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Commons beyond public goods
Los bienes comunes más allá de los bienes públicos

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ABSTRACT

Common pool resources (CPRs) play crucial role in the welfare of rural household. In developing countries like India, CPRs act as development drivers and safety-net provider to Poor People (PP). To overcome 'Tragedy of Commons' and sustainable conservation of commons, cooperation is needed to conserve CPRs due to its features: non excludability and substractability of the yield. But, community institution (rural households or community) sometimes faces challenges to conserve economically when we consider two additional characteristics of commons such as *mobility* and *stationary*. We have carried out field study on 419 CPR dependent households to examine CPR settings of canal irrigation, community forestry and tank irrigation. We found: types, nature and degree of conflicts differ between stock and mobile resources, users follow stock and mobile resource specific institutional arrangement and conflicts are resolved by adopting resource specific methods. The nature, type and degree of conflicts are different between villages and districts. We also developed categorizations of CPRs helpful to the resources users for understanding and anticipating strategies to confront and solve commons conflicts.
Keywords: commons, conflicts, institutional designs, mobile, stationary

RESUMEN

Los recursos comunes (CPR, por sus siglas en inglés) juegan un papel decisivo en el bienestar de los hogares rurales. En países en vías de desarrollo como la India, los CPRs actúan como conductores de desarrollo y proveedores de red de seguridad para la gente pobre (Poor People). Para superar la "tragedia de los comunes" y conservar sustentablemente los bienes comunes, se necesita cooperación para la conservación de los CPRs debido a sus características: la no excluibilidad y la sustractibilidad del rendimiento. Sin embargo, la institución comunitaria (hogares rurales o comunidades) a veces se enfrenta a desafíos para mantenerse económicamente cuando se consideran dos características más de los bienes comunes como son la *movilidad* y la *estacionariedad*. Por lo tanto, se ha llevado a cabo un estudio de campo en 419 hogares dependientes al CPR para examinar el reglaje del CPR con respecto al canal de riego, la silvicultura de la comunidad y la red de riego con tranques. Y se encontró que los tipos, la naturaleza y el grado de los conflictos difieren entre los recursos móviles y de *stock*, también que los usuarios siguen la disposición institucional específica de los recursos móviles y de *stock* y, por último, que los conflictos se resuelven al adoptar métodos específicos para los recursos. La naturaleza, el tipo y el grado de los conflictos son diferentes entre pueblos y distritos. También, se desarrollaron categorizaciones de los CPRs que ayudan a los usuarios de los recursos a comprender y anticipar las estrategias para afrontar y resolver los conflictos de los bienes comunes.
Palabras clave: bienes comunes, conflictos, diseños institucionales, móvil, estacionalidad

INTRODUCTION

Commons are the foundation of human evolution and rural livelihoods. Because of its semi-public goods character potential beneficiaries cannot be excluded from using it and this leads to over-extraction (negative externality) of the resource and consequently to the tragedy of commons (Hardin 1968). The solution is to hand over broad-based property rights, thereby internalizing the externality. But, it is not easy to impose due to high transaction cost, political inefficiency and asymmetric information. Therefore, market approach and command and control based approach failed to manage commons. As a result, community based natural resource management (CBNRM) emerged as an efficient alternative during early 1990 to reduce conflicts. But, CBNRM eventually generated new sets of conflicts (Saigal 2000).

According to Sarkar (2021), "Power, Policy and Property (PPP) owners sensibly allocate more benefit and less cost in self-favour leaving the opposite for (their neighbor) Poor People (PP)". The stockholders involved in the conservation of CPRs represent roles, positions, skills, knowledge, values and interests that are heterogeneous and therefore potentially conflictive (Anderson *et al.* 1999, Agrawal and Gibson 1999). Generally, the goal and objectives of rich (PPP) and the powerful may not be harmonious with the needs of the poor (PP) and the marginalized (Baland and Platteau 1999). Scholars (Ostrom 1990, Baland and Plateau 1996) have shown that successful management of natural resource actually refers to community-based natural resource conflict management mechanism (CBNRCMM).

A number of studies have attempted to address the role of conflicts in commons (Kerr 2007, Bardhan and Dayton-Johnson 2002, Andersson *et al*. 2009, Van Laerhoven and Berge 2010, Janssen *et al.* 2011, Sarkar 2017a, 2017b, Sarkar and Ray 2019). Surprisingly, the CPR literature is dealing with the issue of conflict (cooperation) management mainly from the view point of resource users (communities). It assumes the common characteristics and narrow definition of commons as public goods. The resource units may also differ on two important physical characteristics such as stationary (community forest, tank water) and mobile (canal water). Majority studies consider CPRs as semi-public goods including design principles of Ostrom (1990). Types of CPRs resources on the basis of absence and presence of mobility and storage (Schlager *et al*. 1994) raise some questions. What happens when we consider the stock and mobile characteristics as two additional features of CPRs? Can the existing analytical framework of commons capable of solving the problem? Are the nature of conflicts same for stock and mobile resources? If not, does it depend on the features of the commons? Is the resources specific institutional arrangement necessary? The CPRs literature remains unclear regarding this issue. It also remain unclear how the nature of extraction of common canal water (creating sequential externality) and community forest and tank water (creating pooled externality) affect conflict and cooperation. Therefore, the traditional prescription should be the opposite if we consider the stock and mobile features of commons.

