrative of marginality in the power relation of the city upon its periphery, evidenced in the political ecological transformation of Budhera, the city's hinterland in the service of the city (Swyngedouw 1997). The subfield of urban political ecology has brought the flow of water into focus, as "metabolisms" and "circulations" in the urban environment are probed for their mobilisation within the existing social relations, designed such that surplus values produced by them go to certain social classes (Zimmer 2010; Smith 2010; Heynen 2006; Swyngedouw 2006). The circulation of water then produces not only a physical geography and a material landscape, but also a symbolic and cultural landscape of power (Swyngedouw 1996: 76).

Methodology

The study is a product of field visits carried out in 2015 and 2016 over seven months. The fieldwork involved semi-structured interviews with a variety of actors consisting mainly of farmers, agricultural labourers and herders in and around Budhera, as well as other key informants as members of the irrigation bureaucracy. Whenever possible, the interviews of farmers and bureaucrats were made at their site of work along the canals, outlets and watercourses, so as to make observations on practices and strategies employed by farmers, interaction

among farmers around water and the interface of farmers with irrigation bureaucracy.

The research involved the study of conflict in a setting without violent confrontation over water or even much overt quarrels or disputes. Differentiating conflict and conflicts of interest becomes an important distinction to which the fieldwork had to be sensitive to. In Hindi (the language in which interviews were conducted), the simple translation of conflict comes to be the word *jhagda* which implies only overt confrontation or quarrels. Thus, the word jhagda denotes an open confrontation, which could be physical, verbal or both. In Budhera, to ask directly if there is any jhagda in the village regarding water or farming would be to invite a defensive no, and the explanation "Humaare gaon ke log shaant hain aur jhagda nahi karte" (people in our village are peaceful and do not get into conflicts). Instead a more nuanced word, *tanaav* (tension) was often used, appropriate to invoke passive conflicts of interest rather than the single event of a quarrel. The word tanaav denotes a feeling of constant mental stress or tension between two or more people that may not necessarily erupt into conflicts.

In studying conflict and cooperation, technologies of irrigation like the design of canal structures and physical manifestations as outlets, tube wells, submersibles and pipelines were the focus of attention. The prevailing literature on irrigation management is often critiqued for its limited treatment of technology as a black box without referring to how it is shaped and in turn shapes social and institutional relations (see, for instance, Narain 2004; also see Kloezen and Mollinga 1992; Mollinga and Bolding 1996 for the discourse on the social construction of irrigation technology). Here, the sociotechnical approach refers to these technologies as important determinants of access to water and not "neutral" in terms of social relations and practices that shape this access. An understanding of the sociotechnical regime is thus developed which refers to the mix of technologies and institutions through which peri-urban farmers negotiate access to water and adapt to environmental conditions and scarcity.

Setting

Budhera is located in Gurgaon district in Haryana that has traditionally been India's food basket. Starting from the 1980s, Gurgaon has witnessed rapid growth and land use change, transforming what was once a sleepy village on the periphery of Delhi into a modern city. Land has been acquired by the state and by private real estate developers to build high-rise residential buildings, shopping malls and recreation centres, as well as to provide infrastructure to support urban growth. Several multinationals and corporate giants have their offices and headquarters located in the city.

Our research site, Budhera, is about 14 kilometre (km) away from the city centre. However it is less than 5 km away from Dhankot, a village which can be considered the periphery of the built-up city with high-rise apartment towers and malls under construction. The broad area in which Budhera is located is widely touted to become the new Gurgaon with an important highway connecting to Delhi under construction, the site of a nationally important medical institute, and the location of a huge special economic zone (SEZ) of 25,000 acres announced in 2005, plans for which have been scrapped because of farmers' protest over the land acquisition. Even then around 2,500 acres of land already acquired for the SEZ, some of it belonging to Budhera, are still under possession of the Haryana State Industrial and Infrastructure Development Corporation (HSIIDC) and the area is earmarked to be developed as a Global City under the proposed Delhi–Mumbai Industrial Corridor Project. As such, all the usual suspects of imminent urbanisation are here—high land prices, farmhouses for city residents, medical and engineering colleges, mushrooming of property dealers, commercial growth, etc.

