INCOLD
Indian National Committee on Large Dams

INTERNATIONAL DAM SAFETY CONFERENCE

DRIP
Dam Rehabilitation & Improvement Project

Central Water Commission

Topic: Optimization model for integrated operation of multipurpose reservoir in Narmada Basin

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Introduction

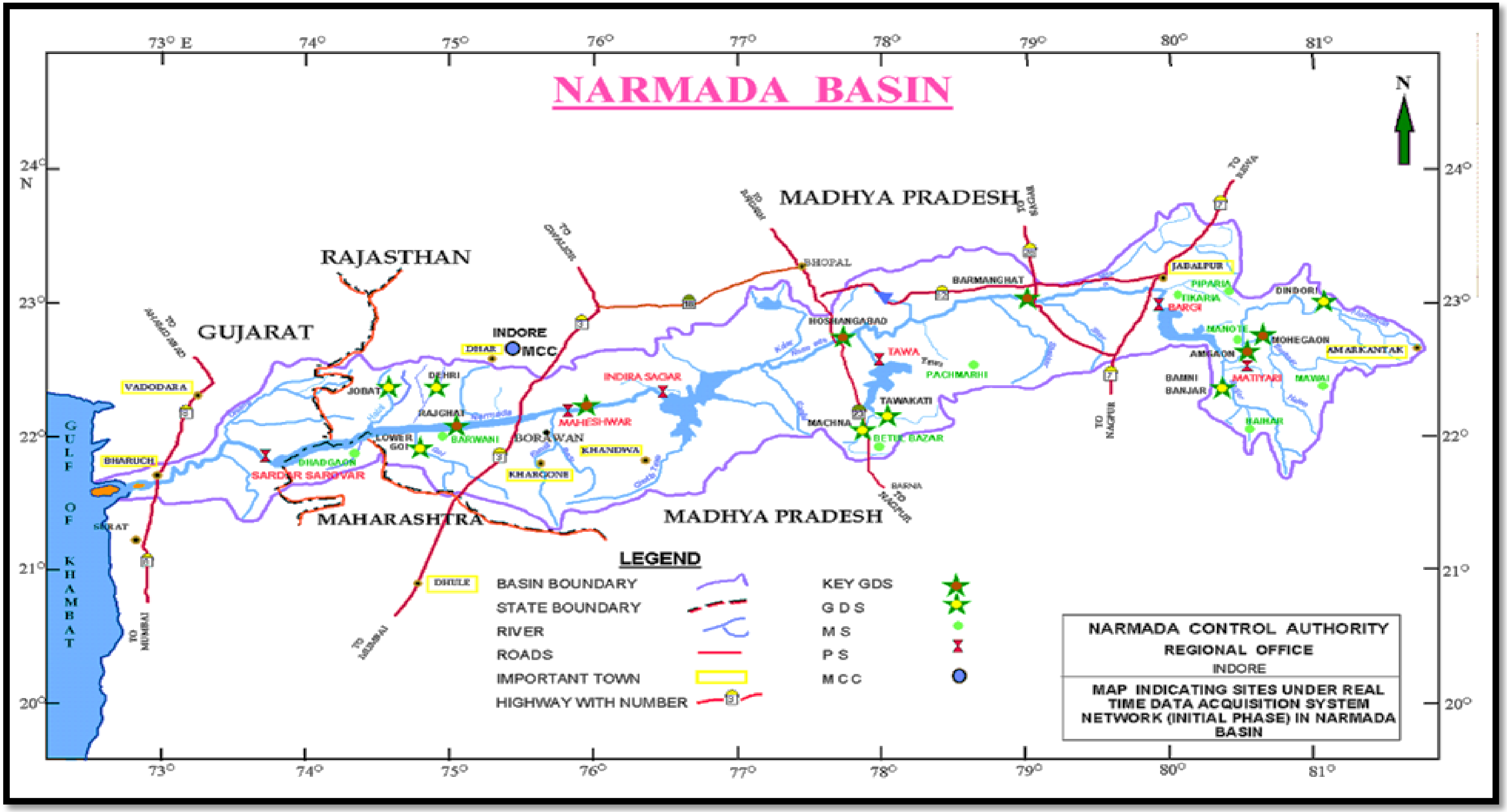
- An Optimization model has been custom-developed by M/s Vassar Labs, Hyderabad jointly with M/s Alluvium, Australia to meet the requirements of Narmada Control Authority for integrated reservoir operation and water accounting within the Narmada Basin in accordance with the NWDT Award (NIROWA Model).
- A Linear Programming method has been used to determine the best way to operate the multi-purpose multi-reservoir system for 14 major reservoirs in the Narmada River basin.
- The Optimization technique finds the best solution from a number of possible alternatives for the given scenarios.
- Three different water years, based on the river flow, have been considered, i.e. drought year. Normal year and wet year.