Thus, the CPR literature has come under closer inquiry. In particular, it has been constrained to the features of the CPRs and factors operating within the community. It is essential to extend the conventional mode of analysis to stock and mobile categories. This research primarily focuses on nature, type and degree of conflicts involved in the mobile and stock resources and the institutional aspects of management and resolution. Adding storage or mobility to a CPR may result in a better mechanism for conflict resolution that resource users could pursue in developing commons management framework[1] (figure 1). The rest of the paper takes the following order. We discuss additional features, CPR theory and working hypotheses in section 2; in section 3, We consider the study sites, data collection and methods; finally, in section 4, the details of results and discussion are presented followed by conclusion and policy implication in section 5.

[1]We examine the importance of mobility and storage, but there are other characteristics too which shape the life of commons (Gilles and Jamtgaard 1981).

Additional features, CPR theory and working hypothesis

Mobile and Stationary

Mobile resource units fluctuate changeably (table 1), such information may not be possible to obtain in advance. It is tough for resource users to precisely judge the changes in flow. The extraction activities on the flow of resource units (canal irrigation) in current period may not be so obvious for the next period. When the cause and source of their problems are unpredictable, it is complex for users to engage in collective action on what would constitute positive institutional arrangements, and users have greater incentives to reject or free-ride upon agreements to extract resource units. Incentive of a rational user is to limit harvesting in order to conserve the stock and reduce the externality is diminished in commons with mobile resources. Users are less certain that they will produce the benefits according to their collective efforts to respond to extraction conflicts.

Table 1 Presence or absence of storage and mobility in commons

CPRs/ Characteristics	Storage	Mobility
Canal Irrigation	Absent	Present
Community Forest	Present	Absent
Tank Irrigation	Present	Absent

Source: Author

Stock resource units allow users to control and contain (table 1). Storage capacity may be an inherent part of a resource like community forest and tank irrigation. Storage capacity of resource units can help users to overcome some of their problems easily than mobile resource. Users may be in a better position to understand the interaction between current extraction activities and future flows. In most of the cases such types of resource (stock) are used by the same community i.e., resource user's community is also fixed. On the other hand, canal water resource units are movable and flowing across the communities.

Development framework

The action arena for resource can be described as a mix of actors or entities (community member, non-community member, institution and infrastructure both human and physical, authority and resources with their features). The interacting actors make decisions and design institutions which influence the sustainability of resource ecosystem (figure 1). The very features of mobile and storage demands different set of agreement, relations (set of rule) or institutions that interact.

Institutional Analysis with Modification from Ostrom, Gardner and Walker (1994)

If we consider these additional features of commons into the framework (figure 1), it generates different levels of outcome in addressing conflicts. As a result, levels of cooperation and conflicts are also different. Intra community bonding for resource use and facing institution differ with their peers because of resource endowment, group size and heterogeneity (Sarkar 2020) of resource user employment and livelihood opportunity in diverse socio economic set-up. Hence, the strength and weakness (linkages or relations in figure 1) across the commons will be different.

The types of conflict in commons

We categorize common-pool conflicts as supply side, demand side and policy side (table 2). Supply side conflicts relate to the optimal size of the stock of mobile units and the productive nature of the resource. It generally arises from deficient investments in the conservation, in protection and in depletion of commons. Conservation conflicts represent opportunities missed.