The village's population consists of around 900 households, about half of whom belong to the lower-caste "Dalit" community. The rest of the households belong majorly to the Pundit, Yadav and Rajput castes. The landholdings with Dalit households are generally small or marginal, and there is a large group of landless villagers among them. Even among the landowning Pundit and Yadav communities, there are very few large landowners with holdings of over 10 acres. The reason for small landholdings is not only the intergenerational fragmentation of property, but also from the rampant sale of land around 2002 to the SEZ project coming up under Reliance Industries and the HSIIDC. The circle rate for an acre in Budhera currently is ₹10 million and the market rate even higher, reflecting an enormous growth in land prices between 2002 and now.

Unwanted Infrastructure in Budhera

While the village's economy has been bolstered by this rise in land value, increase in non-farm employment and demand for rented housing for a growing class of migrant workers commuting to Gurgaon and industrial Manesar for employment, urbanisation is very much a mixed blessing for villagers here. A by-product of Gurgaon's urbanisation has been the construction of many utilities infrastructure that service the city in peri-urban Budhera. The first instance of an urban service infrastructure through Budhera was the construction of the Najafgarh Drain in 1974 at the northern edge of the village, which services Delhi instead of Gurgaon. The construction of the Gurgaon Water Supply (GWS) canal in 1992 was then the next major infrastructure that has great implication for farming in Budhera though it is not an irrigation canal. This process intensified thereafter especially in the 2000s with the construction of the NCR canal, the Gurgaon–Jhajjar Sewage canal, the Chandu–Budhera water treatment plant (WTP) and the laying of power lines and towers en route to the Daulatabad substation in Gurgaon.

The different utilities infrastructures located in the village have an obvious direct consequence: they occupy land. The lands for these canals and the WTP were acquired while the Land Acquisition Act, 1894 was in force which did not require the landowner's consent for the acquisition of land for "public purposes" under the principle of Eminent Domain. Often that is the extent of their "intended" impact on Budhera, as their location near or through the village is only coincidental. The

planning process and the bureaucracies only take account of the exigencies of the land acquisition process and the deprivation of access to land occupied by the project as the sole impact upon Budhera and its villagers. Where the infrastructures have acknowledged secondary impacts, as seepage and groundwater recharge in the area around the NCR and GWS canals, bureaucrats (here, the irrigation department) have an overwhelmingly positive view of these effects as collateral benefits to villagers from the project. It is not standard practice to conduct thorough and location-specific assessments of the projects.

The research finds out then that the actual impact of these infrastructures upon Budhera's agricultural economy soon transpires into the realm of the indirect and the unintended, outside of the regulation and often knowledge of the state. Because the infrastructures are located in geographical proximity to one another, some impacts of an infrastructure can be seen as cumulative to that of another infrastructure around it. It is within the exploration of these indirect, unintended and cumulative impacts then that a picture emerges of a radically altered agricultural geography and an erosion of peasant livelihoods. The reliance on non-farm economy and the increasing employment of youth in the city are then not seen as merely additional income flowing from the city into Budhera's agricultural economy, but rather as a lifeline income for many small farmers and landless labourers who have to contend with the devastation of agriculture in the village in recent years.

Impact of Drinking Water Channels upon Agriculture

The major area of Budhera's farmlands locally known as the jungle for the scrub forest it once was with nilgai and jackal being the major fauna, is largely a place of *kadwa* (bitter) groundwater that is not suitable for cultivation. East and south-west of the jungle, however, the topography and soil texture changes drastically, as one would find great stretches of high sand dunes known as the *tibba* lands. In earlier years, when agriculture was mostly rain-fed, chana (chickpeas) used to be the major crop, along with wheat and bajra (pearl millet). The major source of irrigation used to be from the tibba lands which had porous sandy soil and sweet groundwater. The tibbas themselves were cultivated for vegetables like tori (ridged gourd) and *matar* (peas). The irrigation cannot be done by merely digging channels so that the water flows evenly to the crops because the soil is very porous, and so the labour required to irrigate is much higher. The tibbas were very important to the agricultural economy of Budhera, till the construction of the GWS canal in 1992 and later the NCR canal in 2002.

