

Chapter 6

Changing Agriculture and Climate Variability in Peri-Urban Gurugram, India



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6.1 Introduction

A recent essay on climate change adaptation (CCA) mentions an instance of urban flooding that highlights the stakes of uneven climate protection regimes (Yarina, 2018). In the 2011 flooding of the Chao Phraya delta in Thailand that killed over 800 people, the King's dyke protecting the Bangkok metropolitan area kept the capital dry, while the displaced floodwaters made conditions in peripheral districts worse. Protesting inhabitants from these districts descended on the protected areas, opening the floodgates and tearing holes in the sandbag walls, while the prime minister counselled them to think of the national good. If the city centre flooded, she said, it would cause "foreigners to lose confidence in us and wonder why we cannot save our own capital" (Yarina, 2018, p. 1). The example asks us to urgently and critically consider the way our cities are constructed: city peripheries or peri-urban spaces often exist in an exploitative relationship with the urban, and this inequity could be further exacerbated by the effects of climate change and climate change adaptation (CCA) policies.

In India, a new wave of farmers' movements has taken centre stage, as thousands of farmers marching on cities have captured the public attention and forced us to acknowledge what should have been apparent from the epidemic proportions of farmer suicides every year: that there is a deep structural crisis in Indian agriculture. Yadav (2017) states that the crisis is three-fold: economic, ecological and existential. The economic crisis comprises the volatility of market prices, the stagnation of

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farmer incomes and a lack of capital for modernization. The ecological crisis in Indian agriculture is deeply associated with the after-effects of the Green Revolution: the insatiable treadmill of higher fertilizer, pesticide use and deeper borewells, rising incidence of cancer from pesticide use, and the metaphorical cancer of indebtedness of farmers, swiftly progressing from being manageable to becoming debilitating. These two crises culminate in the existential crisis of Indian agriculture, marked by farmer suicides, distress migration out of farming, and the unravelling of agrarian futures from climate change impacts.

This chapter locates the changing dynamics of agriculture at a frontier where a geographically specific articulation of this crisis comes to the fore: in the peri-urban villages bordering Gurugram City.¹ These villages are still largely agrarian but undergoing rapid and radical changes. A major characteristic of peri-urbanization are the land and water use changes caused by urbanization, such as the speculative buying of farmlands and their transformation into other (non-agricultural; e.g. services, industry) uses, construction of farmhouses, and the siting of canals and water and sewage treatment plants that service the city. In this chapter, the peri-urban areas are understood as dynamic spaces emerging due to rapid urbanization, where agricultural land and water uses are continuously changing and the underlying social, economic, political and institutional systems are in a state of flux (Vij et al., 2018). The core emphasis of our research is to investigate the double exposure of Gurugram's peri-urban space to both urbanization and impacts of climate variability upon peri-urban agriculture. Our chapter looks particularly at how this spatial inequality plays out in peri-urban Gurugram and how climate variability is gradually unfolding and culminating into differential impacts for peri-urban agriculture. Climate variability is primarily represented here by the unpredictability in rainfall patterns, which is increasingly affecting farming and related livelihood activities.

The remainder of this chapter is divided into three sections. In Sect. 6.2 we explain why the peri-urban should be considered a relevant object for analysis. Most analyses of climate change and vulnerability tend to select either rural or urban contexts (Narain & Prakash, 2016, p. 2). We take forward the emerging research agenda of focusing on a peri-urban context of vulnerability and CCA that puts climate change in conversation with the urbanization literature. It details the specific socio-natures produced in peri-urban spaces that villagers, especially farmers, must contend with (Vij et al., 2018). Section 6.3 presents the key findings, explaining the effects of climate change upon peri-urban agriculture. Section 6.4 wraps up the arguments, provides some policy recommendations, and sketches priorities for future research.

6.2 Researching the Peri-Urban

Peri-urban spaces fall within the gap between the urban and rural CCA literature, which emphasise built environments or agrarian systems respectively. The peri-urban, as a space where rural and urban land uses co-exist (Bowyer-Bower, 2006)

¹Gurugram was called Gurgaon until 2016.

or, more broadly, as processes of transition between rural and urban with adverse environmental impacts (Allen, 2003; Narain & Nischal, 2007; Vij et al., 2018), raises specific questions related to its transitional characteristics. There is a growing interest to understand the peri-urban analytically, as a dynamic space where adaptive strategies and mediating institutions are couched within logics of incipient urbanization or the co-existence of agrarian and urban features in a rapidly changing landscape. We consider peri-urban spaces as a relevant analytical category for two reasons.