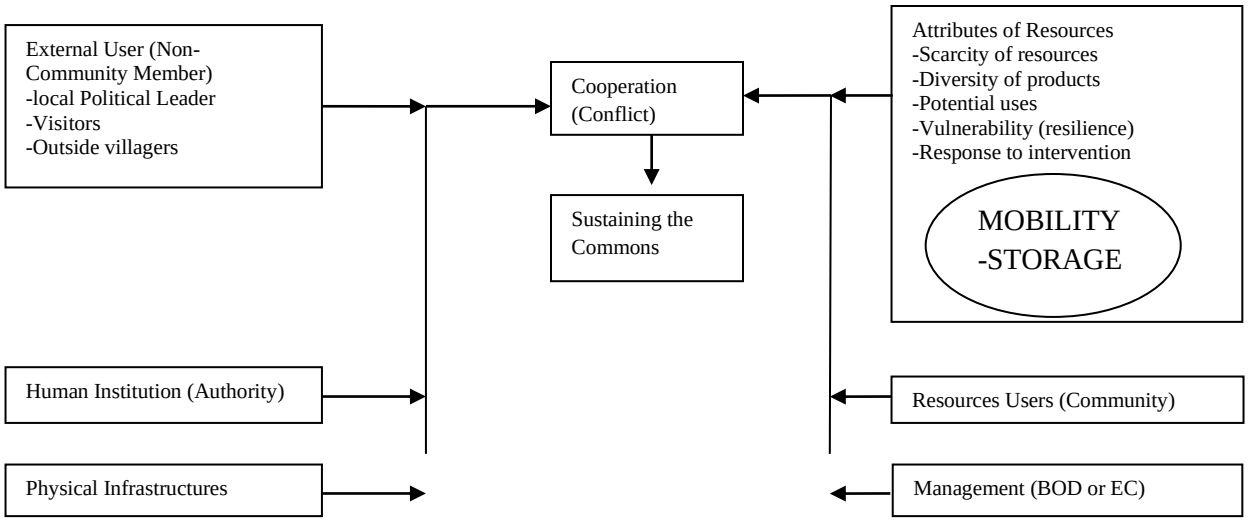


Figure 1 A Development Framework and Institutional Analysis

Table 2 the types of conflict in commons

TYPES OF CPR CONFLICTS		
Supply Side	Demand Side	Policy Side
Conservation conflicts	Extraction conflicts	External users
Protection conflicts	Interfering conflicts	Co-ordination failure
Depletion conflicts	Allocating conflicts	Governance conflict

Souse: understanding of author

Resources are not conserved to their optimal scale. Deficient investments in protection of either the physical facilities or the stock of mobile units may result in erosion of a commons' productive or regenerative capacity and deterioration of the status quo. Depletion conflicts emerge when mobile units are not adequately protected from a variety of threats which in result diminishing their quality and value. Demand side conflicts are related to address sharing the resource in an efficient and equitable manner. Demand side conflicts are: extraction, intervention and allocation conflicts. Extraction conflicts arise from excessive extraction of the mobile units from a resource leading to increased extraction costs per unit of output. Excessive extraction in a year may reduce its availability in upcoming years. Intervention and allocation (positional) involves resource users' physical intervention with one another. In positional allocation conflict, resource users fight over holding control of the most productive areas of a resource.

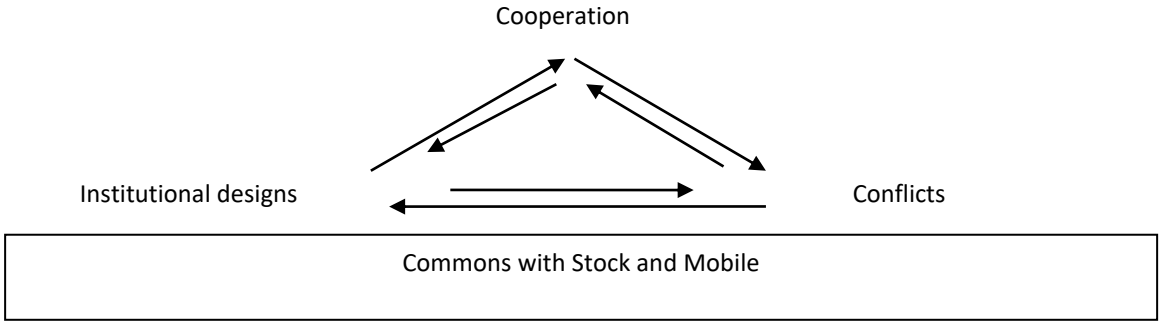
Mobile resource users are also less likely to take action to solve supply side conflicts. Preservation efforts may be more difficult due to unpredictability and incorrectly diagnosing the source of the supply side conflicts whether declining stocks result from excessive demand, maintenance failure or both. Protection efforts in a certain period are a precondition of the existence and/or more abundance flows of the same in future periods. Mobile resource flows also have deleterious effects on the ability of user to diagnose and resolve depletion conflicts. The negative consequences of depletion are passed on to the other users. The substantial information and transaction costs that users of resources with mobile flows face may devastate any activity to design governing arrangement. This allow resource user to cooperate and monitor the flow units and thereby directly address conflicts. To deal

with the problems users face dominant strategies (incentives): first store it, first control it, first come first serve, take it or quit it etc. In such uncontrollable situation, users can make 'water-hub' only through extracting from the unpredictable mobile resource units. Yearly yield from a resource with stationary units may vary dramatically from one year to the next due to: variations in rainfall, land temperature and costs of assessing the quantity of units available for extraction. But, these variations will be less than mobile resource. In general, stationary resource users face higher information and lower transaction costs (higher collective action) relating to the dynamics of the resource units, negotiation and designing institutional arrangements. Stationary units are more readily inventoried and monitored. They do not flow through multiple locations. As a result, resource users can more readily identify solutions to common-pool problems and capture the benefits of such solutions.

The policy side or management and external user side conflicts (*Body* as used by local people instead of executive committee in forest and water masters in irrigation) between communities, manager (policy maker) and external or outside users. Conflict arises from improper management means community and management not protecting the resources properly. Co-ordination conflict surfaces when the external users are not co-operating with the management and/or community. Conflicts exist when the external users intend to maximize unauthorized intervention. Authorities also fail to implement right policy in right time and in right place, as a result conflict emerges. The appropriation, distribution and regeneration process are different across the commons. These types of conflicts are difficult for users of mobile flows to assign because of intricate information and cost, and the difficulty of extracting the benefits. Resource users also face lots of uncertainty while implementing proper institutional design and collective action (figure 2).