The GWS canal is a brick-lined canal that takes drinking water from Yamuna distributary in Kakroi village of Sonipat district to the Basai water treatment plant in Gurgaon over 71 km, and flows through Budhera near its tail-end. The GWS canal was unable to handle the water demand for growing Gurgaon, and so in 2002 the NCR canal was built as a concrete-lined canal of greater capacity along broadly the same route as the GWS drawing drinking water from Kakroi village. The NCR canal's tail-end is at Budhera itself in the Chandu–Budhera WTP. While the GWS and the NCR canals diverge and have different routes upstream towards Kakroi, they flow parallel and adjacent to each other at Budhera.

Groundwater recharge from seepage is one of the secondary intended effects of the GWS and the NCR canals. It is "intended" to the extent that the state (according to the bureaucrats in the planning process) assumes that groundwater recharge is a universally desirable aspect and adds an indirect irrigation benefit to a drinking water canal. For most parts of the NCR and GWS canals, these benefits are real. Farmers have installed tube wells around the canals, and use this high groundwater area as a source of irrigation, drawing underground pipelines for as long as 2 km. The state itself shares a symbiotic relationship with these farmers. For a large part of the downstream-half of the NCR canal, including Budhera, the water table of the land around it is very high (at 10 to 12 feet) from continued seepage. This groundwater height known as natural surface level (NSL) creates great pressure on the concrete lining of the NCR canal. To regulate the pressure, the NCR canal has pressure relief valves (PRVs) installed at every 10 feet to allow the groundwater one-way into the canal. This mechanism is not enough, and the state is dependant on the farmers to bring the water table down by pumping water from around the canals. Thus, while these tube wells perform an important function for the farmers, there are also incidental benefits to the integrity of the canal infrastructure.

The bureaucrats are partially right in construing the benefits of the NCR and the GWS canals to water availability and agriculture in the region. However, this view smacks of a singular homogenising state vision rejecting the diversity of outcomes across different locations and scales that is more common to any intervention. This is in a sense aptly represented in a model drawing of the NCR canal with engineering measurements at the superintendent engineer's office in the Gurgaon irrigation department. The drawing showed the NCR canal as a dug canal, with higher elevation land on both sides overgrown with wheat crop. The conception ignores the full reality of the canal which is bunded and raised above the low-lying adjacent fields for about 9 km at its tail end. The topographic gradient of surrounding lands is significant to the extent of seepage from the canals, and to the consequent benefit or loss to agriculture. In Budhera, where for the most part the canals (GWS and NCR) flow around low-lying lands, severe seepage has raised the groundwater table in nearby lands to a depth of just four feet. The high water table has made lands of up to five acres on either side of the canals uncultivable, belying the image of verdant wheat fields besides the canals. Since the NCR and the GWS flow parallel and adjacent to each other in this stretch, the seepage is a cumulative impact from both canals. The major seepage, according to irrigation officials, is from the older GWS canal, which is brick-lined and in need of repairs, though the newer concrete-lined NCR canal is also prone to seepage of more than 10% of its total output.

The compensation mechanism for the loss to farmers in lands adjoining the GWS and the NCR canals is broken. Instead of a lump sum compensation, farmers are only allowed to

claim the value of crops lost in a year and they have to do it every year. The final compensation comes to just about ₹8,000 a year per acre or less, which is exceeded by the transaction costs involved in dealing with the extensive red tape of the operation and the long delay expected in getting the actual amount. As such, they avoid the compensation process and in accepting their fate, are hopeful for the acquisition of their fallow lands in some upcoming state project along the canals.

The seepage damage in the surrounding low-lying farmlands constitute only a proximate impact of the drinking water channels upon Budhera's agriculture. The larger impact of the canals is in creating a new geography of water availability in the village, and the consequent revaluation of land and resources. The GWS and then the NCR canal drove out rain-fed crops like chana and low-value millets like jowar as farmers switched to wheat and mustard with greater water availability. The canals also led to the clearing of almost all of the sandy tibba lands in Budhera where diverse vegetables used to be grown. With irrigation water available from pumps near the canal, the value of groundwater recharge by these sandy lands diminished, and combined with the additional pressures of labour shortage to do labour-intensive agriculture in the tibbas, the owners of tibba land felt incentivised to sell off the sand for a profit of ₹20 lakh to ₹25 lakh to an acre for the typically 10 feet sand cover on their lands. After clearing the sand, the owners are left with low-lying loamy soil fields for less labour-intensive cultivation of wheat and rice. Over 90% of the tibba lands comprising hundreds of acres, have been cleared in Budhera in recent years, constituting a major ecological change brought about by the canals.