Firstly, peri-urban spaces exist not only at a spatial intersection between the rural and urban, but also at a temporal intersection of the anticipation of urbanization, where the future might be radically unmoored from exigencies of the present, and its extended present, rocked by the currents of the Indian agrarian crisis. As peri-urban spaces are in a state of institutional flux, CCA measures may be extremely difficult to realize there. This is because planned CCA measures are generally implemented by the state (Preston et al., 2011). Peri-urban challenges are hardly recognized in policy circles and, moreover, the peri-urban is currently missing or not prioritized in newer policy domains such as climate policy (Marshall et al., 2009; Roth et al., 2019; Vij, 2019). As CCA focuses on different temporal (short, intermediary and long-term) and spatial (rural, urban, coastal) scales, the institutional flux in peri-urban spaces makes it challenging to fit the peri-urban into a policy framework and to implement that on the ground (Eakin et al., 2010). Further, the state follows a conventional sectoral and structural interpretation of climate impacts, mostly governed by its agencies responsible for water and agriculture. The current system does not take into account the specific impacts of climate change in peri-urban areas and has limited understanding of the ways to address the role of urbanization in these spaces, which creates a policy and institutional gap (Allen, 2003).

Peri-urban spaces mark sites where the material production of the urban is most intensely pursued as well as contested by various state and non-state actors. Peri-urban developments have often been executed by conceiving of these areas as *tabula rasa* or “blank slate”, upon which the financial and political might of the city can enact its vision of urban expansion, literally bulldozing over local agrarian histories and meanings of place. In looking at “ordered” spaces of global capital created in the periphery, Ong (2006, p. 19) remarks that “nowhere are logics of [...] spatial purification more readily deployed than in the creation of new urban spaces of intensified neo-liberal exceptions on the urban periphery”. “Spaces of exception”, like Special Economic Zones or large public and private projects (airports, universities, IT parks), often pushed through without social or environmental auditing or proper democratic processes, are usually located at the peri-urban fringe of major cities, and positioned as modernization and development.

The peri-urban is important in relation to the ongoing urbanization of spaces and therefore for low-income migrant workers who prefer to live in close proximity to their work sites (Kundu, 2009; SELCO Foundation, 2016). The regulation of land use is more relaxed than in urban areas, so migrants find it easier to reside here (Sridhar, 2010). Peri-urban areas, then, become an important hub for migration of people out of rural areas for work. Physical migration, both seasonal and

permanent, from rural areas has intensified in India in the last two decades. Most migration into urban areas is not a move into the modern sector: 94% of rural-urban migrants enter the informal sector, 60% of which are in the self-employment category (Murthy, 2013). In other words, workers end up in the urban informal sector as low-wage workers or self-employed self-exploiting petty commodity producers (ibid.). This migration is a symptom of the shedding of labour from the agrarian sector into urban manufacturing and service sector jobs, often with no better prospects. Much of this migration is forced, and results from the inability of wage workers to survive on smallholdings in agriculture (Colatei & Harriss-White, 2004). In the context of the agrarian crisis, Dipankar Gupta (2005, p. 757) scathingly writes:

Agriculture is an economic residue that generously accommodates non-achievers resigned to a life of sad satisfaction. The villager is as bloodless as the rural economy is lifeless. From rich to poor, the trend is to leave the village [...] The town is not coming to the country, as much as the country is reaching out to the town.

Migration between the village and the city in India has become a highly unequal, spatially uneven relationship, determined and restructured by the general situation of agrarian crisis. This crisis, which is ubiquitous in Indian agriculture, is reproduced and intensified in peri-urban villages as well, but constituted through several contingent factors operative on local, regional, national and global scales. Metabolic geographies of peri-urban areas, as we present in this chapter, are the product of this context of agrarian decline in ways not immediately apparent: the devalorisation of farming and the cynical outlook on agrarian futures among farmers emerge from this distress and influence possible futures and CCA strategies in the peri-urban space, where greater affinity towards the city is the norm.

