Design of Drinking Water Solution for Tanker fed villages in Mokhada Taluka, Thane

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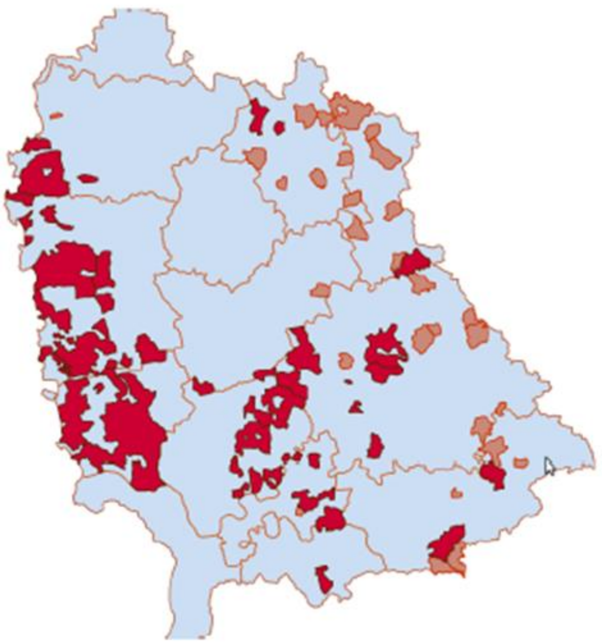
Background: Tanker fed villages in Thane District and Regional Piped Water Schemes

- Severe drinking water shortage in 27 districts and 136 talukas of Maharashtra state (in 2014)
- 190 tanker fed villages in Thane

- Majority of tanker fed villages in Mokhada and Shahapur taluka
  - dependent on single village, groundwater based schemes
  - absence of surface water based Multi-Village Schemes



Problem Statement

- Given the failure of Groundwater based schemes, explore Surface Water based Multi Village Schemes

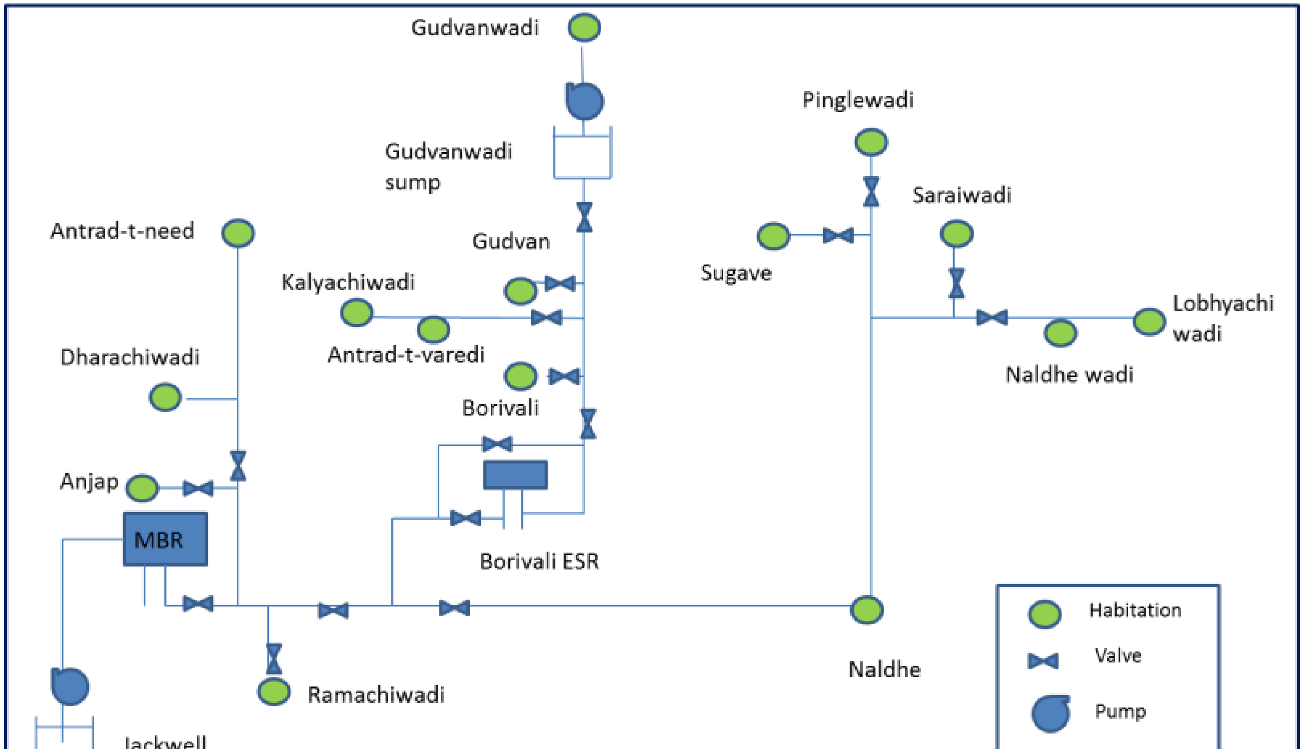
- Focus on
  - Source sustainability
  - Operational/Financial sustainability

