POLITICAL ECONOMY OF WATER GOVERNANCE AND INSTITUTIONS: ANALYSIS OF PUNJAB AGRICULTURE

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Abstract

The paper aims to present an overview of the contemporary political governance and institutional framework for managing irrigation in Punjab. Robust policies and institutions to manage irrigation water effectively, will aid in the process of doubling farmers' income by increasing access to irrigation and encouraging adoption of improved technology. The considerable transition in irrigation sources from surface-based canal water to sub-surface-based groundwater over time is examined. The related subjects of irrigation administration and management of both sources of irrigation have been analysed.

Keywords: Institutions, Irrigation, Management, Groundwater

1. INTRODUCTION

As the gap between projected demand of future and potential supply is likely to grow further, the physical scarcity of water, which is already visible in majority of Indian states, is expected to assume national proportions in the near future. With increasing water scarcity and externalities associated therewith, the institutional arrangements governing water resource development, allocation, and management are receiving increasing policy attention at state, national and international levels. It is important to align the policy matter with Sustainable Development Goals (SDGs) addressing the challenges of no poverty, zero hunger, clean water and sanitation, reduced inequalities, climate change and most importantly peace, justice and strong institutions. Appropriate water governance and water-based institutions are need of the hour for India, especially for irrigation sector.

At levels of state, irrigation has acquired an increasing importance in agriculture. From just 8 million hectares (Mha) in 1800, irrigated area across the world increased fivefold to 40 Mha (13.4 Mha in India) in 1900, to 100 Mha in 1950 and to just over 308 Mha in 2018; with almost one fifth of that area (62 Mha net irrigated area), India has the second highest irrigated land after China. In India the irrigation infrastructure includes a network of canals from rivers, groundwater, well based systems, tanks and other rainwater harvesting systems for agriculture. Large scale irrigation used to be synonymous with canal water irrigation in India and under the aegis of grave inefficiencies in project implementation and operation, canal irrigation has become a costly proposition (Dhawan 1997). The change in irrigation arrangement from surface water to groundwater not only acted as catalyst for rapid agriculture growth but also raised the concern regarding the sustainability of natural aquifers. India being the largest user of groundwater in the world, has seen revolutionary shift from large scale surface water management to wide-spread groundwater extraction in the last 40 years, particularly in the North (Sinha and Densmore 2016). Today groundwater system is the largest, covering-160 million hectare (Mha) of cultivated land in India with 39 Mha irrigated by groundwater, 22 Mha by irrigated canals and about two third of cultivation still dependent on monsoon (Dhawan, 2017). Punjab has always been epitome of green revolution success which played crucial role in safeguarding the nation from falling into Malthusian trap and made it self- sufficient in food production. Punjab is a granary state of India and its input-output system is heavily biased in favour of agriculture (Singh 2009). Punjab model of irrigation is characterised by excess demand for water for irrigation coupled with unconstrained mining of groundwater for meeting the food production requirements of the country (Singh and Bhangoo 2013). As per OECD report (2017), north western India comprising of Punjab has been globally identified as the water stress hot spot, which not only raises the concern of food security but also the livelihood of millions of farmers as well. Punjab witnessed a structural shift in the source of irrigation from canal water irrigation to tube well irrigation. This shift of supply driven to demand driven setup of irrigation is result of the course of public policies chosen by the governments in order to boost the agriculture growth. There has been change from the government controlled institutional set up of canal water system to informal setup of private tube wells. The role of institutions in management aspects has always been undermined in rural setup, especially in irrigation sector

2. PUNJAB

Punjab is the most developed State of India where all the villages are approachable by metaled roads and are cent-percent electrified. The state is flat alluvial plain except in some areas of north eastern border, where it is mountainous and in the South-Western where stable sand dunes form the landscape (Singh and Bangoo 2013). Punjab is pre-dominantly an agrarian state, with only 1.5% of India's geographical land, it has been contributing around two third of the food grains procured annually in the country and is devoid of any mineral or natural resource except water. The intensive nature of agriculture in the state needs heavy requirement of water. The state's irrigation and cropping intensity is 99% and 190% respectively against corresponding figures of 45% and 141% at national level respectively (Govt. of Punjab 2014; Ghuman and Sharma 2016). Punjab's agriculture was highly diversified on the

eve of green revolution but turned into wheat-paddy mono-cropping system which had serious impact on water resources of the state.