The second important reason for taking the peri-urban as an analytical category concerns the rich insights it offers us in relation to processes of urban metabolism. The burgeoning field of Urban Political Ecology (UPE) has provided rich insights in how cities are constructed out of the flows of urbanized nature and has done much to articulate the spatially distanced injustice engendered in flows that place the richest areas and citizens in an exploitative relation with the poorest (see Furlong & Kooy, 2017; Ranganathan & Balazs, 2015; Swyngedouw, 1997). The peri-urban is an active yet under-studied site of urban metabolism. It has long been the bearer of infrastructures for the urban that, for environmental and economic reasons, are relocated there. Usually these infrastructures, which service the city's needs (metabolic or otherwise), produce few benefits to their peri-urban surroundings. In his historical study of Delhi, Sharan (2014, p. 18) mentions how infrastructures and industries that were seen as "nuisance" or "noxious" were moved outside the urban area by both colonial and post-colonial administrators. In this chapter, we focus on metabolic infrastructures, specifically canals, that have been constructed in or through the peri-urban, on the basis of similar logics of outsourcing from the city into devalored space.

These relations of producing the urban and of serving urban metabolic needs by being sites and conduits for urban infrastructure make the peri-urban a productive analytical lens for thinking through urbanization, also in relation to climate change

and CCA. We see the term “peri-urban” as complementary to a range of concepts, categories and analytical lenses that help us better understand the framings and spatial scales at which different processes can be addressed.

6.3 Context and Methodology

6.3.1 Budhera

The authors conducted their research in Budhera, a village on the outskirts of Gurugram city (see Fig. 6.1). The concentration of urban-oriented metabolic infrastructures predominates, thus putting the stamp of urbanization upon it. Although it is also rapidly urbanizing in other respects, Budhera’s peri-urbanity could be considered synonymous with being saturated with the markers of urban metabolism. The village is a site to two drinking water canals, one wastewater canal, and a large water treatment plant, besides being bordered by the Delhi region’s most important sewage channel, the Najafgarh drain, and criss-crossed by multiple high-voltage power lines. Budhera’s landscape is marked throughout by infrastructures that service urban metabolism. The village landscape is a mix of agricultural farmland, urban-support infrastructure and farm-houses of the urban elite. The villagers

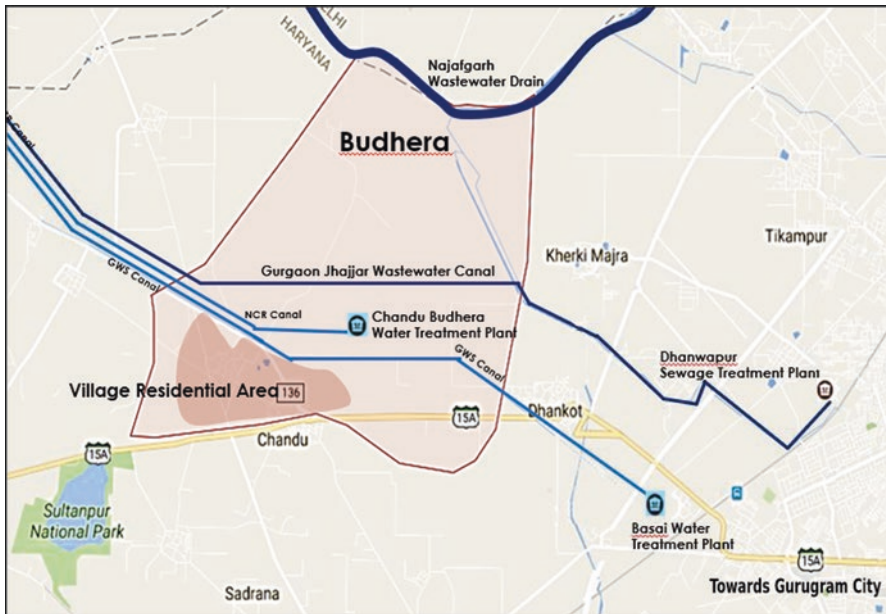


Fig. 6.1 Map of Budhera and its surroundings, marking the canals and the water treatment plant. (Source: authors, using Google maps)

maintain close ties with the city of Gurugram for their consumption, education and medical needs, through jobs in the urban economy and for marketing of their agricultural produce.

Since the economic reforms of 1991, the state government of Haryana has harnessed the growth potential of Gurugram. Its population stood at 1.5 million in 2011, against 0.8 million in 2001 (Census, 2001, 2011).