Water-theft from the Canals

Besides groundwater recharge from which this seepage damage occurs, there are other interfaces by which water in the drinking water canals is made meaningful to agriculture. Something which is very limited in Budhera but highly prevalent in upstream villages along the drinking water channels, is water theft for irrigation. While the waters of both the GWS and the NCR canals are prohibited for irrigation use and junior engineers of the Gurgaon irrigation department go on regular patrols to enforce this prohibition, there is nonetheless widespread water diversion from the canals by farmers into their farms in upstream villages as Badsa (7 km from Budhera).

While there is a provision for *tawan* penalties on farmers, engineers who often do the patrolling do not book the penalty against the farmers who are caught red-handed stealing water. For beginners, they do not have the authority to penalise farmers on the spot. A tawan that is registered is referred to the *patwari* (village revenue official) who uses records of the erring farmer's farm area to estimate water usage, and the penalty for theft is charged according to that, which then is approved by the executive engineer. The collection of tawan is done by the revenue department as arrears of land revenue, but transferred to the irrigation department's accounts. There is a lack of cooperation often between the revenue and irrigation department in this regard. Often the farmers pay off the patwari to understate the cropping area, and thus reduce the penalty. Also the revenue department collects the tawan at a very slow pace or not at all, with many pending. As a result, officers from the irrigation department do not generally file penalty cases. They merely seize or break the pipeline (cheap plastic pipes) used for the theft. As such, there are very few effective restrictions on water theft and the drinking water canals constitute a de facto irrigation channel for many farmers along its course.

Waste Water Irrigation

The Gurgaon–Jhajjar wastewater canal (or the GJC) is the other important canal infrastructure that also incidentally flows through Budhera while having a significant bearing on its agriculture. The GJC represents the urban to rural flow of water taking treated effluent discharge from the Dhanwapur sewage treatment plant in Gurgaon into the Najafgarh Drain (which is the largest surface drain for Delhi and Gurgaon where sewage from over 18 drains, including the GJC discharges into). As a brick-lined canal that intersects the fields of Budhera carrying a pool of stinking black waste water, the major impact of the GJC is not because of seepage into nearby farms, which is very limited even though the canal is raised above the low-lying adjoining fields.

The major impact is from the state-approved but loosely-regulated practice of diverting the waste water for irrigation. The reuse of waste water for irrigation in peri-urban agriculture has become a subject of great interest to city planners, policymakers and researchers for its role in increasing productivity and ensuring food security. Likewise academic literature on the risks and opportunities associated with waste water irrigation is expanding rapidly (IWMI 2003; Raschid-Sally and Jayakody 2009). In Budhera, the diversion of waste water through outlets in the canal usually does not require a motor as the canal is already raised. The use of waste water here gives farmers an abundant perennial irrigation source that saves costs on electricity and also works as a fertiliser input reducing the need for urea and diammonium phosphate by up to 50 kg each per acre.

More than the benefits and disadvantages, however, it is the institutional dynamics surrounding the use of waste water that is interesting in Budhera. The irrigation department during the construction of the canal around 2005 allowed and encouraged farmers to request for personal outlets along the canal (12-inch diameter capped pipes installed near the base of the canal). The state charges a nominal ₹90 per annum as "waste water tax" for use of the outlets, and officials at the sewage treatment plant entertain requests by farmers to open the gates and increase flow to the canal on any specific days of irrigation when there is higher demand. This is, however, the extent of state regulation on the irrigation aspect of the waste water canal as the Jhajjar Irrigation Department in charge of it is concerned only with the maintenance and structural integrity of the canal. There are no formal water user associations (WUAs) or proper listing of beneficiaries of irrigation as is done with other irrigation canals. Even the nominal tax collection has been withdrawn in Budhera in the face of farmer non-cooperation. The irrigation purpose of the GJC thus while tacitly

approved by the state, falls in a "backwaters of development" zone with no active state oversight or intervention.