- Solution Approach
  - Development and extensive use of GIS, and modeling and simulation tools
  - Preferably Gravity Based schemes to minimize operational costs (energy costs)

Ideal Research focus: Multi-criteria constrained optimization of multi-village schemes

- Variables: Water Source, Storage Reservoir locations, Pipe Diameters
- Constraints: Per capita Capital cost government norms
- Optimization: Operation cost

Schematic of infrastructure currently used for seasonal supply



Not to scale; Not all valve positions are shown

Current MJP Focus

- Instead of minimizing Operational costs
  - minimizes capital costs
- Research Stage I
  - Develop tools and solutions for minimizing capital costs for a given source
  - explore different sources
- Research Stage II
  - Develop tools and solutions for minimizing operational costs

Project Area: A cluster of tanker fed villages in Mokhada Taluka

- Home for three reservoirs supplying water to Mumbai
- 92% Adivasi Population
- About 70 habitations depend on tanker water
- Trend shows Increasing no. of tanker fed villages and habitations in spite of huge spending(3.5 cr for current year) on drinking water security measures.

Karegaon Scheme and tanker-fed Villages

- Source for Karegaon scheme getting submerged due to Middle Vaitarna Dam Project
- RWSS department redesigned Karegaon keeping geographical scope unchanged
- 13 tanker fed villages in the vicinity of the scheme
- Explore adding these villages to the proposed scheme

