A heuristic analysis of equity and equality in the institutionalisation of property rights: the Baliraja water distribution experiment, India

Sashi Sivramkrishna*

Foundation to Aid Industrial Recovery,
No. 11, Prime Street, Richmond Town,
Bangalore 560 025, Karnataka, India
E-mail: mail@fairindia.org
*Corresponding author

Amalendu Jyotishi

Ohio University Christ College Academy for
Management Education,
Hosur Road,
Bangalore 560 029, Karnataka, India
E-mail: amalendu@ohiochrist.edu

Abstract: Natural resource management perceived as a search for institutions that can ensure simultaneous fulfilment of three goals: productivity (or efficiency), sustainability and equity. In this article, we study the implications of pursuing the goal of equity in the management of surface water resources for irrigation with a heuristic model incorporating a Leontief-type fixed production function. The analysis has been carried out in the backdrop of the Baliraja water distribution experiment in India. One suggestion is that the allocating tradable water rights over water, a common property natural resource, can be used as an instrument to improve equity. Unfortunately, advocating the use of water distribution as an instrument of poverty alleviation is fraught with implicit assumptions about the rural economy and uncertain outcomes. It is important for planners to understand that the concepts of equity and equality are applicable to inputs and outputs or outcomes. We attempt to understand the implications of equality in water distribution on social welfare with a simple heuristic analysis. Theoretical analysis shows the possible outcomes of such a policy and also intended to raise pertinent questions and hypotheses in studying the effectiveness of irrigation and watershed initiatives where rights over water have been redistributed equally.

Keywords: equality; equity; India; natural resource management; property rights; water distribution.

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Biographical notes: Sashi Sivramkrishna, after completing his MA in Economics from the University of Bombay, went on to pursue doctoral studies at Cornell University, Ithaca, New York. On completion of the programme in 1990, he returned to India and continued research at the Foundation to Aid

Industrial Recovery (FAIR). He has published several articles in international journals including *Journal of Human Development* and *Journal of International Development*. Apart from research, he teaches managerial economics, runs his own business and makes documentary films.

Amalendu Jyotishi obtained his PhD in Economics in the Institute for Social and Economic Change, Bangalore at the Bangalore University. He has worked in various social science research institutes including Gujarat Institute of Development Research. His research interests cover a wide range of issues relating to institutional economics aspects of agribusiness, water markets, forestry, inland fisheries and livelihood issues in varied ecosystems. He has published his research ideas in journals, edited volumes and working articles. He was teaching environmental economics at CEPT University, Ahmedabad. He has also contributed to a digital documentary on National Parks issues and debates. He is one of the core research members of 'Asian Initiative on Legal Pluralism' that primarily focuses on customary and folk laws relating to indigenous people's rights. Currently at OHIO University-Christ College Academy, he teaches financial market analysis and provides academic guidance to the students in their internship and applied research projects.

1 Introduction and objectives

Natural resource management may be perceived as a search for institutions that can ensure simultaneous fulfilment of three goals or outcomes: productivity (or efficiency), sustainability and equity.[1] Amongst these goals, the last equity is a complex one, both in itself and in its relationship to other goals. For instance, it is possible to ask, how does an equal or equitable distribution of inputs affect the quantum of output produced? How does equitable or equal distribution of resources (inputs) affect distribution of outcomes (output)? Does equity in input distribution ensure equity in output distribution or do we need an equal distribution of inputs to achieve an equitable outcome? In this article, we study the rationale and implications on outcomes of pursuing the goal of equity and equality in the management of natural resources or inputs like surface water for irrigation. We do so with a heuristic model incorporating a Leontief-type linear production function. The model and analysis has been constructed against the backdrop of the Baliraja irrigation project in India. Insights from the analysis, however, have a much wider relevance and may be used to understand possible outcomes of natural resource management projects and policies that pursue the goal of economic or social equity.

Achieving equity through poverty alleviation of the core poor has become an important objective of irrigation development projects initiated by governments, international agencies and/or non-governmental organisations (NGOs). A clear indication of this can be found in the project report of the World Bank-assisted Karnataka Community-Based Tank Management Project (World Bank, 2002) in southern India which states:

> "… people such as women, tribals, landless and low-caste groups often remain marginalized in local decision-making. The project will, therefore, establish organizational structures and norms which legitimize and support the inclusion of these groups in decision-making and benefit distribution." (p.23)

In India, there are almost 300 million rural poor, 70% of whom are marginal farmers and landless agricultural labourers. As much as 80% of the usable water resources go to irrigation (Hanumantha Rao, 2002), disproportionately benefiting the landed peasantry. Within the irrigation sector, Phadke (2002) mentions that in one Indian state (Maharashtra) only about 2% of farmers use about 70% of the irrigation water. With a core poor bias becoming mandatory in development initiatives, irrigation projects are being forced to look for strategies that will more directly enhance the benefits that accrue to this segment of the rural population. One suggestion is that water must be seen as a common property resource. Tradable water rights over water must be allocated to each and every individual not just the landed peasantry. In this way, water distribution can be used as an instrument to improve equity in outcomes (Rosegrant and Binswanger, 1994). The Baliraja Memorial Dam project located in the State of Maharashtra in south-central India is a case in point where tradable rights over surface water distribution were proposed as a means to alleviate inequities in the distribution of income and wealth.

