TOWARDS A FAIR AND FEASIBLE ALLOCATION OF CAUVERY WATERS

by

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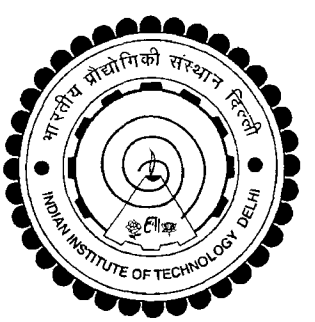

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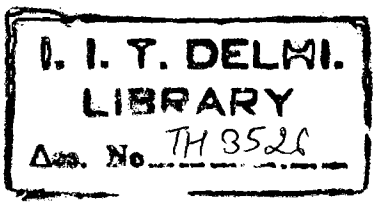

To my beloved Teachers

CERTIFICATE

This is to certify that the thesis entitled **"Towards a Fair and Feasible Allocation of Cauvery Waters"** being submitted by **Ravi Kumar K.** to the **Indian Institute of Technology Delhi, New Delhi (India)** for the award of the degree of Doctor of Philosophy in Civil Engineering Department is a bonafide research work carried out by him under our supervision and guidance. The research reports and the results presented in this thesis have not been submitted, in parts or in full, to any other University or Institute for the award of any degree or diploma.

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ABSTRACT

In the history of water conflicts, various water appropriation doctrines and mechanisms have been proposed for the purpose of conflict resolution. Evidently, the interesting concepts of 'equity' and 'fairness' in water allocations were proposed as a preferred sharing doctrine but its translation beyond a mere theoretical enunciation has not been possible. Past investigators have not succeeded in their attempts to develop an objective frame work to define 'equitable apportionment' in real world water conflicts and this failure has been attributed to the largely perceptive nature of these concepts.

The present study has, appropriately therefore, attempted to address these and related issues with reference to the dispute over sharing of water resources of Cauvery basin in India between the states of Kerala, Tamil Nadu and Karnataka and is presented in four parts. The issues studied in each part relate to the following:

(i) Equity and fairness: Understanding the basic concept of equity and fairness; difficulties associated with its measurement; stakeholders' perceptions about this concept and formulation of a basis for quantification of 'Fair and Equitable' allocations based on the twin paradigm of distributional and procedural justice.

(ii) Conflict situations with dominant socio-political dimensions in which all contenders have perfect knowledge of player options, strategies and priorities.

(iii) Conflict situations with dominant socio-political dimensions but where contenders formulate their respective strategies based only on perceived notions of options, strategies and priorities in respect of contending players.

(iv) Implementation of the derived water appropriations through derived regulatory regimes that define operating policies of four reservoirs in the headwater regions of Cauvery.

In the first part, the Principle of Equitable Allocation has been adopted as a preferred basis for arriving at appropriations and is in line with the recommendations made at the Helsinki Conference, (ILA 1966), and reiterated at the Dublin Conference, (UNCIW 1997). A paradigm has been proposed to quantify these 'Fair and Equitable' (also 'F&E') and it is averred that the proposed methodology addresses the issues of equity and fairness through proportional allocations for distributive fairness and a cooperative, equal opportunity, model for negotiations for the important but perception based notion of procedural justice.

In the second and third parts of the study, Conflict Analysis techniques such as Metagame and Hypergame Analysis have been used to model Cauvery conflict in which component of the study also dwells on the possible influence that the Cauvery Waters Disputes Tribunal (CWDT) may have on the outcome of the dispute. Literature study reveals that these Game Theoretic techniques are ideally suited in the study of conflicts that have a strong socio-political dimension and these latter aspects indeed provide the raison d'etre for the role that these techniques can play in the study of water conflicts.

The technique of Hypergame analysis is a particularly attractive approach in water conflicts as, it often happens, the players in such a type of dispute formulate their respective strategies based only on their perceptions about similar strategies of other players. Misperceptions in a dispute charged with socio-political aspects such as a water related conflict is indeed a distinct possibility and Hypergame Analysis has been

applied to model possible misperceptions upto level 2 in the Cauvery dispute in order to evaluate how misperceptions at these two levels affect the conflict situation and its feasible resolutions.