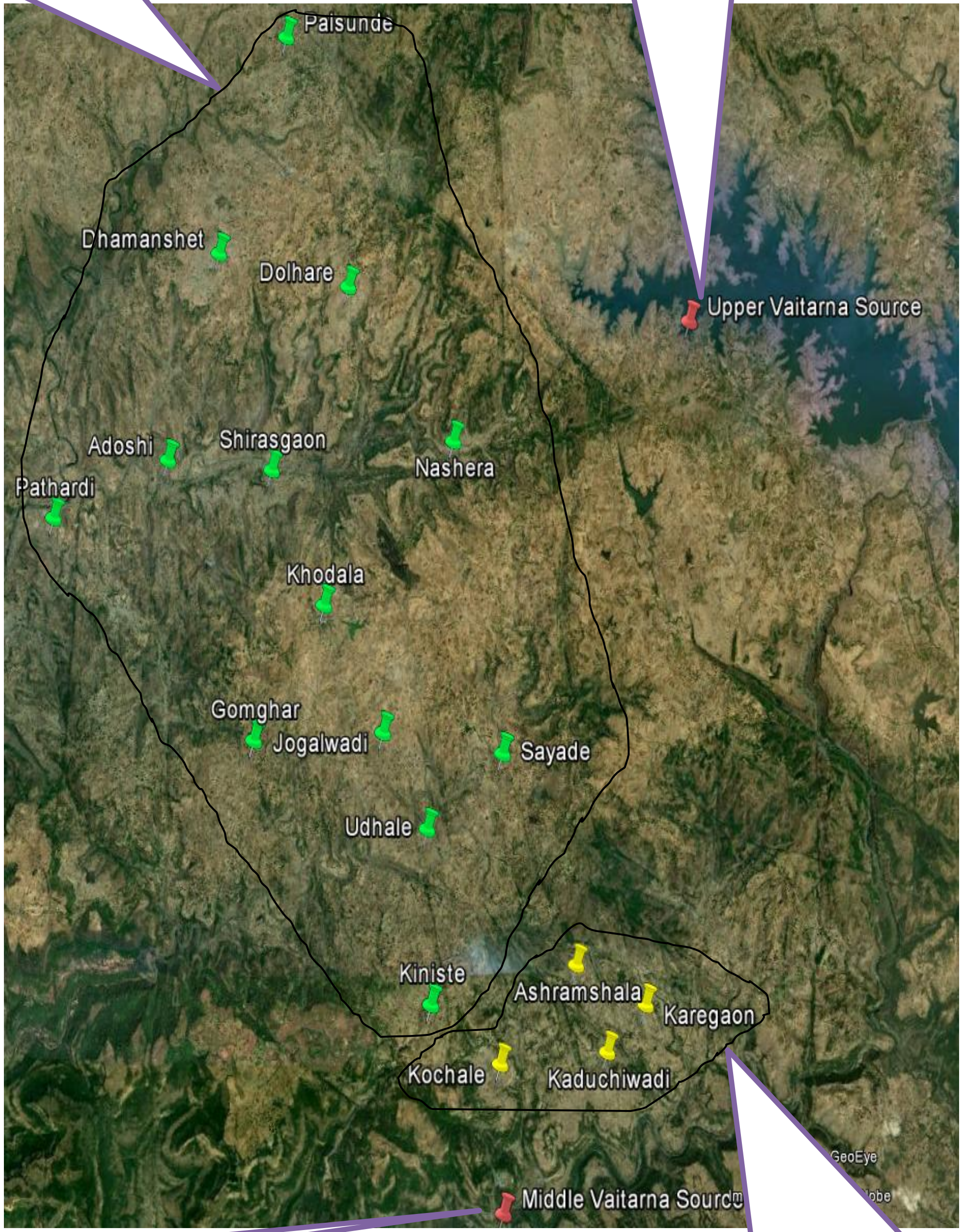
Our Solution

- Higher Elevation of tanker fed villages(avg elevation 363 m) makes Middle Vaitarna infeasible

- A new scheme based on upper Vaitarna can serve all beneficiaries of Karegaon scheme, as well as 13 tanker fed villages of Mokhada

- Gravity Flow helps in bringing down both capital and energy cost.

Description	MJP Scheme	Proposed Scheme
Per Capita Cost(Rs.)	5083	2890
Rural Norm for per capita cost(Rs.)	3495	3495
Cost per 1000L (Rs)	24.18	6.35



Process

- Gather Information
  - Possible Water Sources
  - Village Location/Population
  - Cost of various infrastructure components
  - Norms for water demand and operational/capital cost
- Explore different sources
- MBR and WTP Layout and Sizing
- ESR Location and Sizing
- Pipe Layout and Sizing