Several questions need to be raised in response to any such proposal:

- Who must get rights over the use of water?
- On what basis do these persons or groups claim their right over the water?
- How do excluded groups obtain rights from the present landed elite controlling the resource?
- What is the nature of rights that can be assigned to landless and marginalised people?
- Who decides, negotiates and assigns rights over water? (Bruns and Meinzen-Dick, 2000)

While focusing our attention on these questions, we may overlook a larger question: whether distribution of water[2] should be used at all as an instrument to achieve a society's distributional or equity-related goals. Water (except drinking water) is an input or factor of production in agriculture and other rural activities. Equity in water distribution thus cannot be end in itself; its distribution must be seen as having a significant effect on distribution of outcomes or output. But can we not achieve distributional goals through direct taxation and redistribution of output or income? What are the implications of each method on efficiency or productivity?

One reason why water distribution may be considered as an instrument of poverty alleviation is that taxation is an instrument not available to NGOs or local governmental bodies like the panchayat.[3] Even provincial or federal governments are constrained by the social and the political factors in introducing taxation on agricultural incomes. With such constraints on redistribution of output, development organisations turn to key inputs, such as land and water. With movements for land reform reaching a dead end in many developing countries, water distribution is acquiring greater importance as the next-or second-best solution in achieving the distributional objectives of irrigation projects. However, as the theory of the second-best (Lipsey and Lancaster, 1956) tells us, if one optimality condition in an economic model is not satisfied, it is possible that the next-best solution may actually require changing other variables away from the ones usually assumed to be optimal.

The theory of the second-best has direct relevance to natural resource management initiatives. Advocating the use of water distribution as an instrument of poverty alleviation is fraught with implicit assumptions about the rural economy. Irrigation is

only one of the factors of agricultural production. Policies which assume that varying its distribution can bring about an equitable outcome may in fact end up lowering levels of social welfare. Our article examines the complexities that arise from an allocation of water rights and provides guidelines for socio-economic planning and policy in irrigation projects. We begin by conceptualising equity and equality using Hobbes's and Coase's principles and including water as one of the inputs or resources that determine the quantum and distribution of output (Sections 2 and 3). We then introduce the case of the Baliraja water distribution project in envisioning equity with equal distribution of water through reshuffling of property rights (Sections 4 and 5). By constructing a heuristic model using a Leontief-type production function, we are able to understand the implications of such a policy on economic productivity or quantum of output produced and the distribution of that output (Section 6). Finally, we attempt to draw policy conclusions for irrigation projects and policies that pursue equity goals from our heuristic model of the Baliraja dam project and other similar cases (Sections 7 and 8).

2 Conceptualising equity and equality

Any notion of social welfare must be based on a clear articulation of two concepts, equity and equality. Not only do we need to conceptualise these terms, but also we need to understand how they relate to inputs and output.

Following Murray-Rust, Bakhshal Lashari and Memon (2000), we conceptualise equity as a concept based on a principle of fairness: a distribution of a whole into parts that is acceptable to all members of a community which need not be equal. Equity is contextualised within existing social values, it is a subjective or qualitative term, and what is acceptable to one community need not be acceptable to another or even to the same community over a period of time with changes in its social and economic structure.

For instance, in an equitable water distribution system, some people may obtain a larger share of water due to prior rights, in compensation for a greater contribution of system construction and maintenance (Murray-Rust, Bakhshal Lashari and Memon, 2000). Interesting examples of equity in traditional systems are also found in Agarwal and Narain (1997): for instance, under the *kul* system in Himachal Pradesh, India, in years of scarcity, big landowners gain access to water first and small farmers only later in the season. The community, however, finds the system equitable because demand for labour is spaced out over two phases: this allows small peasants to work on the landlords' fields in the first phase and then their own later. Moreover, no labour shortages occur and wages remain stable throughout the cropping cycle.

Equality, on the other hand, is an objective or quantitative term and is taken to mean equal shares of the whole related to 'a directly measurable parameter' (Murray-Rust, Bakhshal Lashari and Memon, 2000, p.1). In the context of water distribution, this measurable parameter can be size of landholding (proportionate equality) or the individual; in the latter case, every member of society, irrespective of landholding, gender and/or occupation, receives an equal[4] share of water. Non-traditional systems, like those promoted by new social movements and NGOs, usually look for equality in water distribution rather than equity.