Study Area

- The study area selected for the present work; the Indira Sagar project is located in the middle Narmada sub basin on the narrow gorge near village Punasa.
- The **Indira Sagar Reservoir** is the largest reservoir in India with 12,200 MCM gross storage capacity.

Reservoir Features:

- Catchment area up to the dam site = 61,642 km^2
- Full reservoir level = 262.13m
- Maximum drawdown level = 243.23m
- Hydropower capacity = 1000MW (8X125MW)
- Ultimate Irrigation potential = 1.69 lakh ha.


NARMADA BASIN
MADHYA PRADESH
RAJASTHAN
GUJARAT
MAHARASHTRA
MADHYA PRADESH
GULF OF KHAMBAT
INDORE
MCC
JABALPUR
BHOPAL
HOSHANGABAD
BARMANGHAT
TAWA
PACHMARHI
TAWAKATI
MACHNA
BETUL BAZAR
INDIRA SAGAR
MAHESHWAR
BARWANI
RAJGHAT
BORAWAN
KHANDWA
KHARGONE
LOWER GOI
DHADGAON
SARDAR SAROVAR
BHARUCH
VADODARA
SURAT
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DEHRI
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MANOTE
AMGAON
MATIYARI
BAMNI BANJAR
RAIHAR
MAWAI
BARGI
PIPARIA
TIKARIA
LEGEND
BASIN BOUNDARY
STATE BOUNDARY
RIVER
ROADS
IMPORTANT TOWN
HIGHWAY WITH NUMBER
KEY GDS
G D S
M S
P S
M C C
NARMADA CONTROL AUTHORITY
REGIONAL OFFICE
INDORE
MAP INDICATING SITES UNDER REAL TIME DATA ACQUISITION SYSTEM NETWORK (INITIAL PHASE) IN NARMADA BASIN

Objective Functions

The linear programming (LP) technique is applied to improve the reservoir performance and to find the optimal way of operating the reservoir by considering the operational constraints.

The goals of optimization include:

1. Minimize the Domestic water supply/irrigation/industrial water supply **deficits**.
2. Minimize the environmental deficits.
3. Minimize gaps in meeting targeted hydro-power generation.