The Institution of Cooperation Known as *Bhaibandi*

In the absence of any state-backed institution, the regulation of waste water use is taken over by community institutions. The dominant system of sharing waste water is known locally as *bhaibandi*. The outlets in the canal are shared among farmers, many who take the waste water canal along *dhouras* (furrows) to farms located more than a kilometre away. Bhaibandi regulates the operation of these watercourses, their extension and levelling. The word bhaibandi refers to a system of brotherhood, fraternity (the Hindi word *bhai* means brother). The extension of furrows is made through request where a farmer seeking waste water asks the farmer with the closest waste water channel to allow an extension or a sideways breach into his furrow. With many such extensions and diversions, a bhaibandi network in Budhera may stretch to more than a kilometre and serve more than 20 farmers from a single outlet.

As an institution for accessing water, bhaibandi is not regulated by many norms. This is because it determines the sharing of a resource, waste water from Gurgaon that is considered abundantly available in relation to its demand by farmers. Bhaibandi networks are not based upon existing social relations between farmers. Often bhaibandi includes "outsiders" who have purchased land within the village and cultivate land through labourers or sharecropping. The basis of sharing is geographic rather than social.

Cooperation in abundance becomes an easy mechanism and most acts of access in bhaibandi are unregulated. Any farmer in the bhaibandi network is free to open the outlets to the network by removing the stuffed jute bag from under the canal and opening the plastic seal from the other side of the outlet's pipe. Farmers only loosely schedule the opening of outlets among themselves just so as to avoid the irrigation equivalent of a bank run and withdraw waste water from too many outlets at once. Cooperation is also exercised for the maintenance of the dhouras so that obstructions as rocks are removed and a favourable incline is maintained for smooth flow. Once in every one or two years depending on need, the members of a network contribute money according to their share of lands to maintain the furrows.

Seen thus, bhaibandi is an important form of cooperation among farmers. Its loosely regulated nature, however, opens the door for many forms of conflicts, which are rarely overt but mostly in form of invisible conflict of interests.[1] To understand these conflicts, one first needs to look at the damages and by-products of waste water use in Budhera.

By-products of Waste Water Irrigation

Most farmers in Budhera are of the opinion that irrigation from the GJC has on balance caused losses for them. Prolonged irrigation from the waste water canal, after two to three years of increased yield has left the soil degraded, saline and less productive. The average productivity of a wheat field under waste water irrigation has now dropped to around 25 *maan* (1,000 kilos) per acre from the earlier 45 maan (1,800 kilos) produced from groundwater. While waste water use should translate to a reduction in fertiliser input, farmers in Budhera grappling with low yields anyway use a lot of fertiliser bringing the input costs almost at par with tube well irrigation. This overuse of fertiliser further deteriorates soil quality in these fields.

The deterioration of soil from the use of waste water came as a shock to many Budhera farmers who had been told that the canal would carry only treated domestic waste water from residential Gurgaon colonies. The damage from the waste water then was caused mainly by an incident that turns the absence of state oversight on irrigation into a case of blatant state apathy. In 2008–09, there was a period of over a year when the canal carrying the chemical discharge of IMT Manesar, a heavily industrialised part of Gurgaon, was routed into the GJC. This was done without any intimation or discussion with farmers using the canal. The heavy chemicals settled into the soil from the waste water and drastically impacted production causing irreversible damage to the soil.

There are other by-products to waste water farming, one of them is increased monocropping in Budhera. Waste water restricts the choice of profitable crops for the farmer to just two—rice and wheat. Other crops of the area, especially mustard, given the soil texture and climate, are badly affected by waste water and are grown exclusively from tube well groundwater.

Another significant by-product is the rejection of self-consumption by the waste water farmer who unloads the entire harvest of wheat or rice at the market. While there is no difference in the physical appearance of grains from waste water or freshwater, farmers state that waste water wheat or rice taste different from the normally irrigated grain, and the cooked food goes stale quickly and tastes bad. So while in the *mandi* (wholesale market for grains), there is no systemic check or measure that depreciates the selling price of cereals produced from waste water, farmers in Budhera buy their own cereals from the market ascertaining that its source village does not use waste water.

Forced Cooperation in Waste Water Use

Given these problems, farmers are increasingly averse to using waste water irrigation in their fields. However, the number of waste water users are growing in Budhera. This contradiction arises because the patterns of farming around waste water leave farmers little agency in making a choice of irrigation.