Equal sharing of water need not mean that the outcome is equitable. The principle of proportionate equality is one example (Chambers, 1984). But even when the individual, and not land, is the chosen parameter, equality need not imply equity. For the sake of

argument, consider two couples X and Y. X are progressive and have a girl child. They decide not to have any more children. Y on the other hand, being biased against girl children, ends up with four girls and finally a boy before they decide not to have any more children. With an 'equal' distribution of water, family X is allocated three units of water whereas family Y gets seven[5] units. Is this a socially 'equitable' or 'fair' outcome? An answer in the negative implies equality in distribution of inputs need not necessarily entail an equitable distribution of outcomes.

The distribution of inputs according to the principles of equity or equality can neither take for granted nor ignore their effect on distribution of output.[6] More often than not, irrigation projects are clear on their objectives regarding equality or equity in input distribution without realising the full implications of such policies on output or outcomes. Social welfare, however, ultimately depends on the level and distribution of outcomes.

In Figure 1, we construct a 3 × 3 matrix of possible input–output combinations and relate them to various political doctrines.[7] These doctrines, though essentially systemic or macro, often implicitly guide strategies in local or micro-level projects. Acocella (1998) categorises the liberal doctrine (box C in Figure 1) as one where opportunities are equal but outcomes are determined by personal ability which will be unequal (but equitable). The socialist doctrine (box D in Figure 1) which follows the principle 'from each according to his/her ability, to each according to need' is based on efficiency in use of inputs and equal distribution of output under a central plan. A pure market system (box E in Figure 1) ignores the initial distribution of resources, and results in an outcome that is both unequal and inequitable. We show traditional systems, for instance a feudal society, in both boxes A and B, because distribution of output can be considered as equitable (though unequal) by those within a community but inequitable (and unequal) by those on the outside.

Figure 1 A matrix of doctrines through possible combinations of input and outcomes

		Outcomes		
		Unequal but Equitable O_1	Equal O_2	Unequal and Inequitable O_3
Inputs	Unequal but Equitable I_1	Traditional (as perceived by members within the community) (A)		Traditional (as perceived by people outside the community) (B)
	Equal I_2	Liberal (C)	(G)	(F)
	Unequal and Inequitable I_3	(H)	Socialist (D)	Pure Market (E)

The objectives of irrigation projects could also be situated in the matrix. An active pro-poor policy in these projects means that desired outcomes are those specified in column 0_1 or 0_2 of Figure 1. When water is considered an instrument to achieve social justice, equity or equality in its distribution restricts planners to row I_1 or I_2. In this article, we focus on a specific initiative: allocating an equal share of water (row I_2) to every individual and understanding its effect on outcomes. We therefore envision the outcome in box C of the matrix or even box G[8]. As we will see, such 'simple' policies may, though not necessarily[9], result in an inequitable (with the poor worse off) and unequal outcome, i.e. box F.

If allocation of water on an equal basis succeeds in bringing equity or equality in income distribution, then other projects need to consider this as an important policy option. If it fails in meeting its pro-poor objective, we need to know why and must explore other options. One possibility is row I_1 – a return to traditional 'equitable' systems – but with a realisation that distribution of output may be inequitable, especially with non-traditional (or non-feudal) criteria of social justice. If such solutions are unacceptable, the only option would be row I_3; in particular box D or H, with a redistribution of output through direct taxation.

3 Equality and social welfare in water distribution

Distribution of water rights for irrigation purposes in India has been based upon either of two doctrines (Chambers, 1984):

1 *Prior appropriation*. Whoever first exploits a resource has the right to continue to do so. Inequality comes through usage since head-enders get customary right over water usage and tail-enders get less or no water.

2 *Proportionate equality*. Water is supplied in proportion to land surface area. In this case, the landless get no right over water. Inequality comes through landownership.

As seen above, both these doctrines may be considered as inequitable (Chambers, 1984) and this has led to experiments where people have been made the basis for distribution of water rights. Rights over water are distributed equally to every household on the basis of number of members in each family, irrespective of landownership or location. Some initiatives in India include: Sukhomajri in Haryana (Chambers, 1984; Kerr, 2002), Gram Gourav Prathistan (more popularly referred to as Pani Panchayat) in Maharashtra (Chambers, 1984; Shah, 1993; Deshpande and Jyotishi, 2002; Kerr, 2002), the Aga Khan Project in Gujarat (Shah, 1993) and Ramnathapuram in Tamil Nadu (Shah et al., 2002). Such schemes have found general support from economists and activists.