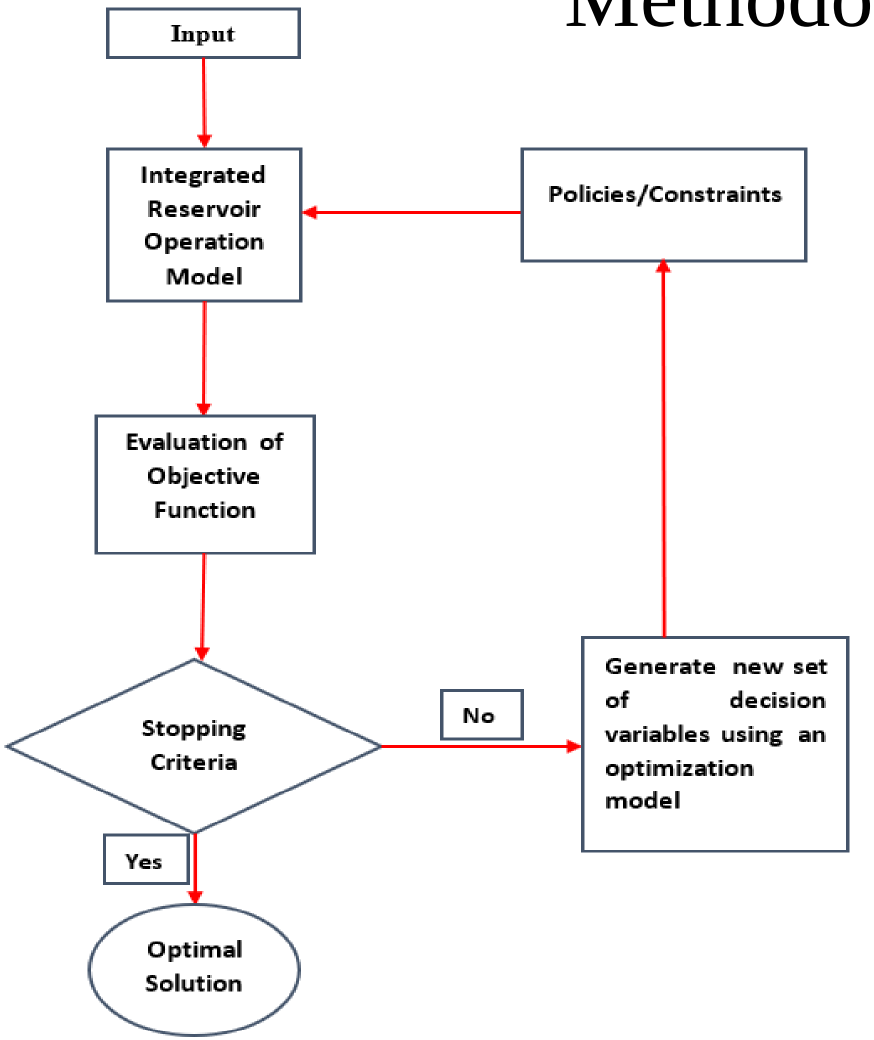
Variables and Constraints

- **Decision Variables:**

  Optimized releases for-
  - Irrigation
  - Domestic Water
  - Industrial water
  - Hydropower
  - Environmental

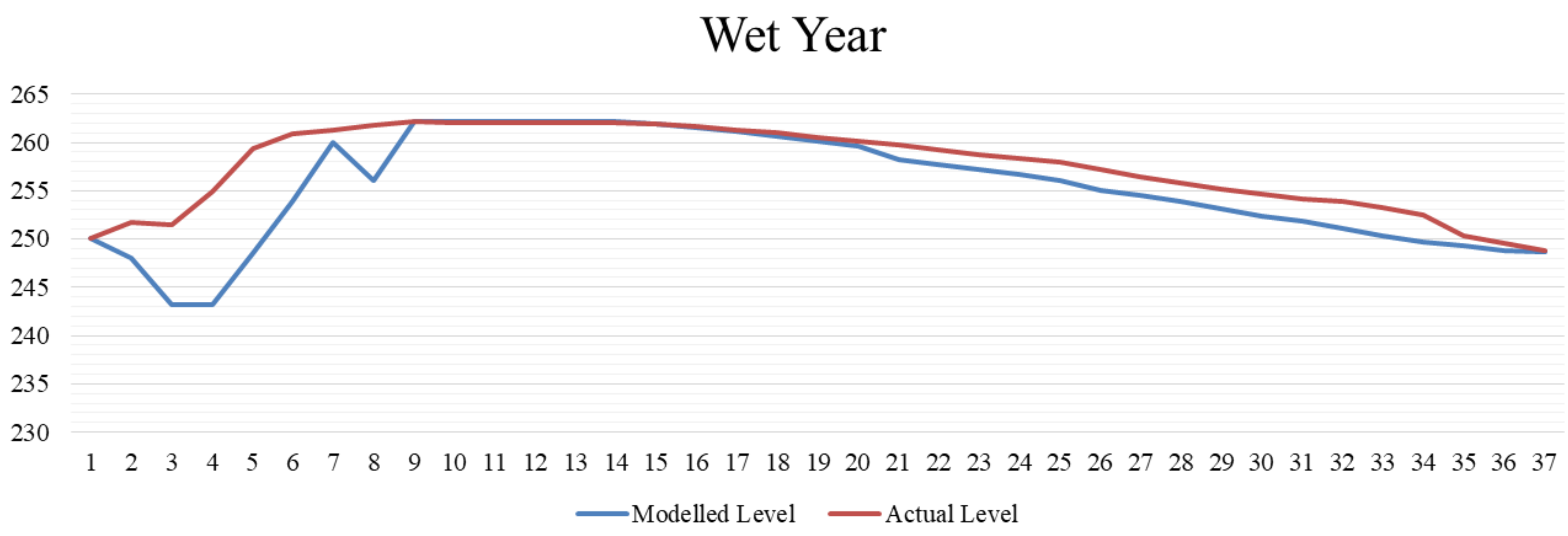
- **Constraints:**
  - Mass balance constraint
  - Dead storage constraint (Storage of the reservoir>=actual dead storage)
  - NWDT sharing rule (irrigation <= state percentage*(total inflows + initial live storages))
  - Return flow constraints
  - Environmental demand (supply>=demand)
  - Irrigation demand constraints (supply<= ultimate demand)