For existing users, the cost involved in switching to a tube-well for groundwater is not insubstantial as it involves laying pipelines across kilometres of farms and installing/renting a motor which can be prohibitively high. There is a lock-in effect in the arrangements of using waste water.

Waste water irrigation in a field is not limited in its effect on the field alone, but also impactful for the seepage to nearby fields. If it seeps in a significant amount to an adjacent field which uses groundwater for particularly vulnerable crops like mustard, then the waste water can cause much crop damage and lead to low yields. The seepage is determined by factors as topography of neighbouring fields and volume of standing waste water in irrigated fields.

This seepage is particularly acute in the *kharif* paddy cultivation sown in May. Paddy in Budhera is cultivated only through waste water. It requires much more water than wheat and is irrigated four times in the season where the high volume of standing waste water in the field causes significant seepage into nearby fields. This creates a conflict of interest when the neighbouring farmer wishes to produce for self-consumption or produce other crops like bajra. The accepted norm among farmers in Budhera, however, is to allow autonomy in deciding what to grow, provided by the common quote "Meri zameen, mein jo bhi boun" (my field, I can grow whatever I want). This conflict then rarely takes any overt form, and is instead resolved as "forced cooperation" where the neighbouring farmer is compelled to cultivate rice himself using waste water. The members have to defect and use waste water, unless a network of farmers owning geographically contiguous land cooperate and switch together to groundwater. This is explanatory for many farmers having to adopt waste water irrigation. Mutually accepted norms, such as allowing the neighbouring farmer to grow the crop of his choice, prevent a conflict of interest from erupting into a conflict.

Loss of the Commons

A discussion of the impact of canal-infrastructure in Budhera is incomplete without taking note of the Chandu–Budhera WTP, spread over 274 acres. It is built over the site of the village's common grazing land of 90 bigha (18 acres), and so its discussion serves as a useful proxy for highlighting the consequence of the loss of commons upon the livestock economy.

Grazing land acquisition and loss of common property resources are a staple part of the urbanisation processes being seen in many peri-urban locations around India. Budhera traditionally had a large cattle population, and had a hereditary caste-profession of herders taking villager's cows and buffaloes to common lands and empty fields for grazing. Two decades ago, there used to be three groups of herders comprising three or four members each, and each group handled around 200 cows and buffaloes. Now there is only a single such group left. The number of cattle in Budhera has fallen drastically, and that has concurred with the loss of commons and grazing land, some of it to private encroachments by farmers for agriculture and some of it to land acquisition for the WTP.

The WTP grazing ground was closest to the village, and now herders have to take the cattle long distances to the lands near the Najafgarh Drain about 4 km away for grazing. Taking the cattle so far to graze tires them and impacts their milking productivity. On many days, the animals return hungry as they do not find enough grass there. So small cattle owners only send old and infertile cattle to the village herd, and stall feed their dairy cattle. Some large owners who cannot feed all their productive cows and buffaloes pay the village herders for grazing them.

The new routes of grazing also create intermittent low-level conflict between the farmers and the herders. Going to the Najafgarh Drain entails moving the animals through the agricultural lands of Budhera where incidence of stray cattle entering the fields on the way and grazing on standing crops become common. There are frequent exchanges of heated words and warnings then, though the loss to farmers is rarely significant.

In stall-feeding, the burden of bringing fodder from the farms is almost exclusively upon the women of the family. Fodder now has to be brought from the fields near the Najafgarh Drain for which women have to walk 4 km both ways, returning with loads of 30 kilos on their head, a great drudgery for them. This observation is evidence again to highlight that the loss of commons disproportionately affects women (Vij and Narain 2016).

Other Effects

The utility infrastructures have other externalities upon Budhera. A major positive externality has been the provision of better-quality and reliable piped drinking water supply from the Chandu–Budhera WTP, although that concession came long after its promised implementation by HUDA authorities, and only after multiple appeals and applications by the village leaders, and on the heels of the state assembly election according to villagers. Earlier the water supply to Budhera was from a government bore well and water plant, from which domestic water supply from the community pipes would be erratic and of poor quality, with worms often in the water. Now the villagers feel assured in using the same water as the wealthy urban residents of Gurgaon.