Finally, in the fourth part, implementation of the derived water appropriations is attempted through regulatory regimes by developing appropriate multi-reservoir operating policies. Suitable operating policies have been designed for the integrated operation of four major reservoirs namely Hemavathy, Harangi, Kabini and KR Sagar situated in the headwater region of Karnataka state.

Some of the important highlights of the study along with an abstract of important findings are as indicated below:

1. Equity is sought through application of the principle of proportionality (distributional fairness) and the issue of fairness is addressed by using a cooperative, equal opportunity, model for negotiations (procedural fairness).
2. The fairness in procedural level is addressed by allowing each competing party the liberty to propose, without external coercion or influence, one or more factors that are most favorable to it, as a valid basis for apportionment.
3. Negotiations are open and transparent and each player has an inalienable right to seek proportional entitlements based on factors that maximize the given player's respective allocation. The factors admissible for selection must reflect hydrological, geographical and water use reality and follow the recommendations of the Dublin Conference (UNCIW 1997).
4. In this study, three factors namely, Drainage Area, Cultivable Area and Virgin runoff contribution have been adopted as factors for deriving 'Fair & Equitable allocations'

to the contenders. These, respectively, are the most preferred factors available individually to Karnataka, Tamil Nadu and Kerala.

5. The need for compromise when total claims exceed resource availability is recognized by all contenders as an obligation and the corresponding action is voluntary.

6. The virgin runoff potential in the basin is a dynamic factor and 'Fair and Equitable' (or 'F&E') allocations are derived and subsequent analysis carried out for five flow categories namely maximum flow (MAX), upper quartile (UQ or 25% dependable flows), median flows (MED or 50% dependable flows), lower quartile (LQ or 75% dependability flows) and minimum (MIN) flows. For analysis, two cases are considered. Case -1 assumes spatial homogeneity in virgin runoff across the basin whereas in case-2, spatial non-homogeneity in virgin runoff potential is considered.

7. Besides annual considerations, separate allocations were derived for (i) Kharif season and (ii) Rabi season. The results suggest that allocations of 6887, 2124.55 and 5442.67 MCM respectively for Karnataka, Kerala and Tamil Nadu constitute 'Fair and Equitable' (or 'F&E') allocations in Kharif season when cultivable area outside the basin is excluded from the analysis. Similarly, as case-2, allocations of 6085.9, 1650.4 and 4472.0 MCM of water respectively to Karnataka, Kerala and Tamil Nadu constitute 'F&E' allocations for Kharif season with respective state flow contributions falling in quartile II, quartile III and quartile III respectively.

8. Conflict Analysis techniques provide a systematic framework for conceptualizing complex conflicts and predicting their possible feasible resolutions.

9. Conflict Analysis techniques have been used to evaluate feasible resolutions to the Cauvery conflict for each of the five categories of flows ranging from MAX to MIN for two specific cases. In the first case, as case-1, the derived 'F&E' allocations have been considered as one of the options to be exercised by the player in addition to their original claims. In case-2, however, only the original claims of the players are considered as credible options.
10. Changing dynamics of the conflict are recognized and in order to develop a proper insight into the Cauvery conflict, the analysis is carried out separately for three reference years of 1924, 1974 and 1990. Conflict models have been developed for both case-1 as well as case-2 corresponding to these years.
11. Metagame Analysis of the reference year 1990 of case-1 based on UQ flows identifies outcomes '296' and '725' as equilibrium outcomes of the *game*. Importantly, outcome '296' awards allocations to Kerala, Tamil Nadu and Karnataka according to the derived 'F&E' allocations whereas outcome '725' awards allocations to Tamil Nadu and Karnataka according to their claims bolstered by Prior Appropriation Doctrine with Kerala obtaining less than her 'F&E' allocation while the other states accordingly sharing the forsaken claim of the latter state .
12. Study reveals that when 'F&E' allocations are included as options for the states (case-1), both Metagame and Hypergame Analyses pick these 'F&E' allocations as possible equilibrium solutions to the dispute thus essentially validating these allocations.
13. In case-2 study, for the reference year 1990 and for median flows, outcome '47' is an equilibrium outcome and is able to support prescriptive rights of Tamil Nadu