Institutional arrangement and conflict management

Stock and mobile commons are subject to the pooled and sequential externality. Therefore, the physical characteristics of mobile and storage shape the opportunities and constraints that users face in attempting to resolve problems, making some strategy choices more likely than others. As in each setting the resource users themselves are the primary designers of the institutional arrangements, they are also the initial settlers of conflicts that come up. Even if the specific mechanism varies, people commonly rely on the following fundamental procedural modes to handle conflicts. *Adjudication*: dependence on judiciary where from final solution generates; *Arbitration*: a person or a group accepted by both conflicting side may offer some mutually agreeable solution; *Avoidance*: matters related to a conflicts are generally mention within the periphery with no outside linkage; *Coercion*: imposing forcefully one's decision upon the others; *Mediation*: selecting a mutually a third person as mediator; *Negotiation*: while people from within the group exchanging views to solve a conflict may voluntarily end up with an agreeable way out (Castro and Nielson 2003, Sarkar 2021).



Source: understanding of author

Figure 2 Relationship among Conflict, Cooperation and Institutional design

In this study backdrop, we can assume two fundamental hypothesizes.

Hypothesis 01: Types, nature and degree of conflict will differ between stock resources (community forest and tank irrigation) and flow or mobile (canal irrigation) and

Hypothesis 02: Because of the different characteristics of the resource units based on mobility and storage, different institutional arrangements and mode of conflict resolution are required for conflict resolution. As a corollary, we can also expect that nature, types and degree of conflicts are different between villages and districts.

STUDY SITE, DATA COLLECTION AND METHODOLOGY

Survey Site

To investigate empirically the involvement of conflict and its influence on commons management we had selected eleven commons villages from Alipurduar, Bardhaman and West Midnapur district of West Bengal, India (21°20′ to 27°32′ N and 85°50′ to 89°52′ E) purposively. Agriculture is the main activity of the villagers of our study sites. Poverty, illiteracy, unemployment and unequal earning opportunities have fostered social disparity and, at some places, constrained the social integration necessary for successful community participation in natural resource conservation.

Data Collection

The data used in this study was collected from the primary survey which was carried out during the period from September 2018 to July 2019 and December 2020 to July 2021 in several intervals. We have also collected some secondary data about village population on various dimensions from District Statistical Handbooks, West Bengal, India (Census 2011) and from records of Divisional Forest Office. A total of 419 households were surveyed comprising a minimum of 10 percent from each village. The village farmers are less heterogeneous in family income, family size, landholdings, primary occupations and so on. Therefore, the sample size may be considered as ideal one. We have surveyed every fifth household from the villages randomly based on our study criteria: variations in total irrigated land, resource command area, status of the resource, household differences, differences in cooperation and institutional setup. We develop a sound and applicable form of questionnaire to identify and analyze the pattern of conflicts. Furthermore, a draft version of the questionnaire was applied to sample villagers to develop a workable one before mass implementation across the communities.

We have also cross-checked the collected data with local authority such as local self-government (*panchayat* in India) members, foresters, key informants like teachers of the local primary schools and the dwellers of neighboring villages. This two-step verification ensures the reliability of the collected data.

3.3 Statistical Analysis

We conducted data analyses, which consisted of measure of basic statistic, Mann– Whitney Test and Kruskall–Wallis Test. A significance level of 0.05 was used to establish statistical significance. To compare the conflicts between resources, the Kruskall–Wallis Test reveals that at least one resource is different from others when more than two common resources are compared, while Mann–Whitney Test shows the level of differences between two resources. Finally, we have considered Paired t-test to know different level of conflicts across the same mode to handle conflicts. We have captured conflicts using Likert scale (Likert 1932). The Cronbach's alpha[2] value is 0.78 (Cronbach 1951).

[2]Internal consistency of Cronbach Alpha: less than 0.5 is unacceptable, between 0.5 and 0.6 is poor, 0.6 and 0.7 is questionable, 0.7 and 0.8 is acceptable, 0.8 and 0.9 is good and more or equal to 0.9 is excellent.

RESULTS AND DISCUSSION

General Information of the Studied Villages

Table 3 General information of the surveyed villages

Name of the village	CPR Types	Total households	Canal	Forest	Tank	Flow(canal)	Stock(forest plus tank)	Canal Command Area (Ha)	Forest Cover (Ha)	Tank Command Area (Ha)	Conflicts
Villages of Alipureduar District											
Chowkir Boss	F	176		4			4		509.00		15
Gadadhar FV	F	314		6			6		1433.86		54
Villages of Bardhaman District											
Gonna	C+T	300	8		5	8	5	(301.6)183.2		(301.6)94.3	33+17
Lakshmiganj	C+F+T	177	6	5	6	6	11	(192.2)123	176.31	(192.2)17	24+19+13
Majhergram	C+T	505	14		11	14	11	(285)251.1		(285)33.9	37+26
Suata	C+F+T	326	7	6	6	7	12	(180.9)166.7	191.00	(180.9)14.1	39+27+19
Villages of West Midnapure District											
Chhoto Chandabilla	F+T	55		5	5		10		77.29	(40.9)1.5	38+6
Joyalbhanga	C	57	2			2		(45)20			4
Pachami	F+T	96		5	5		10		40.00	(73.8)10.8	35+4
Salboni	C+F	135	5	4		5	4	(16)16	21.00		8+31
Shirshi	C+T	122	3		3	3	3	(68.2)47.1		(68.2)21.1	11+2

Source: primary survey from September 2018 to July 2019 and December 2020 to July 2021. Total households are 419. Blank cells imply that the particular CPR is not present in that village. C, F and T represent for canal irrigation, forest and tank irrigation respectively.