The rapid growth of Gurugram is due to its proximity to Delhi and the domestic and international airport, and to the policies pursued by the state government to attract multi-national companies and real estate business (Narain, 2014; Vij et al., 2018; Vij & Narain, 2016). The rapid growth of the city that has in the past subsumed other peripheral villages in its urban spread, provides the backdrop to a state of anticipatory urbanization in Budhera. Anticipatory knowledge on urbanization draws attention to a possible future and reflects on responsive measures for the present by peri-urban residents (White, 2016). Villagers expect high-rise buildings and shopping malls to arrive at their doorstep within the coming decade, rendering obsolete their age-old occupation of farming. This anticipation was expressed by a farmer stating that “in four years, I will sell this land to a builder, get a flat and open a grocery shop in the area, sitting on a chair all day with no more work to do”.

This chapter is based on qualitative research by each of the authors. Both authors followed a case study design, mostly using semi-structured interviews but also methods of participant observation, transect walks and focus group discussions. An empirico-inductive framework was used so as to be reflexive to issues and findings coming from the field and theorize in ways “grounded” in the qualitative data (Charmaz, 2006). Analytical sampling was employed so that respondents were selected on the basis of their relevance to on-going analysis. The first study was done between August and December 2012, and the other between January and November 2015. A total of 84 interviews were conducted during the two rounds of fieldwork. Selection of interview respondents is based on the premise of methodological pragmatism (Johnson & Onwuegbuzie, 2004), following a snowball sampling technique.

6.3.2 Climate Change in Peri-Urban Spaces

Before presenting the findings, we discuss major insights from the literature relating to climate change vulnerability and CCA in peri-urban spaces, still relatively scarce compared to the well-established scientific attention to the global dimensions of environmental change. In the twenty-first century, peri-urban spaces are growing at four times the rate of urban areas and will therefore remain a prominent planning challenge (Piorr, 2011). The published and grey literature has highlighted the challenges of peri-urban agriculture in urbanizing regions, largely focusing on agriculture from the perspective of livelihoods, poverty reduction and ecosystem services. However, little attention has been paid to explaining the interlinkages between

socio-economic and political changes, the vulnerabilities of marginalized communities and climate change variability (Lwasa et al., 2014). Much literature focuses on formal policies and interventions, in which state and non-state actors are tasked to implement National Adaptation Programmes of Action (NAPAs²), National Adaptation Plans (NAPs³) and other climate policies through stronger local investment and action in developing countries. However, relatively little attention is paid to the new organizational and institutional arrangements developing locally in day-to-day social interactions and practices.

Further, peri-urban populations disproportionately receive the negative externalities of urban growth and changing climate without the associated benefits of services and assets (Allen, 2003; Allen et al., 2017). With these challenges in peri-urban spaces, CCA strategies are necessary. CCA scholars argue that there are barriers to CCA, especially social, economic and political ones. Moreover, peri-urban impacts of climate change are not clearly explained with reference to the lack of institutional capacities and uncertain knowledge of climate change in peri-urban spaces. This can be partly linked to the lack of popularity of the concept of the peri-urban in the literature and its complexity in terms of spatial dynamics. The peri-urban can rather be seen as a new kind of highly dynamic and multi-functional territory, where there is inadequate spatial governance (Ravetz et al., 2013).

With rapid urbanization, there is an increase in public and private encroachment of common pool resources (CPRs) such as rainwater harvesting structures and cumulative variability in rainfall and temperature is reducing the dependency of communities on CPRs (Vij & Narain, 2016). Ranjan and Narain (2012) note that peri-urban residents suggest that decreasing rainfall is the cause of reduced dependence on traditional rainwater harvesting structures in peri-urban Gurgaon. With very little water in these structures, the investments needed to maintain these structures are a challenge. Such CPRs in peri-urban spaces were traditionally utilized to support earthen dams and infiltration ponds on hill slopes to slow down runoff and possible flooding. Further, the rainwater harvesting structures were also providing water for year-round production of urban and peri-urban crops. In many peri-urban villages, the adaptation measures were in place historically by means of CPRs that dealt with water scarcity. However, with depleting and encroached CPRs, it will be partly challenging to protect communities from variability of climate change.