Table 1. Gross cropped and irrigated area in Punjab ('000ha)

Year	Gross Cropped Area	Gross Irrigated Area	Percent of gross irrigated area to gross cropped area
1970-71	5678	4293	75.61
1980-81	6763	5781	85.4
1990-91	7502	7055	94.0
2000-01	7935	7664	96.5
2010-11	7941	7724	98.0
2015-16	7872	7765	98.64

Source: Statistical Abstract of Punjab 2016

The percent gross irrigated area to gross cropped area has increased by 23 percentage points from 1970-71 to 2016-17. This has led to a scenario of increased pressure on underground water, as canal water is grossly insufficient to meet the rising demand for irrigation. The area under canal irrigation decreased from 43 percent in 1981 to 27 percent in 2016, in a state where exists a vast and intricate network of canals.

3. CANAL SYSTEM IN PUNJAB

In Punjab, surface water resources are being fully utilized through well-organised canal system. The available surface water resources have fallen short of the irrigation needs of the state which resulted in over exploitation of groundwater resources. For water management and governance issues, Punjab can be divided into three water zones namely Kandi zone covering 19 percent of state's geographical area, Central zone also known as Paddy zone covers 47 percent and South Western Zone with 34 percent. All three zones face different kinds of water related problems. Kandi zone is majorly prone to soil erosion, flash floods, deep water table. Central zone is affected by serious groundwater depletion and pollution and South-Western zone is facing a poor quality of groundwater due to salinity and alkalinity (Jain and Kumar 2007). Adequate water distribution among water users is most important objective of canal irrigation. Due to limited supply of canal water in the system in Punjab, the water is supplied on rotational and proportional basis, also known as system of Warabandi. High efficiency and equity are twin objectives of this rotational system. Three prominent types of warabandi prevalent in Punjab are: Khuli-wari (open turn), Panchayati-wari, and weekly -wari. Based on the size of the land holding, distance from outlet (mogga), and certain other factors, field staff of the irrigation wing fixes the turn, duration and quantity of water for farmers (Singh and Bangoo 2013).

Table 2. Capacity (length, Discharge and Culturable Command Area) of major Canals of Punjab

Sr. No.	Name of Canal system	Length in KM of Main Canal	Discharge at Head (in Cusecs	Culturable Command Area (Ha)
1	Sirhind Canal	59.44	12620	13.59
2	Bist Doab Canal	43.00	1408	1.99
3	Upper Bari Doab Canal	42.35	9000	5.40
4	Sirhind Feeder	136.53	5264	3.60
5	Eastern Canal	8.02	3197	2.16
6	Bhakra Main line	161.36	12455	3.81
7	Shahnehar Canal	24.23	875	0.33
	TOTAL	574.93	44819	30.88

Source: irrigation.punjab.gov.in (as on 4 January 2016)

Initially all major departments involved in canal system performed efficiently but over a period of time the irrigation related institutional setup started to deteriorate. This deterioration of this institutional setup was due to availability of subsidized diesel, free electricity and water which led to total neglect of the canal system and encouraged unabated mining of groundwater. The poor performance of canal irrigation in Punjab can be attributed to low productivity of canal-irrigated land, low return on investment due to free/low price of irrigation water, poor water distribution and underutilization of irrigational potential (Dhawan 2007). There is always latent demand for the surface water by farmers and government needs to tap in and change its role from resource provider to resource facilitator to the farmers in order to promote canal irrigation in appropriate manner.

4. GROUNDWATER SYSTEM

Post green revolution period tube wells, along with canals, emerged as the main source of irrigation in Punjab but area under groundwater irrigation surpassed canal irrigation. Out of the total irrigated area of 2020 thousand hectares in 1960-61, 58 percent was under canal irrigation and 42 percent under tube wells and wells, the situation reversed in 1990-91 when total irrigated area increased to 3816 thousand hectares, 58 percent area came under tube well irrigation and 42 percent under canal irrigation. Irrigated area under canal has currently settled around 27 to 28 percent in the last few years. On the other hand, because of easy availability of highly subsidised or free agriculture electricity, the dependence on groundwater increased especially during decade of 1990s.After 1990s there has been increase in irrigation area under tube wells both in absolute and relative terms. Presently, more than 72 percent of the net area of Punjab is dependent on groundwater. The table also highlights that not only area under irrigation especially under

tube well irrigation increased but irrigation intensity also increased from 54 percent in 1960 to 99 percent in 2016, and cropping intensity from 126 percent in 1960 to 190 percent in 2016.

Table3. Net Sown Area Under Irrigation in Punjab Through Canals and Tube well: 1960-2017 ('000 hectare)

Year	Canal	Tube wells & Wells	Total Irrigated Area	Irrigation Intensity	Cropping Intensity
1960-61	1173 (58.07)	829 (41.04)	2020	54	126
1970-71	1286 (45.57)	1591 (56.26)	2888	71	140
1980-81	1427 (42.19)	1939 (57.33)	3382	81	161
1990-91	1660 (43.50)	2233 (58.52)	3816	93	178
2000-01	1002 (24.92)	3074 (74.45)	4021	94	186
2010-11	1113 (27.35)	2954 (72.58)	4070	98	190
2016-17	1152 (27.91)	2975 (72.09)	4127	99	190

Source: Govt. of Punjab, Statistical Abstract of Punjab (Various Years)

It is evident from the table that share of tube well irrigated area registered a steady increase since 1960s as high yielding varieties of seeds were highly responsive to water. Assured supply of water was, thus a necessity not a choice. The availability of surface water resources is unable to meet the demand for agriculture which resulted in increasing dependence on underground water resources.