Table 3 shows the types of CPRs present in the commons villages. In the table, C, F and T stand for canal irrigation, forest and tank irrigation respectively. It illustrates the resource specific (mobile and stock) households. It also shows the significant correlation between canal command area and the total irrigated area ($p = 0.001$). Table also shows the total irrigated land and tank irrigated land across the surveyed villages. There is a significant relationship between total irrigated land and tank irrigated land ($p = 0.052$). Therefore, livelihoods of the village people are highly dependent on the presence of commons in the villages.

Again, table 3 shows the presence of conflicts are significantly different between tank villages and forest villages ($p = 0.039$). The distribution of conflicts are not significantly different between forest villages and canal villages ($p = 0.321$). The presence of conflicts between tank village and canal villages are significantly different ($p = 0.010$). Again, the occurrences of conflicts across study districts are significantly different ($p = 0.000$).

Conflicts (types, incentive and institution) between the storage and mobile commons

Causes of conflict in commons

(I) Channeling/Flowing water within or outside the system: This types of conflict is very low in forest commons. As a result, there is a difference between canal and forest, between forest and tank and also among

canal, forest and tank. There is no significant difference between canal and tank commons. According to the Kruskall-Wallis Test, the causes of conflict is different in three commons (table 4). The physical features of commons, mobile and storage are responsible for such conflicts in managing resource. **(II-III) Siltation and soil salinity:** The problems of siltation and soil salinity can be found in canal and tank irrigation network. Such types of problems are not found in community forest. Therefore, table 4 shows no difference between canal and tank commons but there is a significant difference among the three commons. **(IV) Forest boundary, size of the tank and length of canal:** Forest boundary, size of the tank and length of canal related levels of conflicts are same between the two types of commons and among the three types of commons. **(V) Hazardous activity of local animals/insects:** These types of conflicts are different between the two types of commons and among the three types of commons. Human-elephant conflicts are one of the most dangerous forms of conflict. The causes of conflicts are mainly insufficient food and breakdown of the food-chain in the forest (Ogra 2009). These are happening seasonally. This result is supported by Wilson *et al*. (2013). **(VI) Reconstruction:** The level and incidence of conflicts due to reconstruction are same in canal and tank irrigation. In other cases these conflicts differ significantly. The Kruskal-Wallis Test shows significant difference in the type of conflict prevailing in three types of commons (table 4).

Conflicts at the community level

(I) Share of Benefits flows: Benefit sharing conflicts are not significantly different between forest and canal villages, but are significantly different in forest and tank villages, canal and tank resource user community. Table 4 also shows levels of conflicts are different among the three types of resource users. There is a formal committee in community forest – the FPC known as JFMC in India. Such types of formal committees are not present in canal and tank irrigated communities. But, the existence of informal committees takes care of resource management there. **(II) Open and equitable participation in decision making:** In spite of different institutions, participation in decision making for conservation of resource types and level of conflicts is same in formal and informal community. **(III) Illicit resource appropriation:** Conflict due to illicit resource appropriation in canal and forest commons is not significantly different i.e. the levels of conflicts are same but, the natures of appropriation are different. The nature of extraction in common canal water is sequential externality and in community forest is pooled externality. Therefore, nature of resource harvesting also affect conflict and cooperation. The degrees of conflicts between forest, tank villages and canal, tank villages are significantly different (table 4). The table indicates that such types of conflicts within the three types of resources are also significantly different. **(IV) Access to secondary production of resources (NTFPs and fish):** Secondary products of forest (Non-Timber Forest Product, NTFPs) and water (fish) are important to community livelihood. The collection procedures of such secondary products by the resource users are also different. Such types of products are fixed (storage) and moveable (mobile). As a result, table 4 shows conflicts between and among three resources are significantly different. **(V) Unequal contributions (time, cash and kinds):** Contribution of the resource user community in terms of time, cash and kinds are different among the commons. Even if, nature of conflicts are not significantly different between canal and tank resource but all other results (table 4) are significantly different. **(VI) Authority/Leadership among the community:** A common form of collective action is the adoption of a group authority or, in small group dilemmas, a leader to regulate the provision of common goods (Endney 1980). We considered a leader (*Moral* in the local vocabulary) who may be rich farmer or having strong connections with the ruling party or respected by the villagers plays a significant role to water allocation amicably. **(VII) Absence of negotiations:** Resource harvesting nature between forest, canal and tank are different. As a result, levels of negotiation within the resource user community are also different. **(VIII) Collaborative actions:** The level of conflicts arises due to collective action (anatomy, monitoring and so on). The natures of conflicts between two and among three resources are significantly different. Institutional arrangements are solely responsible for such results (table 4). **(IX) Class, caste and gender:** Class, caste and gender related conflicts are different in canal - forest resources and forest

- tank resources (table 4). However, such types of conflicts are not significantly different between canal and tank community. Kruskal-Wallis Test shows such types of conflicts and their nature and degree are different among three types of resource user communities.