Methodology



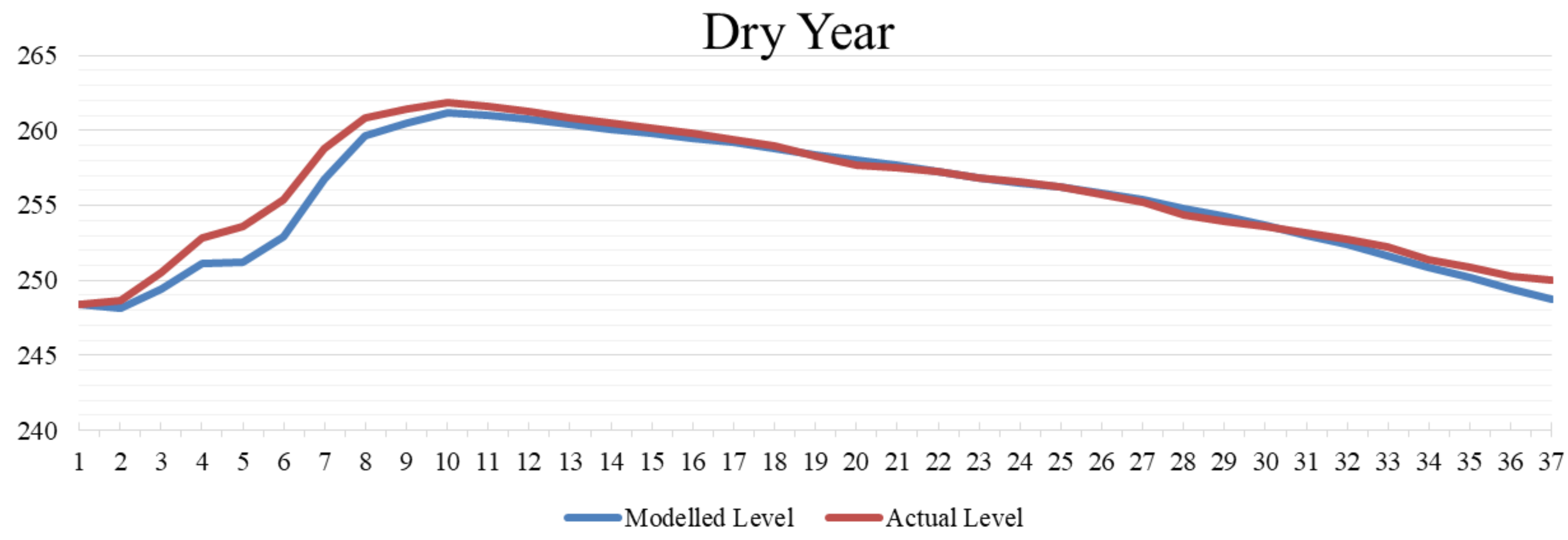
Input Data

- Elevation Area Capacity Table
- Inflows
- Precipitation
- Percolation
- Evaporation
- Demands
- Initial water level
- Target storage level