²NAPA is a process for Least Developed Countries (LDCs) to identify priority activities that respond to urgent needs to adapt to climate change; see <https://unfccc.int/topics/resilience/workstreams/national-adaptation-programmes-of-action/introduction>

³The NAP process was established under the Cancun Adaptation Framework (UNFCCC-CAF, 2010). It enables countries to formulate and implement national plans that identify medium- and long-term adaptation needs. NAPs further help in developing and implementing strategies and programmes to address those needs. It is a continuous, progressive and iterative process which follows a country-driven, gender-sensitive and participatory approach.

6.4 Commons, Canals and Peri-Urban Agriculture

In this section we use two processes associated with urbanization that are observable and salient in the peri-urban space to create a situated, differentiated understanding of the combined effects of urbanization and climate change-related stress. These processes are, first, the current and future loss of CPRs to urban expansion and, second, the emergence of drinking water and wastewater canals as an expression of urban metabolism, disrupting the peri-urban landscape with new externalities but also creating new opportunities.

CPRs are a category of natural resources that are owned, controlled and managed by a group of people. It includes community pastures, ponds, forests, and wastelands — all important natural resource endowments in the rural areas of India (Jodha, 1986). CPRs especially support the livelihoods of marginal and landless households that have little alternative means in terms of private assets. Ostrom (1992) has contributed to a scientific understanding of the conditions under which CPRs can be managed sustainably and thus survive over generations. Since the early 1960s, CPRs have been declining in India (Ballabh et al., 2002; Jodha, 1985; Manikandan & Sundaram, 2017). In India this process is caused by several factors, such as privatization of common resources, commercialization and modernization of agriculture, population growth and land reform programmes. Narain (2014), Rakodi (1999), Vij (2014), and Vij and Narain et al. (2016) have pointed out that CPRs are declining, and even more rapidly so in peri-urban spaces. Thus, the latter two publications have shown how these intensified processes in peri-urban spaces are related to the increase in competition for resource uses between urban, peri-urban, and rural resource-dependent populations. In the following sections, we present findings from our research that speak to this concern.

A major focus in our research was the emergence in a single village of multiple infrastructures that support urban metabolism. We identified two drinking water canals —the Gurgaon Water Supply canal (GWS canal; see Fig. 6.2) and the National Capital Region canal (NCR canal)— and two wastewater channels —the Gurgaon-Jhajjar Wastewater canal (GJC Canal or wastewater canal) and the larger Najafgarh Drain— that all cross the boundaries of Budhera village. Further, the Chandu-Budhera Water Treatment Plant occupies 274 acres of land that have been taken from the agricultural and common grazing lands of the village. In Budhera, they are as much an expression of urbanization as the residential apartments, shopping malls and recreation centres that form the more conventional imaginaries of urbanization.

While CPRs such as grazing land and traditional rainwater harvesting structures in Budhera are degrading or decreasing, these various canals are becoming part of the peri-urban waterscape (Vij et al., 2018; Vij & Narain, 2016). We consider canals as emerging CPRs in peri-urban areas, as these structures are managed and governed by agriculture-related norms in a way that is, to some extent, similar to those that have historically developed in the disappearing CPRs (Vij & Narain, 2016). For instance, when a wastewater canal starts to be used for irrigation, farmers engage in



Fig. 6.2 The GWS drinking water canal and the newer NCR canal to the left running parallel alongside the fields. (Photo Sumit Vij)

forms of collective action, devise rules on the use and management of the water, and thus are (re-)defining the canal and its water as a form of property (von Benda-Beckmann et al., 2006), as “hydraulic property” (Coward Jr & Levine, 1987). In these processes, such emerging infrastructures become the sites of new forms of cooperation and conflicts between peri-urban residents (Vij et al., 2018).

The impact that these infrastructures have on the lives and livelihoods of villagers in Budhera are significant. The canals and treatment plants behave as open, leaky systems and, through the processes of seepage, irrigation, breaches and groundwater recharge, become part of the social and hydraulic landscape of Budhera as much as they are part of Gurugram city. Some of the insights from the study were recently published in a paper that sought to establish the presence of metabolic infrastructures as an important constituent when conceptualizing the peri-urban fringe (Mishra & Narain, 2018).