Causes of conflict due to management (Rule in use)

(I) **Disputes with officials:** The resource user communities and government manage commons and occasionally face disputes among themselves. Low levels of disputes however, are effective for successful resource conservation. According to the Mann-Whitney Test, such disputes which frequently arise between forest and canal commons is not significantly different but, they are different between forest, tank and tank, canal commons. Kruskal Wallis Test shows significant difference within the three commons. (II) **Consistency of policy, rules and regulation to sustain the commons:** Policies, rules and regulations are present in both the forest community and forest departmental level but, such types of institutional arrangement are not present in canal and tank community levels. Therefore, policy, rules and regulation related conflict are not significantly different in canal and tank community level (table 4). However, Mann-Whitney result shows conflicts are significantly different between other two groups of resources canal, forest and forest, tank. Kruskal Wallis Test shows among three types of resources related conflicts are significantly different. (III-IV) **Causes of conflicts due to Governing official:** The levels of conflicts resolution by the governmental action between two resources and among three resources are significantly different. The institutional arrangements are completely different from top to bottom to manage canal, forest and tank commons. **(V) Resource withdrawals** (specific location, size, season and fixed order, time slot, percentage) by the resource user groups are different due to different physical features (storage, mobile) in community forest, tank and canal water. Resource withdrawal related level of conflict not significantly different between forest and tank resource (table 4). But, other results are significantly different. (VI) **Distance from assigned resource location:** Distance from assigned resource location related conflict significantly different between canal and forest; tank and canal resource. Such types of conflicts are not significantly different between forest and tank resource (table 4). According to the Kruskal Wallis Test, the levels of conflicts among the three resources are significantly different. (VII) **Incentive:** Incentive (positive and negative) is an important instrument to enhance cooperation. There is no significant difference between tank and canal resource (table 4). Except this, other results are significantly different. (VIII-XI) **Conflict at the policy level:** Conflict at the policy level may also be responsible for successful management of commons (Saigal 2000). Table 4 shows policy level conflicts are same between the canal and tank water but the other results related to this conflicts are significant different. (XII) **Conflict due to appropriation rule:** Resource users are adopting stock and mobile specific strategies in confronting and solving commons conflicts due to additional features of CPRs. Community frequently faces conflicts arising due to governance or monitoring activity. The conservation of commons highly depends on monitoring activities by the resource user community. The levels, nature and types of conflicts due to appropriation rules are not significantly different between forest and tank resource. Remaining results are significantly different.

Table 4 Nature of conflicts on the basis of types, incentive and institution between the storage and mobile commons

Causes of Conflicts	Two-sample Wilcoxon rank-sum (Mann-Whitney) test (p-value)			Kruskal-Wallis equality-of-populations rank test (p-value)
	Canal and Forest	Forest and Tank	Canal and Tank	Canal, Forest and Tank
Causes of conflict in commons				
(I) Channeling/Flowing water within or outside the system	0.0000	0.0000	0.9472	0.0001
(II) Siltation	0.0000	0.0000	1.000	0.0001
(III) Soil salinity	0.0000	0.0000	1.000	0.0001
(IV) Resources boundary, size and length	1.000	1.000	1.000	1.0000
(V) Hazardous activity of local animals/insects	0.0000	0.0000	0.0000	0.0001
(VI) Reconstruction	0.0000	0.0000	0.9472	0.0001
Conflicts in community level				
(I) Share of benefit flow	0.8577	0.0000	0.0000	0.0001
(II) Open and equitable participation in decision making	0.2568	0.2791	1.000	0.9702
(III) Illicit resource appropriation	0.3825	0.0000	0.0000	0.0001
(IV) Access to secondary production of resources (NTFPs and fish)	0.0000	0.0000	0.0000	0.0001
(V) Unequal contributions (times, cash and kinds)	0.0000	0.0000	0.0891	0.0001
(VI) Authority/Leadership among the community	0.0000	0.0000	0.0000	0.0001
(VII) Absence of negotiations	0.0000	0.0000	0.0000	0.0001
(VIII) Collaborative actions	0.0000	0.0000	0.0000	0.0001
(IX) Class, caste and gender	0.0000	0.0000	0.2948	0.0001
Causes of conflict due to management (Rule in use)				
(I) Disputes with officials	0.7236	0.0000	0.0000	0.0001
(II) Consistency of policy, rules and regulation to sustain the commons	0.0000	0.0000	0.3398	0.0001
(III) Quarrel may not end up in a court cases with the governmental officials	0.8577	0.9102	0.9472	0.9988
(IV) Government action to reduce conflicts	0.0000	0.0000	0.0000	0.0001
(V) Resources withdrawal (specific location, size, season and fixed order, time slot, percentage)	0.0000	1.000	0.0000	0.0001
(VI) Distance from assigned resource location	0.0000	0.2791	0.0000	0.0001
(VII) Incentive mechanism for cooperation (penalty, sanctioning and so on)	0.0000	0.0000	0.2948	0.0001
(VIII) Provision of security by the state authority	0.0000	0.0000	1.000	0.0001
(IX) Conflict within resource departments	0.0000	0.0000	1.000	0.0001
(X) Conflict at the policy level	0.0000	0.0000	1.000	0.0001
(XI) Conflict due to governance	0.0000	0.0000	1.000	0.0001
(XII) Conflict due to appropriation rule	0.0000	1.000	0.0000	0.0001
Causes of conflict due to external users				