In their comprehensive study of the Pani Panchayat scheme, Deshpande and Jyotishi (2002) emphasise that:

> "the equitable distribution of benefits across farm families helps in establishing a just society. Family instead of area, as the distributional weight, helps to correct the distortions caused by ill distribution of land." (p.290)

Shah (1993), for instance, articulates the objective of distributing water equally amongst households as follows:

> "In our search for social justice and for ways to reduce rural economic inequalities, land reforms have all but lost their relevance. But a more equitable distribution of water rights may still provide a major opportunity." (p.15)

> "Equal shares [of resources] could produce distributive effects similar to a powerful land reform." (p.7)

Kerr (2002) in his recent work on watershed development in India has made a similar argument:

> "The last few years have seen a growing concern about ensuring that poor, landless people benefit from watershed development … return to the ideas first introduced in the Sukhomajri and Pani Panchayat projects calling for poor people to gain usufruct rights to natural resources made more plentiful or more productive through watershed development." (p.1391)

In fact, there is an implicit argument in Kerr's article that giving an equal share of water to every household is superior to, for example, granting fishing rights or sharing products of common lands with landless people. The latter, he argues, "… while favorable toward poverty alleviation, pale in comparison with the full and equal water rights granted to landless households in *Sukhomajri* and under *Pani Panchayat*." (p.1391)

Claude Alvares (n.d.), referring to the Pani Panchayat project, also favours such equal sharing of water:

> "It [equal sharing of water] gave the landless an economic (and, therefore, bargaining) power that had always been denied them because they did not own land." (p.3)

> "Several of the principles behind the organization of the Pani Panchayat ought to be made part of public policy. First, the principle that people should have equal shares in common resources, if adopted, would revolutionize society in far-reaching ways." (p.8)

The Pani Panchayat allocated water shares equally, allowing the landless members of the water cooperative to lease lands. However, it did not allow the landless poor pecuniary exchange of their water shares (Phadke, 2002). One scheme that went beyond mere water sharing was the Baliraja Dam project. Not only was water shared on a per individual basis, but also members were entitled to shares that could be traded. Landless members could therefore sell their shares to others or use their share of water by leasing land from others (Phadke, 2002). The idea is clear: an equal distribution of resources (or inputs) would reduce disparities in income (or output). In other words, allocating private property rights over resources like water can be used as a tool to achieve a 'better' distribution in income. However, it is not clear whether 'better' distribution in output implies equity or equality in output distribution.

4 The Baliraja project and water distribution experiment

The Baliraja movement[10] in the 1980s was the work of the *Mukti Sangharsh*, a people's democratic struggle against powerful sand miners. The movement acquired rights for sand mining from the state and utilised these to construct the 4.5 m high Baliraja

Memorial Dam. In line with its philosophy, the movement advocated two important objectives in the distribution of surface water resources from the dam. First, it addressed the question of sustainability. It was decided that in the drought-prone region where the dam was located it was important to move farmers away from cultivation of water-intensive crops like sugar cane. To realise its second objective, equity, the movement implemented a scheme for the equal sharing of water amongst all households, including the landless, in the villages of Tendulwadi and Balwadi. The landless or marginal farmers could either sell their share of surplus water or rent-in land for cultivation on a sharecropping basis. A price reflecting scarcity of water resources would help the movement meet its objective of equity. Going back to Figure 1, the Baliraja project hoped to bring about equity or equality in outcomes through an equal distribution of water rights (box C or G).

The Baliraja project serves as an anecdotal case or a background against which we carry out a heuristic analysis of the implications on social welfare of equal sharing of surface water. It is important to reiterate that this article is not an empirical evaluation of the Baliraja or any other specific project.

5 Social justice through reshuffling property rights: the economist's concern

Even if we agree about redistributive goals (and it is here that economists tend to disagree), there is still the question of how best these goals can be achieved; namely, about the means of achieving social justice. For several reasons[11], economists believe that redistribution of wealth is better achieved through progressive taxation of output or income rather than through reshuffling property rights over resources or factors of production. However as we discussed above, there are those who contend that redistributing access over inputs (like water) could bring about a greater degree of equality in outcomes.

Deciding on the means to achieve social justice cannot ignore the effects of these methods on efficiency or productivity. For a moment, let us consider the second scenario, i.e. where we redistribute rights over resources. The question then arises as to how such rights should be distributed. The Coase (1960) theorem can provide some assistance. It argues that the use of resources will be efficient regardless of the legal rule defining the allocation of property rights over these resources. This is subject to the condition that there is successful private (but accommodating or cooperative) bargaining and the transaction cost is zero or low enough for it not to inhibit bargaining. In real-world situations, successful private bargaining cannot be taken for granted. Not only are there transaction costs, but also several uncertainties and complexities pertaining to the particular resource in question and to the regional – sectoral context in which bargaining takes place.

This makes the Hobbes theorem[12] relevant: the law should allocate property rights to the party who values them most. By doing so, the law makes exchange of rights unnecessary and saves the cost of transactions (Cooter and Ulen, 1997). Output is maximised and distributional goals can be achieved through direct taxation of output. While saving transaction costs for exchanging rights, in principle, the Hobbes theorem, however, requires a perfectly informed legislator who knows exactly who values the property rights most.

These limitations apart, what do the Coase and Hobbes theorems mean in the context of water distribution? On the basis of the Coase theorem, assigning equal rights over water should lead to an efficient solution if private bargaining is efficient. If the costs of bargaining are too high or bargaining does not succeed for whatever reason, then the Hobbes theorem becomes more relevant. Equity could be more efficiently and effectively achieved through a progressive tax on output rather than distributing water rights equally.