Sources of Information

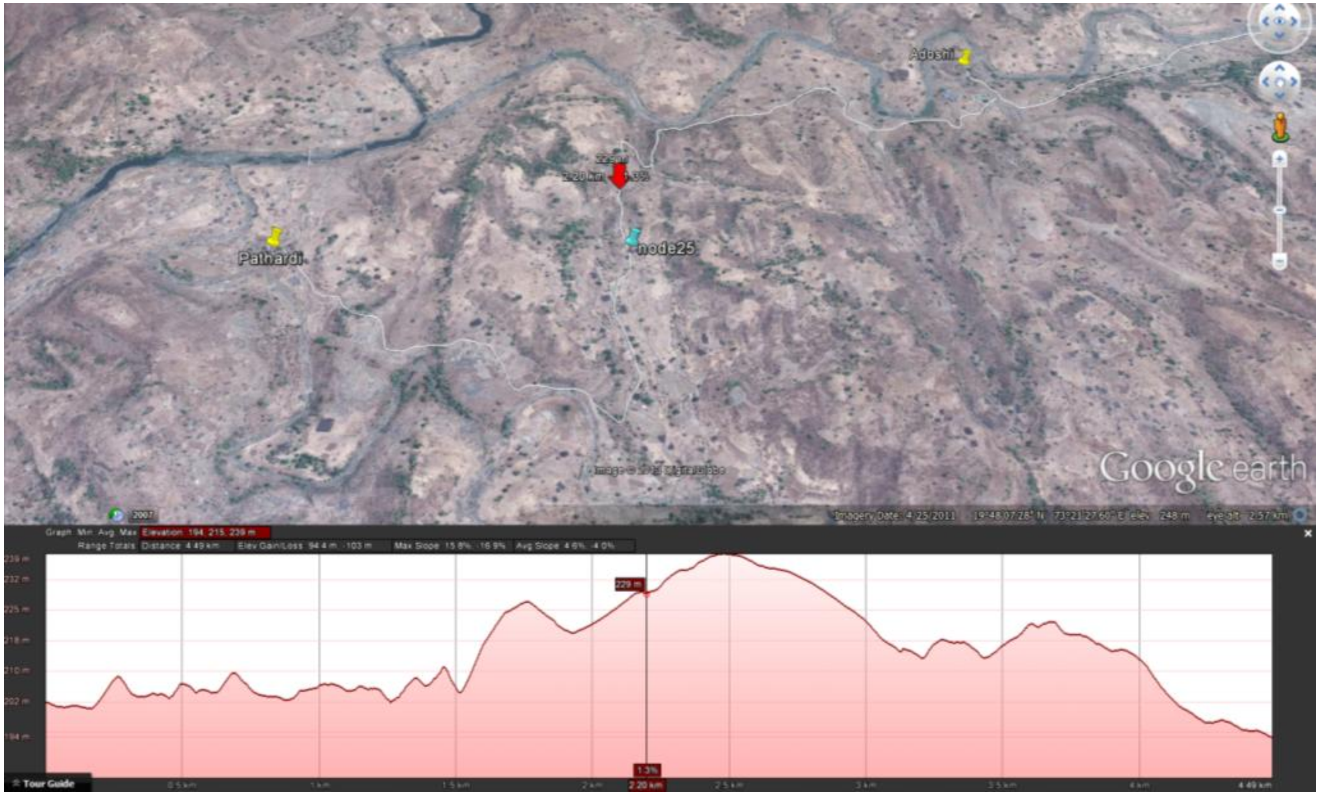
- MJP
  - Cost of Infrastructure like WTP, ESRs, Pipes
  - Norm of Water Demand
  - Norms for Capital/Operational Cost
  - Guidelines for Sizing of MBR, WTP and ESRs
  - Guidelines for Scheduling

Tools

- Reservoir location and Network design: GIS
- Pipe Sizing – JalTantra (tool developed at IITB)
- Supply Schedule - EPANET

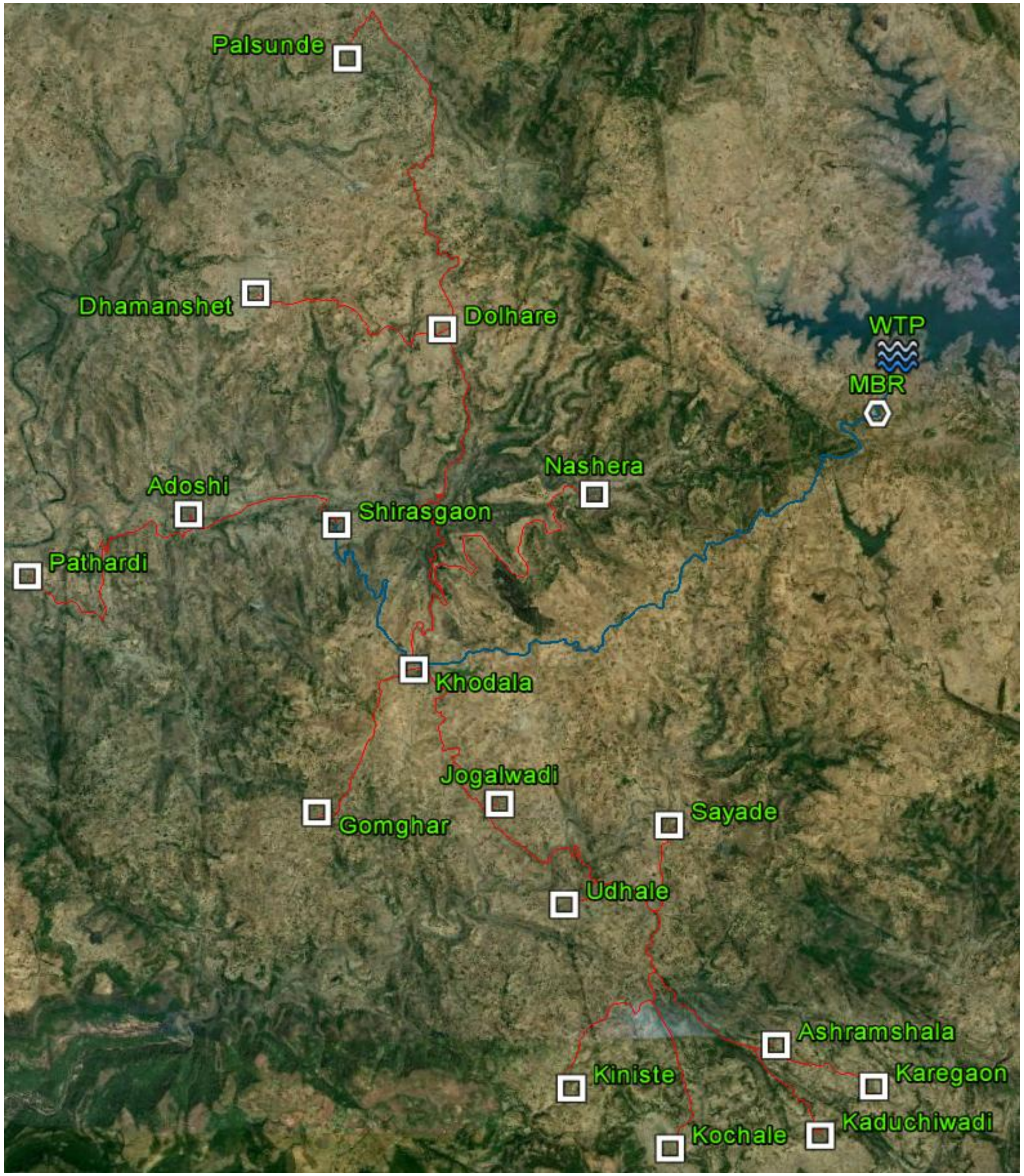
- Research goal: eventually do all of the above with one program