(I) Negotiation between community and local leader	0.0000	1.000	0.0000	0.0001
(II) Politician holds their promise about the tenure of resource	0.8577	0.0000	0.0000	0.0001
(III) Politician convey our problem/complaints to the State Authority	0.8577	0.0000	0.0000	0.0001
(IV) Politician do not use resource for their own sake	0.8577	0.0000	0.0000	0.0001
(V) Politician know the NRM related problem since they have the adequate knowledge	1.000	1.000	1.000	1.0000
(VI) Local leader (political) respecting the natural resource management (NRM)	1.000	1.000	1.000	1.0000
(VII) Poaching activity	0.0000	0.0000	1.000	0.0001
(VIII) Community relation to the external community/villagers	0.0000	0.0000	0.0000	0.0001
(IX) Growth of commons (vegetation/availability)	0.0000	0.0000	0.0000	0.0001
Causes of conflict due to infrastructure (human and physical)				
(I) Level of cooperation between State authority, Executive Committee and other resource committees	0.0000	0.0000	0.0000	0.0001
(II) State authority and politicians are efficient to manage to management.	0.0000	0.0000	1.000	0.0001
(III) State authority provision of basic assistance	0.0000	0.0000	0.0000	0.0001
(IV) Quality of road infrastructure, accommodation and communication	0.0000	0.0000	1.000	0.0001
(V) Level of understanding between Executive committee and external user	0.0000	0.0000	0.0000	0.0001
(VI) Infrastructure, uncertainty and external shocks	0.0000	0.0000	0.0000	0.0001

Source: primary survey from September 2018 to July 2019 and December 2020 to July 2021 and the calculation of author.

Causes of conflict due to external users:

(I) **Negotiation between community and local leader:** Negotiations between community and local leaders (political) are crucial for conservation of commons. The levels of conflicts are due to the absence of negotiations are significantly different between forest - canal irrigation and forest - tank irrigation. Such types of conflict are not different between tank and forest (table 4). According to the Kruskal-Wallis Test, difference is present among three types of resources. (II-VI) **Politicians for Conflict resolution:** Cooperation between local political leaders and resource communities are essential for sustainable resource management. The levels of conflicts between these two sides are not significantly different between canal and forest resource (table 4). Other results of Mann-Whiney Test and Kruskal-Wallis Test are significantly different. CPRs management activity of politicians in term of promise about the tenure of resource, conveying community problems to the higher authorities and not using resource for their own sake are not significantly different between canal and forest commons. However, Mann-Whiney Test between forest - tank and tank - canal the conflicts are significantly different. Kruskal Wallis test also shows politician related conflicts are different among the three types of resources. Resource user communities' relation and understanding with the non user communities is essential for sustaining commons. Local ruling party leaders who come from non-user community know the NRM related problem quite well. Therefore, the conflicts related to

their adequate knowledge are same across resources. **(VII) Poaching activity of the external user:** There are no significant differences in tank and canal but all other results are significantly different (table 4). The Salbani Forest Protection Committee is fully managed by women members. This form of management was the outcome of conflicts between male and female members for poaching the trees. Mid-nights are golden time for poachers as during these hours village people being afraid of elephant attacks and do not come out to monitor generally. Elephant attack phobia combined with poachers operation generates more conflicts. (VIII) **Community relation to external community:** The level, degree and incidence of conflict between resource community and non resource community are significantly different between two pairs of resources and among three pair. **(IX) Growth of commons:** The result shows the degrees of conflicts are significantly different between two types of resources and among.

Causes of conflict due to infrastructure (human and physical)