There are peculiar and specific problems that arise as well. Budhera is located near to the Sultanpur Bird Sanctuary, a wetland area famous for migratory birds arriving in winter. The great storage tanks of the WTP and the waterlogged wetlands around it have, however, given the birds an alternate site for nesting, with the farms of Budhera ripe for forage nearby. Thousands of these migratory birds now flock to Budhera in winter, attacking the wheat fields and causing significant crop damage. The farmers in turn have to keep regular watch over their fields to protect against these new pests, courtesy of the Chandu–Budhera WTP.

Another specific emerging problem has been dengue fever which every year during the rain months around July to September becomes a public health issue. The year 2015 saw the highest incidence of dengue in Delhi and Gurgaon in 10 years. The dengue virus-carrying *Aedes Aegypti* mosquito breeds in clean, stagnant water. The waterlogged fields from the canals and WTP provide acres of ideal breeding grounds to these mosquitoes. The incidence of dengue reached epidemic standards in Budhera in 2015 where according to estimates from people interviewed, every family had a dengue patient and there were around 10 deaths due to the disease. Most patients were treated in private hospitals in Gurgaon. Thus we see that the canal woes of Budhera residents are compounded with a public health crisis in the village.

Conclusions

Having the growing city arrive at your neighbourhood has multiple implications for peasants who within a few years find themselves as peri-urban residents in a local economy

pulling towards new forms of livelihoods and employment. The transition is marked most significantly in the increase in land values which brings great economic benefits to a small section of well-placed rural elites. But it is also marked by other processes, one of which is the mushrooming of peri-urban infrastructures directing resource flows to the city. These large infrastructural systems, like the canals of Budhera, interact and shape the natural environment around them. They also function as sociotechnical systems that become "embedded into other structures, social arrangements and technologies" (Leigh-Star 1999: 381).

Constructed through the assertion of eminent domain, the canals of Budhera are evidence to the institutional apathy that can be produced by the urgencies of infrastructural deficit for a rapidly growing city. The stakes for farmers in the peri-urban regions from these systems are obscured or absent in the decision-making process for networked infrastructures that concerns itself with the growing needs of the city, not even the city at large but only certain enclaves of upper and middle class citizens living in gated communities connected to this network of water and sewage supply (for work on the growing fragmentation and polarisation in urban water infrastructures, see Gandy 2004). Gurgaon may not draw directly upon the peri-urban water resources of Budhera (see Ruet et al 2007 for such a dynamic in Chennai), but in acting as a conduit and site for the facilitating infrastructure, it very much constitutes the ecological hinterland of Gurgaon and a part of the city's metabolism.

The study of Budhera offers some important lessons that we highlight as some suggestions from our part. The place-specific impacts that networked infrastructures have on peri-urban residents need to be included as factors in their cost–benefit calculus, and institutions of governance in these regions be strengthened to negotiate with the central city and the canal bureaucracy on matters of resource allocations and flows. The waste water canal in Budhera is a de facto irrigation canal with abundant water supply (for now) but also with particular conflict issues. Developing social trust should entail first, the state compensating farmers for the damage to their crops from industrial water discharge into the canal, and second, working out with local participation to constitute a modified WUA that could address the specific context. A formal participative institution could, for example, resolve some collective action problems like the rerouting of farm channels (*dhouras*). Currently dhouras are dug, extended and diverted on an ad hoc basis based on an absolute right of the landowner. Rerouting them with concerns for topography and the neighbouring farm-owner's choice would resolve conflicts of interest and merging adjacent dhouras would reduce maintenance costs. Any intervention, however, should build on the already-existing local norms of cooperation and that is a general policy prescription as well that emerges from our study.

NOTE

1 This is similar to the analysis of *bhaichara*-based water distribution in the protective irrigation systems of North-West India. See Narain (2003). Water is allocated by the state, but distributed among farmers on the basis of their bhaichara (sense of cooperation, fraternity).

REFERENCES

Bavinck, M, L Pellegrini and E Mostert (eds) (2014): *Conflicts over Natural Resources in the Global South: Conceptual Approaches*, CRC Press.

Desai, R and S Sanghvi (2017): "Water and Conflict in Bombay Hotel, Ahmedabad," *Economic & Political Weekly*, 52(7), p 49.

Gandy, M (2004): "Rethinking Urban Metabolism: Water, Space and the Modern City," *City*, Vol 8, pp 363–79.