An instance of this concerns the GJC, which is used by farmers in Budhera as a source of nominally priced (almost free) irrigation water (Fig. 6.3). This canal conveys treated discharge from the Dhanwapur sewage treatment plant (one of Gurugram’s two major STP plants), passing through Budhera and several other villages before merging into the larger Najafgarh Drain (Delhi region’s major wastewater outlet). The practice of irrigation from the GJC is state-sanctioned, against a nominal charge of INR 50 (or \$0.72) per year imposed on farmers for use of wastewater.



Fig. 6.3 Agricultural fields in Budhera. A motor pumps water from the wastewater canal. (Photo Pratik Mishra)

Wastewater not only irrigates the fields but also partially fertilizes it, reducing input costs for farmers. The wastewater canal flowing through Budhera is banded at a higher level than the adjacent fields, so irrigating from it is merely a question of opening the seal from pre-installed outlets in the canals. Wastewater is thus (almost) free and quick (the 12-inch pipe outlets take only 3–4 h to irrigate an acre) and can be widely distributed through furrows that extend up to a few kilometres from the canal. Thus, it irrigates fields located farther off, maintained by an informal cooperative arrangement among farmers. There are, however, problems with wastewater irrigation as well. Once there was a tragic mix-up of industrial effluents from another canal into the GJC. Farmers, unwitting of this danger, irrigated their fields with heavy metals that settled in the soil and brought down productivity drastically. Farmers also have an aversion against irrigating food with wastewater, which they consider “dirty”. They don’t consume any produce from their own harvests of wheat and rice, when grown with wastewater. But nevertheless, wastewater irrigation is a popular technology that is used by most farmers in Budhera.

Being so close to Gurugram, a large number of young people and laborers from Budhera have moved into the city or commute for work. There have been many speculative purchases of land here in the preceding decades, mainly by outsiders who had identified the potential for financial gains from rising land prices. The absentee landlords of both these categories lend out their land on so-called *kann-bataai* (sharecropping) arrangements to tenants. In this system the tenant either makes an upfront payment to the landowner when entering the agreement, or pays

a fixed rent of grain and fodder after harvest. Both the *kann-bataai* tenants and the landowners tend to be short-sighted on the agricultural productivity of land and find wastewater irrigation cost-effective. Hence they were among the early adopters of wastewater. Because, according to farmers, crops grown with groundwater irrigation tend to spoil or rot when wastewater enters into the mix, farmers of land adjacent to the wastewater canal are forced to cultivate using its water. This domino effect means that most farmers in Budhera cultivate through the GJC wastewater canal.

In Budhera, it has been noted that the rising demand for land and the increasing pressure of population have led to encroachment of water bodies called *johads* (earthen rainwater harvesting structures or ponds). Moreover, with higher rainfall variability, the lowering of the water table has pushed farmers in Budhera to use ever more costly tubewells to be able to access water for irrigation (Vij, 2014). The high costs of digging deeper tubewells has deprived marginal farmers of access to groundwater, eventually bringing changes in the occupation of marginalized peri-urban communities (Vij & Narain, 2016). Respondents in Budhera repeatedly mentioned this changing availability of water for some as a result of changing patterns of rainfall and growing stress on groundwater. One of them mentioned that Budhera used to be famous for its cultivation of muskmelon, and that families in the village used to receive marriage proposals from elsewhere thanks to the availability of fresh water and muskmelon. With the decline in rainfall and growing pressures on groundwater from the surrounding areas, the cultivation of muskmelon has completely stopped.

6.5 Changing Agricultural Patterns with Climate Variability

The main manifestations of climate change in Budhera are the increasing unpredictability of weather cycles and extreme events, and the uncertainties this is creating for farmers cultivating their crops with wastewater. Studies in and around Budhera reveal several ways in which a changing climate is experienced by the residents (Narain & Singh, 2017; Ranjan & Narain, 2012). These include a longer duration of summers, shorter winters and changes in patterns of precipitation. Many local residents report a disappearance of the *chaumaasa*, or the 4 month monsoon period of rainfall. These observations are also corroborated by the analysis of hydro-meteorological data (see Narain et al., 2016). When this research was conducted in 2015, three out of the four previous harvests of rice and wheat (the crops in the *kharif* and *rabi*⁴ seasons respectively) had resulted in an economic loss for farmers, twice from unseasonal rains and pests, and once from low market prices. In March 2015, unseasonal rains struck Budhera and damaged the winter wheat harvest that was near to being cut. This period was recorded as the wettest March in 48 years.

⁴The monsoon and winter crops.