whereas outcomes '55' and '117' support an allocation that is compatible with CWDT's Interim Award of 5805 MCM (205 TMC) coming from areas upstream of Mettur. For the same case, it is further observed that outcome '117' supports Karnataka's full claim of 8732.9 MCM (308.4 TMC), where as outcomes '55' and '47' support only her prescriptive right of 5809.2 MCM (205.15 TMC). As far as the allocations to Kerala are concerned, outcomes '55' and '47' fully support Kerala's claim of 61.9 TMC from Kabini sub-basin, in addition to the allocations that the state will receive from Bhavani and Amaravathy sub-basins, whereas outcome '117' awards only 40.9 TMC to Kerala.

4. Analysis of the conflict for reference year 1924 shows that at least one equilibrium outcome predicts resolutions to the Cauvery dispute that is consistent with the actual evolution of the conflict.
5. The study reveals that 'F&E' allocations for Kerala can support the state's proposal to transfer 991.2 MCM (35 TMC) of water annually for hydropower purpose with at least 75% dependability without in any way affecting the respective 'F&E' allocations of other co-basin states.
6. The 2nd level hypergame study, with 'F&E' allocations as an option - case-1, for UQ and MED flows, favours Kerala because of her perceptions matching with perceptions of both Tamil Nadu and Karnataka. For example, outcomes '296' and '725' result as the equilibrium outcomes of the 2nd level hypergame based on UQ and MED flows are seen to match with the equilibrium outcomes '296' and '725' of Kerala's 1st level hypergame.

17. In the remaining three flow categories namely, MAX, LQ and MIN, equilibrium outcomes of the overall 2nd level hypergame match with the equilibrium outcomes of each player's respective 1st level hypergame in the corresponding flow category. Thus, it is observed that the game develops in a manner similar to a metagame situation where each player knows about the options and preference orderings of other players.
18. CWDT is introduced as a fourth player in the conflict and the resulting game analyzed for both cases 1 & 2. CWDT's apportionments, as proposed in their interim proposal of May, 2006, have been introduced as the latter's options. In both these cases only a 1st level hypergame based on 1st level misperceptions among the players are modeled.
19. Case-1 study with CWDT as the fourth player reveals that 1st level hypergame based on flow categories of MAX, UQ and MIN favor Kerala as her perceptions match with the perceptions of Tamil Nadu and Karnataka, whereas 1st level hypergame based on flow categories of MED and LQ does not favor any player due to a mismatch in perceptions.
20. The impact of the need to meet water allocation requirements of Tamil Nadu on operating policies of four upstream reservoirs has been explored. For this purpose, the twin requirements of irrigation and out of basin transfer of 594.73 MCM (21 TMC) by Kerala for hydropower from the Kabini sub-basin have also been incorporated as a special case to explore its impact on these operating policies.
21. Operating policies have been designed based on four proposed decision criteria.

22. It is observed that, corresponding to each of the proposed four decision criteria, the net inflow requirements into Mettur can be met upto at least 95% of the proposed allocation for all five flow categories.

23. The results show that Kerala's sought hydropower generation requirement of 594.73 MCM (21 TMC) does not have any adverse impact on water usage in Karnataka.

24. It is observed that model criterion 1 performs better than all other models and across all the flow categories for case-1 with regard to water usage by Karnataka and Kerala and, importantly, with regard to inflow into Mettur reservoir as well.

5. The overall performance of model 1 seems to be better for flow categories UQ, MED, and LQ, whereas performance of model 4 is better in the years when flow is in categories MAX and MIN based on the model derived water usage in Karnataka and Kerala and the mandatory inflows into Mettur reservoir in Tamil Nadu.

CONTENTS