Our concern here is not a simple equity – efficiency trade-off, but the possibility that allocations of property rights, without taking into account the complexities of private cooperative bargaining, could lead to a deterioration of social welfare based on the Hicks –Kaldor[13] and even possibly the Pareto criterion.[14] Such deterioration in social welfare will adversely effect the poorest of the poor; the purpose of equal water distribution initiatives will be self-defeating.

6 Analysis of equality in water distribution using a heuristic model

In this section, we attempt to understand the implications of equality in water distribution on social welfare. The analysis shows the theoretically possible outcomes of such a policy and is intended to raise pertinent questions and hypothesis in studying the effectiveness of irrigation initiatives where rights over water are redistributed equally.

Consider a real economy with two farmers, F_1 and F_2, producing an output Y using three inputs: land (L), labour (N) and water (W). Each farmer faces a Leontief-type fixed production function given by:

$$Y_i = \min(L_i, N_i, W_i), \quad i = F_1,\ F_2 \ (\text{or } 1, 2). \tag{1}$$

It may be argued that linear production functions like the Leontief-type fixed production function may not be the best way to represent the relationship between inputs and output in the agricultural sector. However, as a simple heuristic model, this approach, we think, is acceptable. It is highly unlikely that our main findings will change with other types of non-linear production functions.

Let the initial endowments be given as:

$$\begin{aligned} &L_1 = 90 \quad L_2 = 10 \\ &N_1 = 50 \quad N_2 = 50 \\ &W_1 = 90 \quad W_2 = 10 \\ &Y_1 = 50 \quad Y_2 = 10 \quad Y_{1+2} = 60. \end{aligned} \tag{2}$$

Clearly, this is a sub-optimal situation and there exists a possibility for cooperative bargaining between F_1 and F_2. The optimal situation will be where:

$$\begin{aligned} &L_1 = 90 \quad L_2 = 10 \\ &N_1 = 90 \quad N_2 = 10 \\ &W_1 = 90 \quad W_2 = 10 \\ &Y_1 = 90 \quad Y_2 = 10 \quad Y_{1+2} = 100. \end{aligned} \tag{3}$$

F_1 must pay F_2 a wage (a share of Y_1) for his labour services. The wage will be a result of the bargaining game between F_1 and F_2. A 'reasonable'[15] solution will give a wage rate p_N: $0 < p_N < 40$. This exchange will mean an improvement in social welfare on the basis of both the Hicks–Kaldor and the Pareto criterion.

As pointed out by Cooter and Ulen (1997), a reasonable solution invokes social norms. In the context of rural labour markets, a reasonable solution would have to take into consideration not merely demand and supply, but several complexities including class and caste structure, interlocked markets, availability of migrant labour and so on.

Starting from Equation (3), consider now that water is equally redistributed amongst households in this village so that initial endowments of resources and output are:

$$\begin{aligned} &L_1 = 90 \quad L_2 = 10 \\ &N_1 = 90 \quad N_2 = 10 \\ &W_1 = 50 \quad W_2 = 50 \\ &Y_1 = 50 \quad Y_2 = 10 \quad Y_{1+2} = 60. \end{aligned} \tag{4}$$

Once again, this is a sub-optimal situation and there exists a possibility for cooperative bargaining between F_1 and F_2. One possible solution is where the distribution through exchange reverts to Equation (3).

F_1 must pay F_2 a price for F_2's water share. The price of water will be a result of the bargaining game between F_1 and F_2. A solution will give us a water price, p_W: $0 < p_W < 40$. This exchange will mean an improvement in social welfare on the basis of both the Hicks–Kaldor and the Pareto criterion. Let us assume that a reasonable water price is $p_W = 20$. This gives $Y_1 = 70$, $Y_2 = 30$ and $Y_{1+2} = 100$.

Corollary 1. A 'reasonable' solution to the bargaining game depends on the existence of a water market.

Corollary 2. Even if there exists an efficient water market, equal allocation of water by itself cannot bring about equality in income. However, income of F_2 does improve with allocation of water rights, though the extent of improvement depends on p_W.

Corollary 2 makes it clear that equal distribution of outcomes through equal distribution of water is not feasible. A more likely outcome would be to reach box C, an 'equitable' one with the degree of equity depending on p_W.

Returning to Corollary 1, let us delve further into the importance of water markets. Consider an initial resource endowment as:

$$\begin{aligned} &L_1 = 90 \quad L_2 = 10 \\ &N_1 = 50 \quad N_2 = 50 \\ &W_1 = 50 \quad W_2 = 50 \\ &Y_1 = 50 \quad Y_2 = 10 \quad Y_{1+2} = 60. \end{aligned} \tag{5}$$

One possible solution to maximise social output is an exchange of resources as in Equation (3) above so that $Y_{1+2} = 100$. F_2 will get an amount $(p'_N + p'_W)$: $0 < (p'_N + p'_W) < 40$.