In February 2015, Caftanji, a farmer had already been worried about watering his fields using wastewater. Three days of strong sunshine, unusual for chilly February, had begun to wilt the wheat. He irrigated his field, but when the weather reverted to the cold temperatures typical of February, the wastewater standing in the field damaged crop and soil. This problem is more acute than with groundwater because wastewater takes longer to evaporate. The situation was worsened by seepage from the drinking water canals that had raised the water table in adjoining fields. Thus, timing of the watering cycles for the crops is becoming ever more important, but also more difficult in view of the changing rainfall cycles.

Locally, two types of farmers are distinguished on the basis of their sowing cycles: *aggetas* (early sowers) and *pacchetas* (late sowers). Being a *paccheta* used to be a strategic choice for farmers in the past, depending upon farmers' decisions to keep their farms fallow or ploughing the stubble, or harvest late. However, *paccheta* now has become a synonym for laziness in farming. For the *rabi* wheat crop, a *paccheta* would harvest the wheat in March or April. Farmers have identified this period as especially risky and prone to rainfall, and responded to this risk by becoming all *aggetas*, hastily harvesting the rice crop and sowing the wheat with very little time in between. Farmers often resorted to stubble burning in their hurry to clear the field. However, after this practice had been declared illegal in light of the air pollution in nearby Delhi—a prohibition that is strictly enforced in Budhera—stubble burning has become rare.

The winter season of 2015 was marked by prolonged heat and a late onset of cold weather, as well as unseasonal rains in December. As a consequence, mustard, which is the second important winter crop of Budhera, suffered a double blow. *Aggeta* mustard farmers sowed their fields in October, hoping for low temperatures by November. However, the extended warm period during the first half of November led to early flowering in mustard plants, which impeded further growth and lowered the yields. Later, in December, the unseasonal rain caused the fields to be wet when the *paccheta* mustard was to be sown, and farmers had to wait for the soil to dry. Once they realized they would be late, most of them decided to leave the fields fallow or plant *jowar* (fox-tail millet) instead. Here both the *aggeta* and *paccheta* farmers faced different problems in sowing mustard.

The late onset of winter and the extended periods of sunshine were beneficial to some farmers. Those whose fields are located in low-lying areas near the GWS and NCR canals, which have very high-water tables from seepage, are generally the *pacchetas*, as the soil in their fields remains moist and takes time to dry. The moist soil also affects the harvesting of rice. In the harvesting process, rice plants are tied into stacks and kept on the field for 2–3 days before they are taken to the mill. With a wet soil, farmers aren't able yet to harvest the rice as it would spoil on the moist ground. However, with the prolonged sunshine, the farms near the canals had time to dry out. The farmers sowed wheat at the same time as farmer on other fields and were not the *pacchetas* for that year. The impact of climate variability thus plays out differentially at a micro-level, depending on various contingent factors.

The cumulative impact of these factors of urbanization (damage from the canals and wastewater irrigation) and climate variability or change is negotiated by

farmers; not only in short-run decisions about cropping calendars but also impacting more stable long-run configurations like the fixing of rents for sharecropping. As mentioned, it is common for landowners in Budhera to rent their land to sharecroppers under an informal tenure system, locally known as *Kann-bataai*. For the after-harvest payment system, the rates paid by tenants have gone down as a consequence of reduced productivity and greater risks in agriculture. For a long time, the rent in *kann-bataai* used to be stable around 40 *man*⁵ of wheat per acre for a year. From around 2014, the rates have generally gone down to 25 *man*.

There is also a structural shift in the institution of *kann-bataai*, or how sharecropping functions in the village. *Kann-bataai* labourers seldom work small plots of land through a sharecropping arrangement nowadays. This has become an unfeasible arrangement in Budhera, and has practically vanished. The system is now mostly restricted to large sharecroppers who manage teams of labourers working large plots of land rented from either a single large landowner or from many smaller landowners.

The greater scale of sharecropping operations may help manage risks in mild shocks to production but is of no use in major climate shocks. One of the farmers who had lost much from the unseasonal rains of March 2015 was a landowner-cum-sharecropper. He had three acres of land of his own, and 11 acres from another farmer through *kann-bataai*, with an upfront payment of INR 150,000 (or \$2172). His harvest from a combined cultivation of 14 acres was around 60 quintals, which was an abysmal return for him. In case of crop failure, the loss is borne by the tenant and not the landowner; state policy fails to recognize informal tenants and only compensates landowners.

