

# Science and Technology

*Development, Culture and Politics.*

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# Organization of the talk

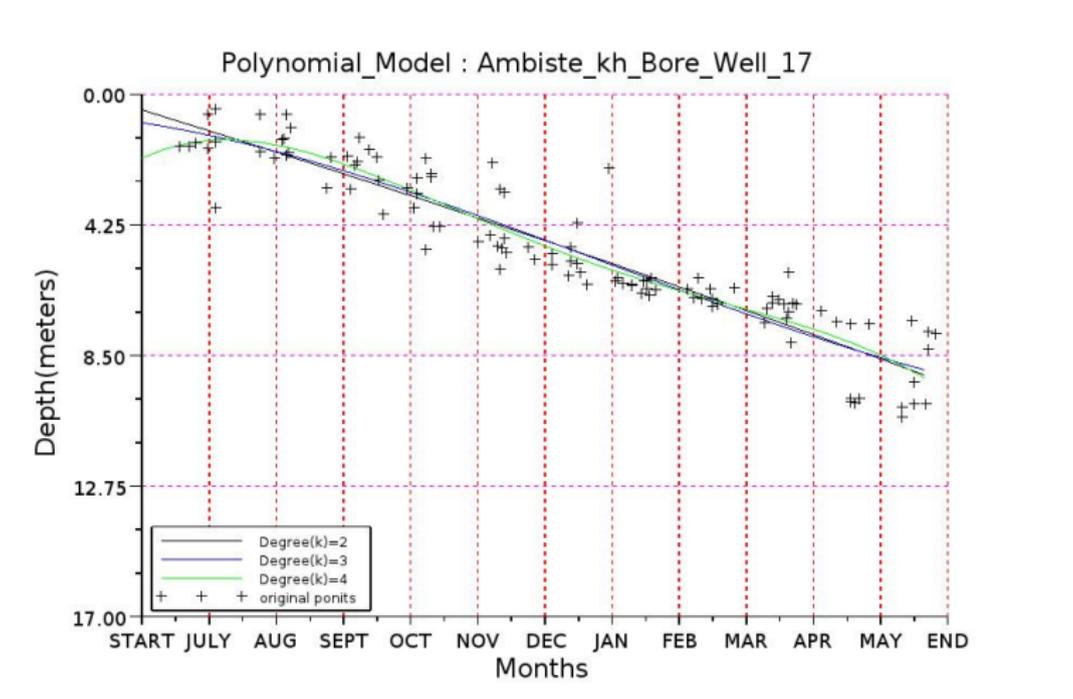
- The method of science and of engineering.
- Society, Development and R&D.
- The Drinking Water case study.
- The Big Picture
- Blue-sky!

# Science-Observing phenomena and explaining them

- **Observation and Documentation**-need for instruments, identifying variables, careful organization of data
- **Formulation of Laws**-constructing a relationship between the variables.
- **Testing**-testing the validity of the law by observing a new scenario or by experiments.

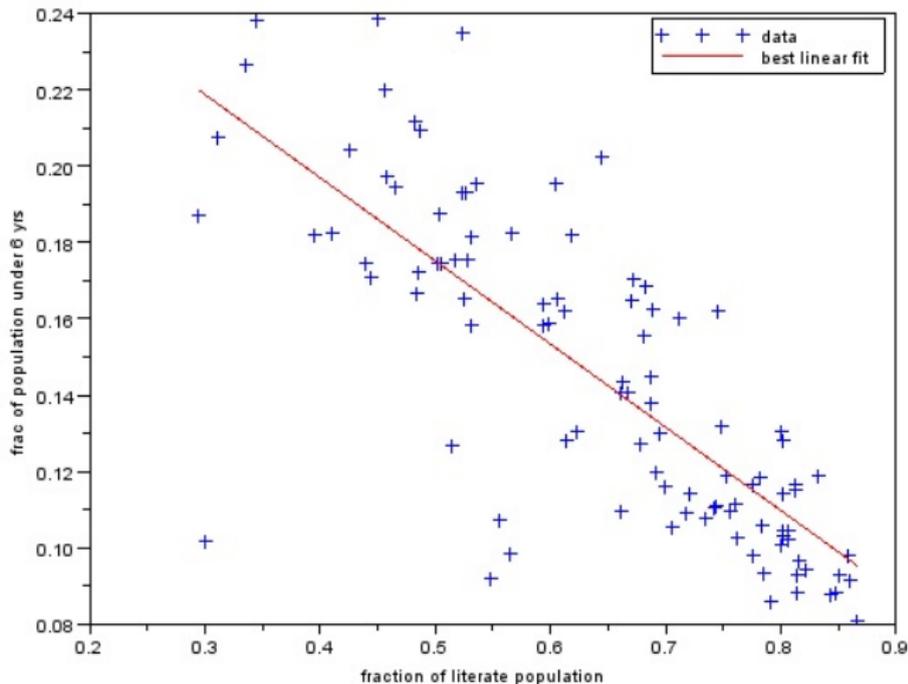
The above steps are repeated till a satisfactory model/theory is obtained.