What happens if no water market exists or in other words, F_1 and F_2 are unable to exchange their rights over water? We then have a situation where F_1 will not employ labour services and the situation remains as given by the initial endowments, i.e. as in

Equation (5) above with $Y_{1+2} = 60$. Both F_1 and F_2 are worse off than with unequal distribution of water as in Equation (2), giving us:

Corollary 3. The non-existence of a water market may mean deterioration in social welfare under both the Pareto and the Hicks–Kaldor criterion.

It is important that in 'non-existence' of water market, we include lack of markets with reasonable transaction costs. The importance of transaction costs associated with the redistribution and exchange of water (T_W) must be understood prior to any arrangement redistributing water rights. T_W, as we have seen, includes not only costs of obtaining information on productivity of water, but also legal and other negotiation costs. Moreover, the physical and technical costs of storage, transport and measurement of water need to be considered (Rosegrant and Binswanger, 1994). Returning to the Coase theorem, T_W is a key determinant of whether sharing water equally will have the desired effect on equity. A strong institutional arrangement is an important prerequisite to keep T_W within reasonable limits (Rosegrant and Binswanger, 1994).

Corollary 4. High transaction cost in cooperative bargaining in water markets could lead to loss in social welfare. Bargaining in labour markets is likely to have lower transaction costs.

Where transaction costs in trading water rights are too high, equal distribution of water may not be advisable.

Corollary 5. Given that labour markets exist, using the Hobbes theorem and allocating water share according to land area (principle of proportionate equality) would mean that both F_1 and F_2 are better off.[16]

Returning to Equation (2), we saw that a reasonable solution would mean p_N: $0 < p_N < 40$. With Equation (5), if exchange of water and labour does take place, we must have $(p'_N + p'_W)$: $0 < (p'_N + p'_W) < 40$. A reasonable solution, as we have seen, invokes social complexities which means one cannot assume that $(p'_N + p'_W) > p_N$.

Corollary 6. A forced redistribution of water resources could have a negative impact on wage rates to compensate the landed elite for p_W.

This brings us to another important result. There can be no doubt that the ideal situation for both efficiency and equity is when endowments are given as:

$$\begin{aligned} &L_1 = 50 \quad L_2 = 50 \\ &N_1 = 50 \quad N_2 = 50 \\ &W_1 = 50 \quad W_2 = 50 \\ &Y_1 = 50 \quad Y_2 = 50 \quad Y_{1+2} = 100. \end{aligned} \tag{6}$$

Corollary 7. When endowments are not equal in more than one market, correcting the imbalance in one market alone may not be the second-best solution.

With initial endowments as in Equation (5), another possible cooperative solution between F_1 and F_2 would be through a sharecropping[17] agreement, where F_1 transfer 40 units of land to F_2 (or F_2 rents-in land on a sharecropping basis). A reasonable solution, say a 50 : 50 sharecropping arrangement, would once again mean an improvement in F_2's income although equality in income between F_1 and F_2 is not possible.

Corollary 8. The lack of water markets would mean that sharecropping[18] is more likely to be the outcome of equal sharing of water.

Corollary 9. Equal sharing of water may need a simultaneous application of the normative Coase theorem (Cooter and Ulen, 1997): structure the law so as to remove impediments to private (sharecropping) agreements.

Essentially, we need to lower transactions costs; in the case of sharecropping this will mean assigning simple, clear and well-defined property rights to land.

However, sharecropping may not be the final option, especially, where F_1 has access to an alternative source of water. This alternative could be groundwater that can be used for irrigation by pumping it to the surface, instead of buying surface water from a reservoir.

In a situation where cheap groundwater is available, consider an initial distribution of resources as in Equation (5) above. With no water market, cooperative bargaining would mean sharecropping at, say, $p_L = 20$ units of Y and $Y_{1+2} = 100$. However, if F_1 can obtain 40 units of water (groundwater) at a price (C_{GW}) then he would prefer to extract groundwater if:

$$C_{GW} + p_N < p_L. \tag{7}$$

In this case, F_2 is left with surplus water which can neither be sold nor used on land made available on a sharecropping basis.

Corollary 10. Equal sharing of water does not automatically mean an improvement for the landless and marginal farmers.

Corollary 11. Improving equity through sharing of inputs may require a restriction on exploitation of inputs from alternative sources; for instance, this alternative could be exploitation of groundwater.