The peri-urban nature of Budhera rubs off on its agriculture in multiple ways. An interesting, seemingly trivial, detail about agriculture in Budhera was that most large farmers (unlike farmers in other districts of Haryana) don't own their tractors. The price of renting a tractor in Budhera is much lower than in other districts as a collateral effect of the heavy construction activities in Gurugram. At a rental of Rp. 300 per hour, during which you can get four acres ploughed, farmers opt for renting. Many villagers in Budhera and nearby peri-urban villages have become tractor entrepreneurs, who rent out tractors for agriculture for only a small percentage of the time, while mostly renting it out for construction, logistics and other non-farm activities around Gurugram.

6.6 Conclusion

In this chapter we have analysed the loss of common property resources and the emergence of urban canals in the peri-urban space as characteristics of the urbanization processes that are intensely operative in peri-urban Gurugram. We sought to

⁵A *man* (pronounced as rhyming with ton) is a local measure equivalent to 40 kg.

bring these processes in relation to changing agrarian conditions and climate change. Agrarian crisis and conflicts related to urbanization (manifest in land acquisition struggles) have been contentious political issues in India, and they feature much more prominently in political conversations than climate change. Meanwhile development programs and research agendas often use adaptation and resilience to frame policy narratives, including in studies related to the peri-urban, where the focus may deviate from ongoing conflict and struggle over water and land in the peri-urban. The focus on climate change often even tends to depoliticize these issues, as they become all framed in terms of adaptation rather than exploitation, inequality and power (Paprocki, 2018; Scoville-Simonds et al., 2020).

Although popular debates over access to land and water are slowly beginning to develop an explicit climate change formulation, they still do not adequately reflect the urgency of the climate crisis in India. The new realities of farming, such as the decreasing viability of small-holder *kann-bataai* arrangements and the breakdown of irrigation calendars, give rise to new forms of collective action by farmers. These measures of climate adaptation, often local in scale, are socio-ecological processes that are changing social relations among farmers and reflect even in political configurations of farmers' demands on the state. In the ongoing farmers' movement and agrarian politics of India, for instance, it has been observed that, in contrast to the powerful regional farmers' movement in India of the 1970s and 1980s, there has not been a split between the politics of large landowners on one hand and marginal farmers and landless labourers on the other (Jodhka, 2018). Climate change and emerging forms of adaptation among farmers are likely the undercurrents that have an important bearing on political alliances and discourses. Our research has elaborated on these adaptation processes, and future research will hopefully establish links between the political organization of farmers and the articulation of the agrarian crisis with adaptation as a political process.

Due to urbanization and climate change, agriculture is becoming uncertain and peri-urban residents are shifting to alternative livelihood opportunities in the nearby city. These changes are breaking the social fabric of the peri-urban, as not all residents (aged, women, many farmers) have the willingness to sell their land and take up new occupations. In an anticipatory urbanization approach, peri-urban farmers could be encouraged and supported by local authorities in developing sustainable forms of agricultural intensification. Such an approach could, for instance, create opportunities in the cities, using existing agriculture knowledge in innovative organic vegetable and food markets. City authorities and urban planners can also implement zoning regulations to ensure that farming areas, green spaces and water resources are protected from urban and non-agricultural rural development projects. Such policy actors need to understand that these not only affect peri-urban residents but also the urban and rural population and environments. Especially in the longer term these peri-urban issues might affect food production systems, agricultural ecology and agricultural knowledge among peri-urban youths. Budhera represents these peri-urban challenges, and we hope that in the near future the use of anticipatory urbanization approaches can contribute useful perspectives on sustainable peri-urbanization.

Finally, peri-urban research is necessary to unpack the relations between actors in re-defining, re-shaping, using, and managing their resources in the context of climate variability. Peri-urban spaces require contextualized approaches that can help understand processes of degradation and depletion of peri-urban CPRs and other resources, and of the emergence of new resources, such as wastewater canals, and related practices of use and management. These approaches should also emphasise that challenges in peri-urban areas are not only produced by urbanization and climate change, but also due to power dynamics, social relations and biased policy priorities (Narain et al., 2019; Roth et al., 2019). Currently, such an approach towards peri-urban spaces is completely missing in climate change adaptation policies, whether focusing on urban or on rural contexts.

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