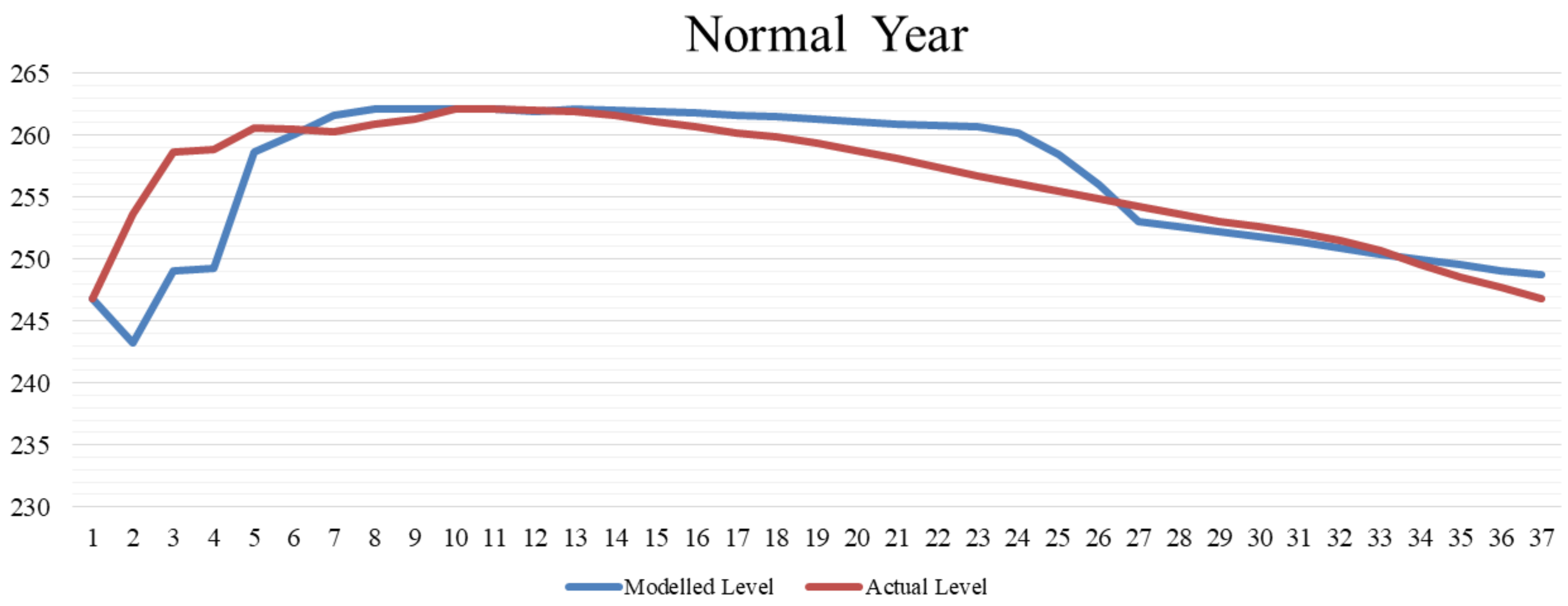


Year	Inflows (Mm³)	Actual spillage (Mm³)	Model spillage (Mm³)	Actual hydropower (Mm³)	Model hydropower (Mm³)	Actual irrigation (Mm³)	Model irrigation (Mm³)
Wet	48644	24189	18613	22201	28006	1114	1653

Result



Year	Inflows (Mm^3)	Actual spillage (Mm^3)	Model spillage (Mm^3)	Actual hydropower (Mm^3)	Model hydropower (Mm^3)	Actual irrigation (Mm^3)	Model irrigation (Mm^3)
Dry	12410	0	0	9255	9421	945	1653



Year	Inflows (Mm³)	Actual spillage (Mm³)	Model spillage (Mm³)	Actual hydropower (Mm³)	Model hydropower (Mm³)	Actual irrigation (Mm³)	Model irrigation (Mm³)
Normal	31229	6274	3504	23377	24318	661	1653

Conclusions

- The results derived from the model allow the decision makers to consider the proposed optimal solutions.
- The model was set to suggest the optimal operative policy.
- The model suggests depleting the reservoir level by releasing for hydropower in initial time steps so that the anticipated inflow in the next time step should be absorbed and the unnecessary spillage can be minimized.

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