The understanding of cooperative bargaining in land, labour and water markets will be incomplete without taking into account the market for a vital input, credit (R). Using the Leontief-type fixed production function with credit as an input gives us:

$$Y_i = \min (L_i, N_i, W_i, R_i),\ i = F_1, F_2 \tag{8}$$

Consider an initial resource distribution as:

$$\begin{aligned} &L_1 = 90 \quad L_2 = 10 \\ &N_1 = 50 \quad N_2 = 50 \\ &W_1 = 90 \quad W_2 = 10 \\ &R_1 = 100 \quad R_2 = 0 \\ &Y_1 = 50 \quad Y_2 = 0^{19} \quad Y_{1+2} = 50 \end{aligned} \tag{9}$$

The imperfect 'endowment' of credit amongst F_1 and F_2 makes water redistribution a 'useless' exercise. Access to credit is likely to landowners rather than water owners since water is unlikely to be considered collateral for loans. Two options are available to F_2. The first is to sell his labour to F_1 at p_N: $0 < p_N < 40$. However, output is not maximised with $Y_{1+2} = 90$. F_2 may also decide to rent out his land to F_1 so that he received $(p_N + p_L)$: $0 < (p_N + p_L) < 50$.

In fact, where C_{WG} is low and imperfect markets, like that for credit, exist we may even find 'reverse sharecropping' from F_2 to F_1.

Corollary 12. It may not be sufficient to merely lower T_W or develop technologies to distribute water rights to the landless poor and marginal peasants to bring about equity in output when imperfect markets like that for credit are taken into consideration.

Finally, we must return to the economist's contention that social justice may be better achieved through a progressive taxation than redistribution of property rights in water. Given that initial endowments as in Equation (6) are unlikely, equal sharing of water could mean a loss in social welfare as per Corollaries 3, 4 and 10 so that:

Corollary 13. If the transaction cost of imposing a progressive tax on output $T_X < T_W$, then equity is better achieved with an income or output tax.

In India, agricultural income remains untaxed. Even then, one cannot ignore the possibility that the landless and marginal farmer might actually be worse off from a reduction in employment and wage income due to inefficient water and credit markets.

7 The Baliraja experiment revisited

In the late 1980s, one of the authors visited the Baliraja Dam Project. At that time, discussion amongst the activists leading the movement was around issues of equity and sustainability which we have presented in Section 4. More than 15 years later, the present authors decided to revisit the project which the second author did. Some of his observations were reported in Jyotishi and Rout (2005). We briefly summarise these more recent observations made on revisiting the Baliraja project.

First, a number of large farmers were extracting groundwater using electric pump sets to cultivate sugar cane, a highly water-intensive crop. Second, in some cases, large farmers grew subsistence crops with their share of surface water from the Baliraja Dam, but cultivated sugar cane in remaining portions of their holdings using groundwater. Third, big farmers also leased land[20] from marginal farmers on a 25% sharecropping basis and grew sugar cane using groundwater. The return to the marginal farmer from this 25% share was higher than that from growing subsistence crops. Moreover, without the need to cultivate their land, marginal farmers were able to work in sugar factories and earn decent wages. Last, there was no evidence that a water market had emerged in the Baliraja project area. The equal sharing of water seemed pointless in meeting its objective of bringing about equality in output distribution.[21]

Our heuristic model provides a number of possible leads as to why the Baliraja project may have 'failed' in realising its goals. From the non-existence of water markets to availability of groundwater and credit, the various corollaries presented above become a valid hypothesis for an empirical study of the project.

We must make one comparison here between the Baliraja project and the Pani Panchayat scheme, discussed in Section 3 above. While the former had by and large abandoned its initial objectives of equity, the latter has been more successful in meeting this objective (Deshpande and Jyotishi, 2002). It is obvious that equal sharing of water makes good economic sense when members of the water cooperative have a fairly equal endowment of resources (in particular, land and access to credit) to begin with (Endowment (6) above). Members of the Pani Panchayat or water council were mostly marginalised farmers with small landholdings. Moreover, sale of water rights was not permitted and this meant that farmers were motivated to cultivate mainly less water-intensive subsistence crops. More than 'equality' (which already existed amongst

the members of the cooperative), the question of food security was tackled effectively by restricting cultivation of water-intensive commercial crops like sugar cane.

When differences in land endowments are significant, equal sharing of water will not result in equity or equality in output. Even if land (re)distribution is forced upon members of a collective, the distributional objectives of a water-sharing project may be far from being realised. An interesting example is the Andhi Khola Irrigation Scheme in Nepal (van Etten, van Koppen and Pun, 2002) where delays, transfer of poor-quality lands and transfer charges that had to be borne by the landless all combined to dilute the objective of the project.

> "The most opportune moment for the land transfer, well before construction, was lost. This rendered the land price for the poor high and it benefited larger farmers willing to sell. Inequalities remained substantive." (p.18)

The rooted complexities of the rural economy cannot be assumed away; in fact, they render any simplistic idea of redistributing wealth and income through redistribution of property rights over inputs like equal water shares completely ineffective.

van Etten, van Koppen and Pun (2002) make a similar observation:

> "Another option to ensure less unequal benefits for the poor is by allocating water rights equally among all landowners, tenants and landless people. In these cases, water is not only used to irrigate own plots but also for exchange and sale, which opens up new possibilities for those with little or no land. This allocation principle of 'water to the people' is claimed to be more pro-poor than the common principle of 'water to the land' by which water is allocated to landowners in the command area, proportional to their land size … there is little or no empirical evidence to show whether this option of allocating equal water rights does actually benefit the poor." (p.1)

Our heuristic model can give us a way of evaluating the possible outcomes of what may at first appear to be schemes that will obviously benefit the poor and bring about greater equality in the distribution of outcomes.