Table 4. Number of Tube wells: 1970-2016 in Punjab

Year	Diesel operated		Electricity operated		Total
	No.	Percent	No.	Percent	No.
1970-71	101000	52.60	91000	47.40	192000
1980-81	320000	53.33	280000	46.67	600000
1990-91	200000	25.00	600000	75.00	800000
2000-01	285000	18.18	788000	81.62	1073000
2010-11	240000	17.36	1142000	82.64	1382000
2014-15	171000	12.16	1235000	87.84	1406000
2015-16	165000	11.62	1254000	88.38	1419000
2016-17	165000	11.62	1254000	88.38	1419000

Source: Govt. of Punjab, Statistical Abstract of Punjab (Various Years)

As regards groundwater in Punjab, there are two types of tube wells: diesel-operated and electricity-operated. Over the span of four decades the number of tube wells has grown by more than 7 times from 1.92 lakh in 1970-71 to 14.19 lakh in 2016-17. Further breakup in no. of tube wells into diesel and electricity operated is indicative of shift from diesel-operated tub well to electricity-operated. The share of diesel- operated tube well reduced from 52 percent in 1970-71 to 11 percent in 2016-17 whereas share of electricity -operated tube well has almost doubled from 47 percent in 1970-71 to 88 percent in 2016-17. With the widespread rural electrification coupled with a flat- free electricity subsidy has led to major increase in the number of groundwater based irrigation system of tube wells against the surface water use. In the absence of any adequate systematic and institutionalised governing policy to regulate irrigation demand has resulted in unabated mining of groundwater leading to its over exploitation. There has been no incentive to formularise an institutional framework for groundwater irrigation. Thus, such unprecedent exploitation has raised number of questions on the sustainability of the groundwater irrigation in Punjab. Over the period of time, the extent of groundwater exploitation has been on the rise, as is evident from table5 below

Table 5. Extent of Groundwater Exploitation in Punjab: 1984-2013 (No. of Development Blocks)

Category of Blocks	1984	1986	1989	1992	1999	2004	2009	2011	2013
Dark (Over Exploited)	53 (44.92)	55 (46.61)	62 (52.54)	63 (53.39)	73 (52.90)	103 (75.18)	110 (79.71)	110 (79.71)	105 (76)
Dark/Critical	7 (5.93)	9 (7.63)	7 (5.63)	7 (5.93)	11 (7.97)	5 (3.64)	3 (2.17)	4 (2.90)	4 (2.90)
Grey/Semi Critical	22 (18.64)	18 (15.25)	20 (16.95)	15 (12.71)	16 (11.59)	4 (2.91)	2 (1.45)	2 (1.45)	3 (2.17)
White/Safe	36 (30.51)	26 (30.51)	29 (24.58)	33 (33)	38 (27.97)	25 (18.24)	23 (16.67)	22 (15.94)	26 (18.84)
TOTAL	118	118	118	118	138	137	138	138	138

Source: Central Groundwater Board (2017), Dynamic Groundwater Resources of Punjab State

The number of over exploited blocks increased from 44 percent in 1984 to 76 percent in 2013. Thus, over the span of 29 years, the number of over-exploited blocks increased by nearly 32 percentage points. Significantly, the trend of over exploited blocks has been steadily upward throughout the period.

5. INSTITUTIONAL FRAMEWORK IN WATER SECTOR

Traditionally, water sector has been dominated by engineering concerns. The emphasis was on the construction of physical facilities such as water distribution networks and treatment plants. Scant attention has been given to the institutional and managerial aspects related to operating and using the facility. One key feature with considerable institutional implications is the administrative demarcation of different water sub sectors. While the canal irrigation sector is developed and managed by public agencies,

groundwater irrigation is managed by independent farmers (Saleth 2004). This, therefore, begets the question as to how different irrigation property regimes need to be managed cohesively, keeping their individual characteristics and impacts in mind.

In order to develop Punjab agriculture for food security, a massive and intricate canal irrigation network came into existence with government effort. This, along with subsequent personal efforts supported by government policies to harness groundwater for irrigation, led to the creation of a number of departments that helped in the efficient creation, operation and management of the irrigation system. Over a period of time, however, the irrigation related institutional setup deteriorated in consonance with other public institutions. The current stage of water development of Punjab groundwaters for irrigation leading to its depletion makes it imperative to examine the role of institutions and management in right perspective.