(I) **Level of cooperation between state resource management authority and resource user-community:** Level of cooperation between state resource management authority and resource user-community level executive committee (EC) is an important aspect for effective management of commons. Canal and tank irrigation is working without ECs. Although, there are canal water departmental hierarchy (from sectional officer at the base to divisional officer at the top) and forest departmental hierarchy (from beat officer at the base to divisional officer to the top) but no such departmental hierarchy is present in tank water. Local self-government is taking the responsibility for tank management. Here, we find three different resource specific management activities. As a result, degrees of conflicts between two types of resources and among three types are significantly different. (II) **The level of cooperation between state resource authority (Beat, Range and Divisional officer in forest, Engineer, Section officer in canal and local government in tank) and politician:** The level of cooperation between state resource authority (Beat, Range and Divisional officer in forest; Engineer, section officer in canal and local government in tank irrigation) and politician is very effective to manage commons. (Example: Canal Meet for amicable water supply). The level of conflicts between resource authorities and politicians are different between canal - forest and forest - tank commons. However, table 4 shows no significant difference between canal and tank commons. But, they are different among three commons. **(III) Basic assistance by the authority/Government assistance present mainly/only in community forest (as tube-well, culvert, power-tiller for cultivation, waiting-room, bath room, roads, marshall/sub-marshall pump for irrigation, trophy and so on):** Provision of basic assistance by the state authority to the resource user community and the degree and incidence of conflicts that occur thereafter is significantly different in two resource cases and in three also. (IV) **The causes of conflict due to quality of road infrastructure:** The causes of conflict due to quality of road infrastructure and communication are different between canal - forest and forest - tank commons. But, table 4 shows no significant difference between canal and tank commons. Kruskul Wallis Test shows significantly different level of conflicts. (V) **Conflicts due to understanding between EC and external resource user:** Conflicts due to understanding between EC and external resource user are significantly different between two resources and among three. (VI) **Infrastructure, uncertainty and external shocks:** These shocks (fire in forest, overtopping, water logging and overflow in canal) come as an uncertainty to the resource user and degrading the commons. In case of canal, when the aeration of the soil is satisfactory bacteriological activities produce the required nitrates from the nitrogenous compounds present in the soil, crop productivity increases. On the other hand, excessive moisture content creates anaerobic condition in the soil, plant roots do not get the required nourishments and results in low crop productivity. Hence, we observe significantly different level of conflict between two resources and among three resources (table 4).

The types of conflict in commons

Table 5 Types of conflicts across the commons (in the last five years)

Types of conflicts	Canal irrigation	Forestry	Tank irrigation
Supply Side(56)	8	37	11
Demand Side(253)	96	103	54
Policy Side(153)	52	79	22

Source: Primary survey from September 2018 to July 2019 and December 2020 to July 2021.

The categorization of conflicts of in table 5, are significantly different between canal irrigation, forest commons and tank irrigation ($p = 0.001$). Table 5 reveals that frequencies of conflicts have a close link with the physical features of resources. The levels of conflict are maximum in canal irrigation due to the absence of village level institutions like water user community and active participation of authorities for appropriation, distribution and provision.

Methods of Conflict Resolution

Table 6 Conflict resolutions

Mode to handle conflict	Canal	Forest	Tank	Mobile	Storage
Adjustment	2	18	0	2	18
Arbitration	27	60	11	27	71
Avoidance	23	37	14	23	51
Coercion	26	36	27	26	63
Mediation	31	44	14	31	58
Negotiation	47	24	21	47	45

Source: primary survey September 2018 to July 2019 and December 2020 to July 2021 and the calculation of author.

Table 6 shows the different mode of handling conflicts in commons. It shows that methods of conflict resolutions are different across commons due to differences in hierarchy institutional arrangements. But, overall results show a significant difference between tank and forest resource ($p = 0.005$). These are not significantly different between forest and canal resource ($p = 0.122$). Although, tank and canal resources are used for irrigation but the methods are significantly different ($p = 0.065$). Again, if we consider resource specific features of commons, mobile and stock (beyond public goods) we find significant differences ($p = 0.013$) between stock resource (community forest and tank irrigation) and mobile resource (canal irrigation).

CONCLUSIONS AND POLICY IMPLICATIONS

Types, nature and degree of conflict will differ between stock (forest and tank irrigation) and mobile resources (canal irrigation). Hence, different institutional arrangements are necessary for conflict resolution. The physical characteristics of mobile and storage affect the types of commons conflicts. Users exert little direct control over its use. Thus, they are more supposed to tackle with the conflicts when multiple individuals, attempting to harvest mobile resource within a defined area arise. They have to coordinate their harvesting by allocating space and/or time slots to ensure resource access to every user. In canal irrigation, irrigators may be given access to water by allocating time slots, with the length of the slot determined by the numbers of irrigators and by the land irrigators hold. Stock resources like community forest the incidence of such conflicts are relatively low. The available institutional arrangements are mostly insufficient in study areas. We have found the following: community forests have complete institutional arrangement (from JFMC at the lower tier up to Divisional officer at the top); common canal have very loose institutional arrangement at the bottom and, tank water irrigation have loose institutional arrangement at the bottom. Community is solving the conflict with the assistance of the police and/or Judiciary.

Government authorities have multiple roles to play in the governance of CPRs. Resource users are often found incapable in addressing troublesome problems alone. Authorities, in consultation with user representative may be in a better position to handle crucial situation and implement some appropriate agreements to solve different issues. In some cases they may provide information (especially for canal) to develop institutional arrangements at different tiers. They may also create an environment for resource users to develop their own institution by taking utmost case of CPRs health. Their knowledge and experiences of resource users taken together may form appropriate ways to find workable solutions to a number of CPRs problems. In some cases, role of authorities may be more direct, ranging from providing appropriate information in time to devising and applying diverse set of rules. Finally, healthy working environment through ideal interactions and mutual understanding of Govt. authorities and resource users may strengthen policy decision making process.

Conflicts, generally defined as lack of cooperation among members, are subject to some limitations. Some significant gaps which we could not cover due to resource and time constraint and left for future studies: Is the notion of conflicts always a problem? If not, identification of negative and positive conflicts for the sustainable management of common pool resources is crucial. Second, study may be considered with multiple linkages between the entities under a dynamic framework.

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