# An Example-water level in a borewell

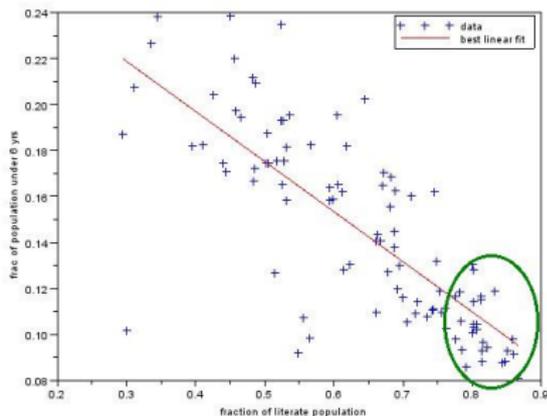
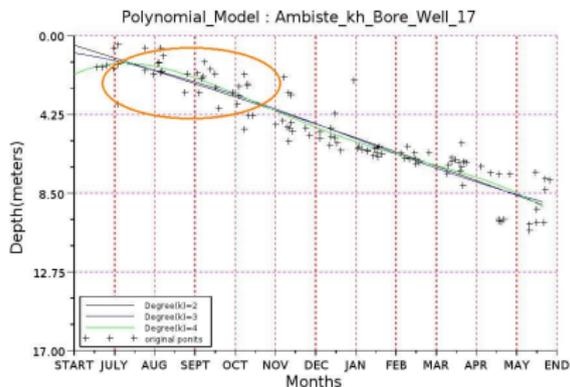


# An Example from Social Sciences-Shahpur taluka, Thane

## Population fraction under 6 yrs vs. literate fraction



# Engineering-where do we want to be?



- What should I do so that my borewell water is no deeper than 4 meters?
- What should I do so that my villages are 90% literate?
- What should I do so that my public transport is better?
- **What does the society value?**

# The Engineering Cycle

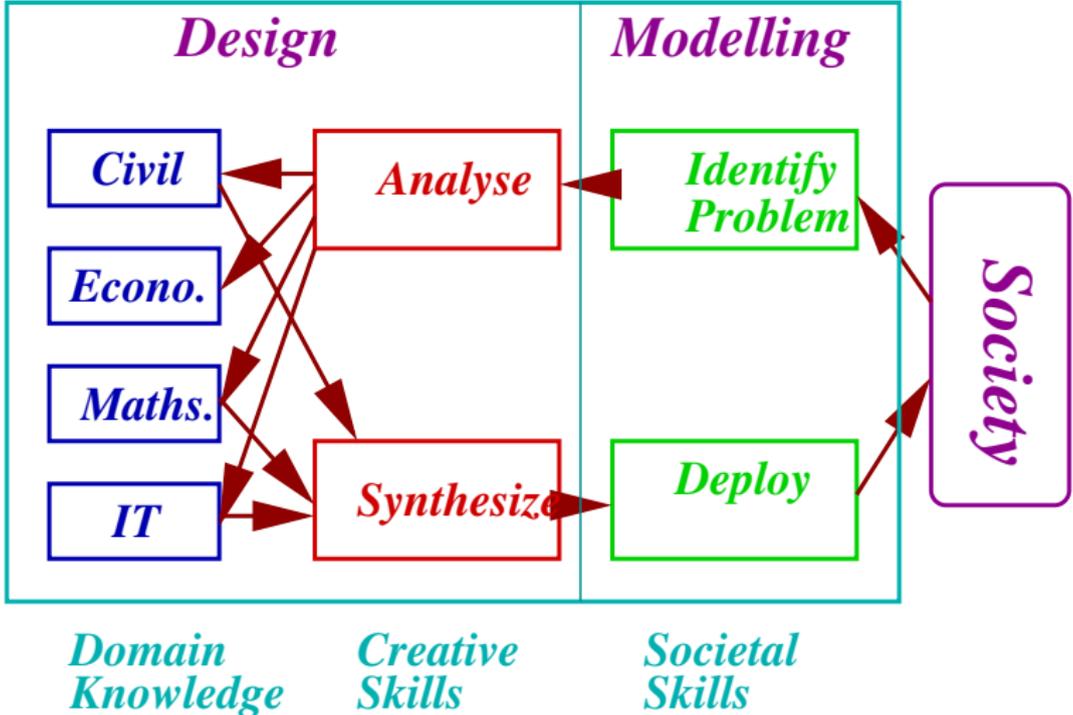
- Identify a *societal problem* and a *stakeholder!*
- Analyse the problem and separate it into elementary subproblems (maybe in different fields)
- Solve the problem in the individual fields.
- Synthesize the complete solution.
- Deploy and get back to stakeholder.