The state of Punjab aims to undertake conservation and management of its water resources, improve water use efficiency, control water pollution, minimize wastage, and ensure equitable distribution of water across state by addressing the impact of water depletion in agriculture sector. Punjab being an agriculturally intensive state, the focus is on the issues of optimal utilization of water resources.

The three key elements of water management in Punjab include:

- Availability of water source, its augmentation and distribution
- Regulation-which implies implementation of laws and monitoring
- Promotion of water conservation technology

The Punjab State Water Policy was first adopted in May 1997 on the lines of National Water Policy-1987 (NWP 1987). Taking into consideration the challenges and dynamics in management of Punjab water resources, the existing water policy was revised and was introduced in the form of Draft State Water Policy, 2008. The draft envisioned the efficient and judicious use of water for all purposes, especially for irrigation purpose in a manner that promotes it sustainability and conservation.

The Punjab Groundwater (Control and Regulation) Act.1998 was enacted to regulate indiscriminate extraction of groundwater. Further, in March 2009 the Punjab Preservation of Sub-Soil Water Act, 2009, to restrict paddy transplantation not before 10th June. State Electricity Board has been advised to supply power after 10th June in order to limit over extraction of groundwater before monsoon. Several centrally sponsored schemes and loans from financial institutions such as NABARD, World Bank and ADB, help to finance various initiatives of water management (Bharat 2015). Punjab has initiated various irrigation based programmes like Accelerated Irrigation Benefit Programme, Participatory Irrigation Management Programme, Command Area Development and Water Management Programme, Project to rehabilitate ponds in all villages of the state, Project for modernisation, remodelling, renovation and extension of canals, deep tube wells, lining of water courses, cleaning of canals, which has resulted in increase in net irrigated area and promotion of conjunctive use of surface water and groundwater for irrigation purposes.

6. POLICY REFORM OPTIONS

Analysis is indicative that in order to maintain food security in the country, Punjab has unabashedly mined groundwater and ignored the maintenance of surface water which has resulted in serious environmental, ecological and economic consequences in the region. In this context, there is need for overhauling of the current institution of both surface water and groundwater irrigation in Punjab. The government institutions dealing with groundwater like the Central Ground Water Board, State Ground Water Departments, NABARD, etc. have been playing an observatory rather than a monitoring role. Against this backdrop, the recent Mihir Shah Committee on solving India's water crisis suggests a shift from the supply centric approach to a people centric approach, aimed at reviving the community-based approach so as the empower the communities to take informed decisions on all aspects of water usage, management and conservation. The committee recommends a major overhaul in the institutional framework of Central Water Commission and the Central Ground Water Board for a more multidisciplinary and holistic water management approach. They suggest the formation of a National Water Commission to bring both the institutions under its ambit and fill in the gaps unaddressed by them (India Water Portal, 2017). The beginning of implementation of these reforms is still awaited. It is agreed that green growth strategies in the water sector require a balance between water use and water protection within an integrated water resources management framework. Effective regulation, coordination and management of water sector can help Punjab manage its water resources sustainably, which at present are facing major quality and availability issues. The state is now at cross roads since its agriculture, supporting many livelihoods, has reached a plateau under the available technologies and natural resource (Bharat 2015).

Punjab is yet to formulate a ground water policy. It needs to develop an implementation framework for policies and mechanisms for operationalizing them in adequate institutional setup. There is a need for strengthening of groundwater authorities in the State by providing more autonomy. This would help promote water conservation and recharge of ground water. Several watershed development projects are being implemented in the state especially in Kandi area. This needs to be sustained for long term along with promotion of water conservation practices among general public.

The gap between irrigation potential created and actual irrigation achieved also needs to be bridged. This is possible by arresting siltation in canals and reservoirs and by remodelling, reconditioning, repair, maintenance and upgradation of existing canal system to provide assured water supply up to the tail end. For an integrated and efficient monitoring, informed systemic responses and decision making there is need of developing mechanisms by using innovative information and communication technology (ICT) tools and technologies. ICT based system can also be used to increase awareness among farming community about the changing climate, its affects and how it can be mitigated or adapted. Lessons need to be from Israel, an extremely water scarce region with a

per capita availability of less than 200 cm. The country is known as the land of innovations in water management, be it drip irrigation or recycling of urban wastewater for use in agriculture. Lessons include: building public awareness of the value of water, access to quality data for integrated management, massive infrastructure investment parallelly with institutional reforms, among many others (Marin, Tal, Yeres, & Ringskog, 2017). While some efforts have been made to correct the wrongs via institutional mechanisms, much more needs to be done immediately. There are only two times for our resources- now and too late.

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