8 Conclusions

Issues of equity (fairness) and equality are at the core of many development controversies. In the setting of a developing country, these are particularly acute with respect to property rights in water. However, a more in-depth understanding of the rural economy is important before adopting simplistic solutions to achieve equity or equality in income and wealth.

This article develops a bargaining model of water distribution rights in order to analyse various outcomes (equity and efficiency) in response to different initial allocation of water property rights. The article begins with a model where one factor (labour) can be allocated among 'firms', another (land) cannot and a third (water) is subject to various restrictions (transaction costs, etc.), to see how different assumptions regarding water rights will or will not lead to efficient trades. Discussion is also centred on how outcomes relate to themes, such as equity, efficiency and equality and market outcomes pioneered by Coase and Hobbes.

Given the constraints and imperfections that exist in rural markets, the preferred policy option would be a Hobbesian approach based on direct taxation. This may not only provide an outcome superior in terms of efficiency and equality to Coase's tradable

property rights, but also may in fact be the only possible solution to meet the objectives of equity or equality and efficiency.

Observations, both in the 1980s and then a decade and a half later, of the Baliraja water distribution experiment were the starting point for our heuristic model and analysis. It proved a promising site for explorations into these issues. Our present research article stopped short of an empirical testing of the various corollaries with respect to the Baliraja or other projects like the Pani Panchayat and Andhi Kola. The basis for such an empirical analysis has been developed but remains to be carried out. This, however, does not limit the significance of the present work. The corollaries derived from our heuristic analysis provide a useful set of hypotheses that need to be examined in drawing up policies and projects that intend to realise redistribution goals.

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Notes

[1] Equity in what? Distribution of resources or outcomes? We return to this question later in the article.

[2] When we say 'distribution of water', we mean 'distribution of water rights'. These terms are used interchangeably throughout this article.

[3] Local government body at the village level in India.

[4] Our analysis holds good for any redistribution of rights over water, even if it is not perfectly 'equal'. What is important is that water rights are not related to landholding so that even the landless are assigned a share of water resources. Hereafter, equal distribution must be understood in this sense.

[5] Each member of the family gets one unit.

[6] We speak here of equity and equality in water distribution. However, the issue is a larger one and encompasses many social and economic subjects. Arguments for and against reservation on the basis of caste and religion often confuse equality with equity.

[7] The input–output matrix presented in Figure 1 only presents how equity and equality is generally perceived under various doctrines. The doctrines are of course far more complex than shown in Figure 1. A more in-depth analysis of these doctrines is beyond the scope of this article.

[8] Equality in terms of distribution of output produced under the project.

[9] This is the *raison d'être* for our case study of the Baliraja irrigation project.

[10] We have not traced the interesting history of the Baliraja movement. This can be found in Joy and Rao (1988), Phadke (2002) and Jyotishi and Rout (2005).

[11] These include transaction costs of redistributing an input or output, and distortionary effects of redistributing property rights (see Cooter and Ulen, 1997). Moreover, political, economic, social and technological factors are also crucial forces that influence reshuffling of property rights.

[12] To Hobbes humans carry the inherent drive to fight so that 'only by imposing will upon the ruled can society be organized to run efficiently and peacefully' (Tidwell, 1998, p.42).

[13] Hicks–Kaldor deterioration (improvement) in welfare: aggregate net benefit declines (increases).

[14] Pareto deterioration (improvement) in welfare: nobody (at least one person) is better off and at least one person (nobody) is worse off.

[15] Cooter and Ulen (1997) distinguish between a rational and reasonable solution. A rational solution could be $p_N = 40 - e$ or $p_N = 0 + e$ where e is infinitesimally small. A rational wage is unlikely to be acceptable and a reasonable solution is more likely.

[16] Both F_1 and F_2 are better off with a resource distribution given by Equation (2) than by Equation (6).

[17] We ignore the possibility of land sales, since sharecropping is the preferred option in most rural economies.

[18] Most rural economies, especially, those of South and Southeast Asian regions, already have traditional (non-formal) rules for sharecropping arrangements, thereby keeping transaction costs low.

[19] Output is '0' given the Leontief Production form, although in reality it may be possible to have positive output even with zero credit.

[20] This is what we termed 'reverse sharecropping' above.

[21] As mentioned above, the Baliraja experiment also aimed at achieving sustainability in one of India's most drought-prone regions, by inducing farmers to take on subsistence crops instead of sugar cane. This, however, seems not to have taken place on any significant scale.