Heynen, N (2006): "Green Urban Political Ecologies: Toward a Better Understanding of Inner-city Environmental Change," *Environment and Planning*, Vol 38, pp 499–516.

IWMI (2003): "Confronting the Realities of Wastewater Use in Agriculture," *Water Policy Briefing*–9, International Water Management Institute, Colombo, Sri Lanka, 6p.

Kaika, M and E Swyngedouw (2000): "Fetishizing the Modern City: The Phantasmagoria of Urban Technological Networks," *International Journal of Urban and Regional Research*, Vol 24, pp 120–38.

Kloezen, W and P P Mollinga (1992): "Opening Closed Gates: Recognizing the Social Nature of Irrigation Artefacts," J Slabbers and G Diemer (eds), *Irrigators and Engineers*, University of Wageningen, Amsterdam: Thesis, pp 53–64.

Loftus, A (2012): *Everyday Environmentalism: Creating an Urban Political Ecology,* Minneapolis: University of Minnesota Press.

Leigh-Star, S (1999): "The Ethnography of Infrastructure," *American Behavioual Scientist*, Vol 43, pp 377–91.

Mollinga, P P (2003): *On the Waterfront: Water Distribution, Technology and Agrarian Change in a South Indian Canal Irrigation System,* New Delhi: Orient Longman.

Mollinga, P P and A Bolding (1996): "Signposts of Struggle: Pipe Outlets as the Material Interface between Water Users and the State in a Large-scale Irrigation System in South India," *Crops, Peoples and Irrigation*, F P Huibers and G Diemer (eds), London: Intermediate Technology Publications.

Monstadt, J (2009): "Conceptualizing the Political Ecology of Urban Infrastructures: Insights from Technology and Urban Studies," *Environment and Planning*, Vol 41, pp 1924–42.

Narain, V (2003): *Institutions, Technology, and Water Control: Water Users Associations and Irrigation Management Reform in Two Large-scale Systems in India*, New Delhi: Orient Longman.

— (2004): "Brackets and Black Boxes: Research on Water Users' Associations," *Water Policy*, Vol 6, pp 185–96.

Radonic, L and S Kelly-Richards (2015): "Pipes and Praxis: A Methodological Contribution to the Urban Political Ecology of Water," *Journal of Political Ecology*, 22(1), pp 389–409.

Raschid-Sally, L and P Jayakody (2009): "Drivers and Characteristics of Wastewater Agriculture in Developing Countries: Results from a Global Assessment," *IWMI Research Report-127,* Colombo, Srilanka, p 35.

Rodgers, D and B O'Neill (2012): "Infrastructural Violence: Introduction to the Special Issue," *Ethnography*, 13(4), pp 401–12.

Roy, A (2009): "Why India Cannot Plan Its Cities: Informality, Insurgence and the Idiom of Urbanization," *Planning Theory,* 8 (1), pp 76–87.

Ruet, J, M Gambiez and E Lancour (2007): "Private Appropriation of Resource: Impact of Peri-urban Farmers Selling Water to Chennai Metropolitan Water Board," *Cities*, Vol 24, pp 110–21.

Smith, N (2010): *Uneven Development: Nature, Capital, and the Production of Space*, University of Georgia Press.

Swyngedouw, E (1996): "The City as a Hybrid: On Nature, Society and Cyborg Urbanization," *Capitalism Nature Socialism*, Vol 7, pp 65–80.

— (1997): "Power, Nature, and the City, the Conquest of Water and the Political Ecology of Urbanization in Guayaquil, Ecuador: 1880–1990," *Environment and Planning*, Vol 29, pp 311–32.

— (2006): "Metabolic Urbanization: The Making of Cyborg Cities," *In the Nature of Cities: Urban Political Ecology and the Politics of Urban Metabolism*, M Kaika, N Heynen and E Swyngedouw (eds), London–New York: Routledge.

Vij, S and V Narain (2016): "Land, Water & Power: The Demise of Common Property Resources in Periurban Gurgaon, India," *Land Use Policy*, Vol 50, pp 59–66.

Wade, R (1979): "The Social Response to Irrigation: An Indian Case Study," *The Journal of Development Studies*, Vol 16, pp 3–26.

Zimmer, A (2010): "Urban Political Ecology: Theoretical Concepts, Challenges, and Suggested Future Directions," *Erdkunde*, pp 343–54.

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