Water Resources Management

a) Use of Remote Sensing for Irrigation Water Allocations

A model for optimal crop water allocations in the canal command areas has been developed and its use demonstrated with the case study of the command under Distributary No. 36 of the Tunga Bhadra project. The model uses processed data on crop areas obtained from satellite imageries in updating allocation decisions in real time. It is shown through the application that crop yields can be significantly improved by updating irrigation allocation decisions using information from satellite imageries in real time.

b) Optimization of Water Resource Systems

Efficient optimization techniques based on swarm intelligence and evolutionary computation principles have been proposed for single and multi-objective optimization in water resources systems. To overcome the inherent limitations of conventional optimization techniques, meta-heuristic techniques such as ant colony optimization (ACO), particle swarm optimization (PSO) and differential evolution (DE) are developed for single and multi-objective optimization. To achieve robust Pareto optimal fronts for multi-objective problems, a novel approach is developed by incorporating Pareto optimality principles into PSO algorithm, called elitist-mutated multi-objective particle swarm optimization (EM-MOPSO). Non-dominated solutions for three-objective Hirakud reservoir operation model obtained using EM-MOPSO are shown in Figure 61. For effectively handling interdependence relationships among decision variables of multi-objective water resource problems, an efficient multi-objective solver, namely multi-objective differential evolution (MODE) is developed. The developed MODE algorithm is evaluated with several test problems and also applied to a case study of Hirakud reservoir to derive operational tradeoffs in the reservoir system optimization. To demonstrate the applicability of the developed optimal operating policies for real time reservoir operation, reservoir inflow forecasting models are developed using soft computing approaches viz., artificial neural networks (ANNs), adaptive network fuzzy inference system (ANFIS) and hybrid particle swarm optimization trained neural network (PSONN). These methods are then applied to a few case studies in planning and operation of reservoir systems in India.

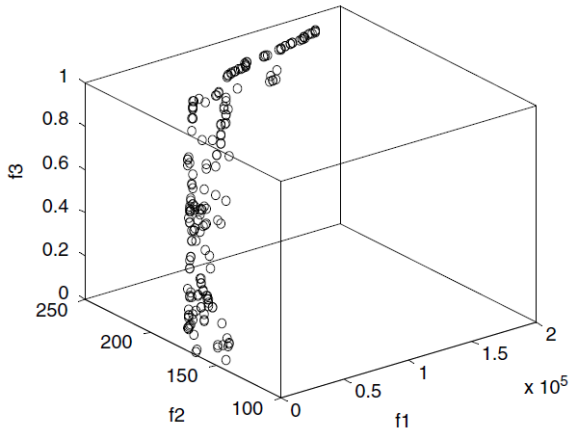

Figure 61: Non-dominated solutions obtained for three-objective reservoir operation model using EM-MOPSO. f1-sum of squared deficits of irrigation releases $(Mm^3)^2$; f2-hydropower production (M kwh); f3-satisfaction level of water quality

c) Structured Irrigation Network

Network analysis models are developed based on the gradually varied flow analysis as applicable for irrigation networks. Studies are conducted to compare the traditional and structured irrigation systems for their efficacy in handling equitable supply to the entire command of the network. It has been found that the traditional irrigation system with pipe outlets and gated structures is biased towards upstream with no and very less supply towards the tail end of the distribution system. It is shown that using the structured irrigation concept (with only flow control and no gates), and with simple modification of the existing infrastructure, an equitable supply can be achieved. This has been demonstrated by the application of the developed model on the field study of the Bagewadi distributary.