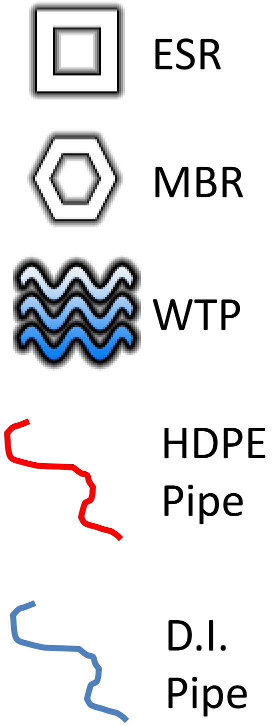
Use of Tools : GIS



Locate water sources, villages, and assets
Deciding where to break the pipes
Calculating distances

JalTantra: A System for Design and Optimization of Water Distribution Networks





JalTantra: ILP Formulation

- Boolean Variables i_j =1 if pipe i uses the commercial pipe j, 0 otherwise
- Pipe Constraint (for each pipe *i*): $\sum_{j=1}^{m} i\_j = 1$
- HeadLoss Constraint (at each node *n*):

$$\sum \left(\sum_{j=1}^{m} loss(i,j) * i\_j \right) \leq H_{REF} - Elev(n) - P_{min}(n)$$

