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## Modelling the Bargaining on Scarce Water Resources in the Trans-himalayan Region of Nepal

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### Abstract

Irrigation in the Trans-Himalayan region, where water is a scarce commodity, is organised through local institutions. The existing social hierarchy, where the society is divided into upper-ruling class and lower-working, profoundly influences the water management in the region. Both classes assume different roles towards the management of water, both in decision making and their physical execution. The upper class is responsible for the water related decisions and investment in irrigation infrastructures while the lower class contributes labour for the irrigation system construction and maintenance. In addition, the latter class is also a source of labour in farms owned both classes. The ruling class enjoys the property right over water and make prime use of water by planting higher value crops though they share some amount of water with the lower class. Due to limited supply of water to the lower class, they plant crops having lower water demand for their subsistence, and part of their fields may remain fallow. The optimisation of economic benefits, given the social hierarchy, political power and rights on water is the aim of the study. This challenge is addressed by modelling the problem into a stylized reciprocal principal-agent model. As the upper class enjoys rights on water and lower class constitutes majority of the available labour, the former class is regarded as a principal in the case of sharing the water, while the latter is considered as a principal in sharing the labour. The water-principal provides water to the agent depending upon the labour provided by them while the labour principal allocates labour to the agent depending on water provided by them. The benefit functions, the participation constraints and the response functions of both classes were derived algebraically. An attempt is made to quantify the political power coefficients of the two classes because the problem is bargaining in scope rather than a pure principal-agent relation. The power coefficient is plugged into the net benefit function of the principals and the net benefit is maximised subject to the participation and incentive constraints which gives the optimised solution of this specific problem.

**Keywords:** Bargaining, principal-agent model, property rights, social-hierarchy, water