Summation over all pipes in the path from source to node n

H_{REF} : Head at Reference Node

$Elev(n)$: Elevation of Node n

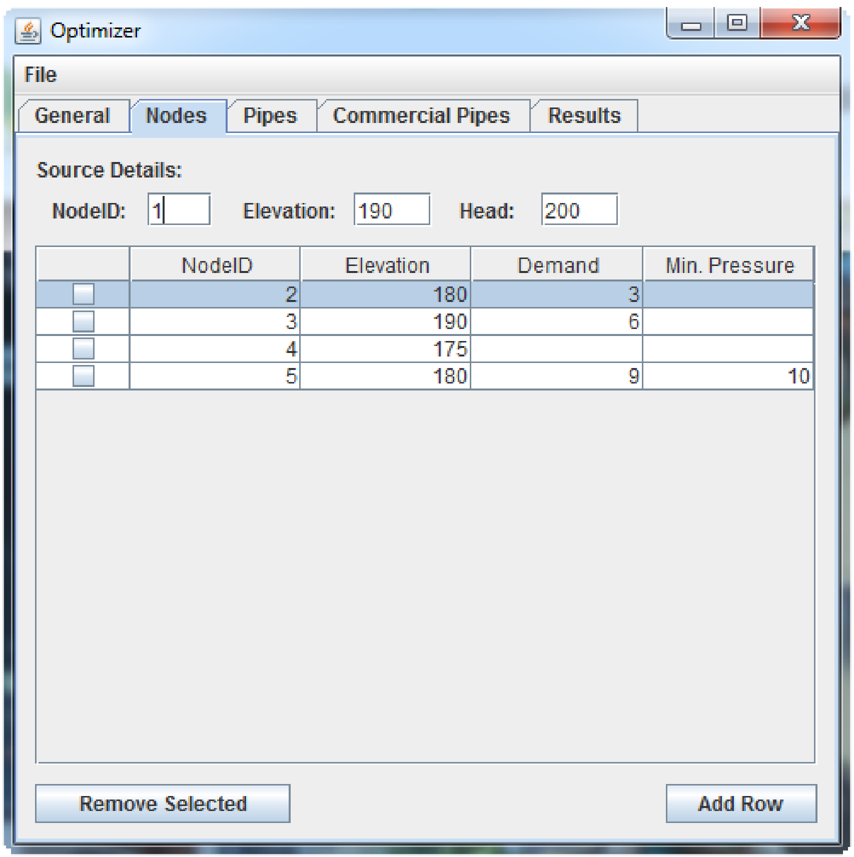
$P_{min}(n)$: Minimum Pressure required at node *n*

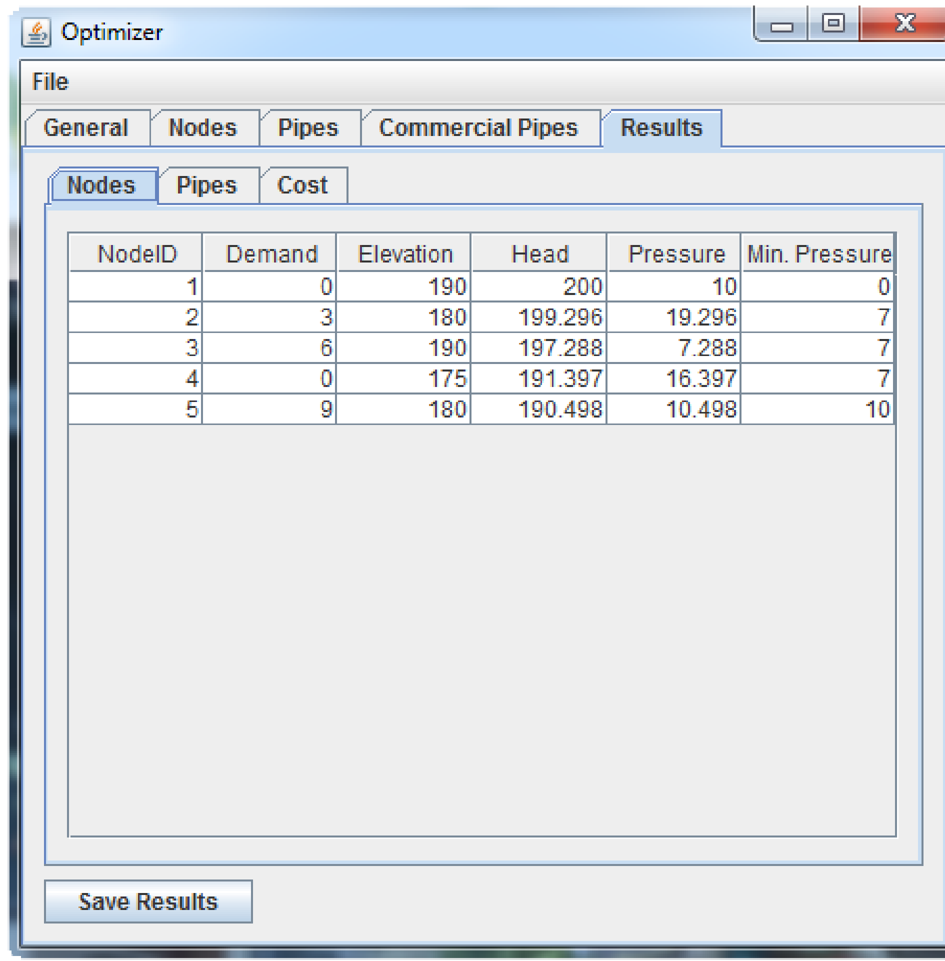
loss(i,j) = Headloss(length(i), flow(i), diameter(j), roughness(j))

We use the Hazen-Williams Equation for calculating Headloss:

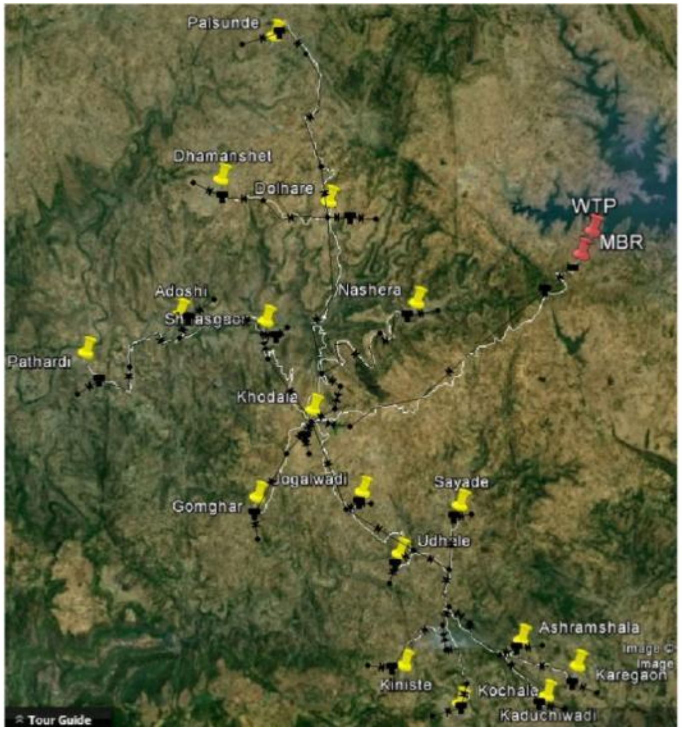
$$\frac{10.68 * length * \frac{flow}{roughness}^{1.852}}{diameter^{4.87}}$$

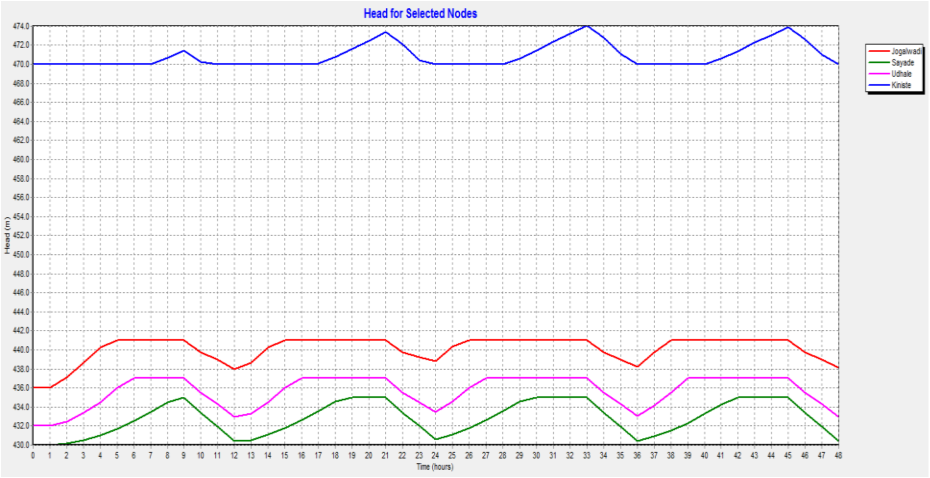
JalTantra User Interface





Use of Tools: EPANET Verification for extended period operation





Way Forward: Having designed the solution ..

- Water Conference in Khodala on May 31st, 2014
- Local people involved in taking the initiative forward
- Local MP and MLA were also present
- Secretary, Tribal Development Department, GoM also interested

Conclusions

- Use of tools such as Google Earth, JalTantra/EPANET simulations using GIS data to do the scheme costing/verification
- Potential for making entire Mokhada Taluka tanker free
- Our task does not end with scheme design
- Who should receive our output is important to consider

~ THANK YOU ~