## Remember...

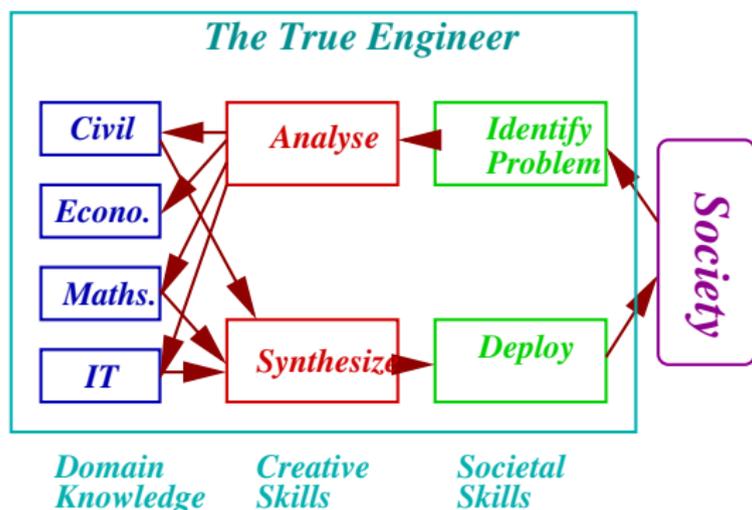
- *Science* tries to describe reality while *Engineering* wants to *change* it.
- *Delivering Change* is the key engineering function.
- *Modelling and Design* are the processes by which this is achieved.

# Understanding Modelling and Design

## *The True Engineer*

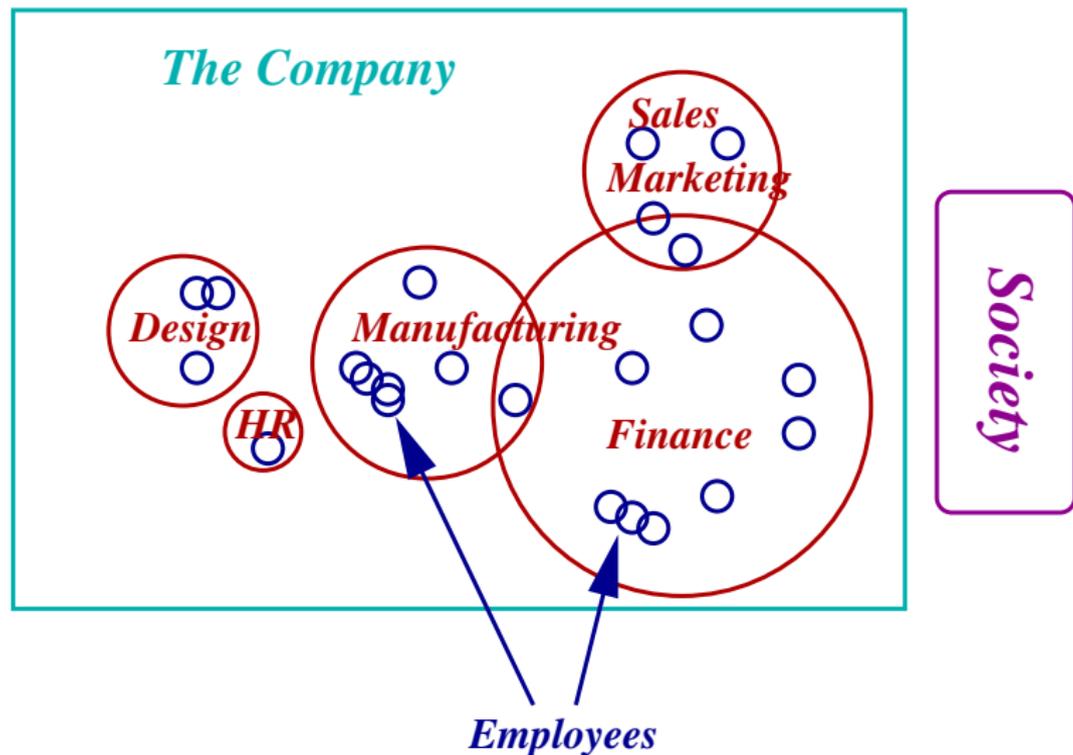


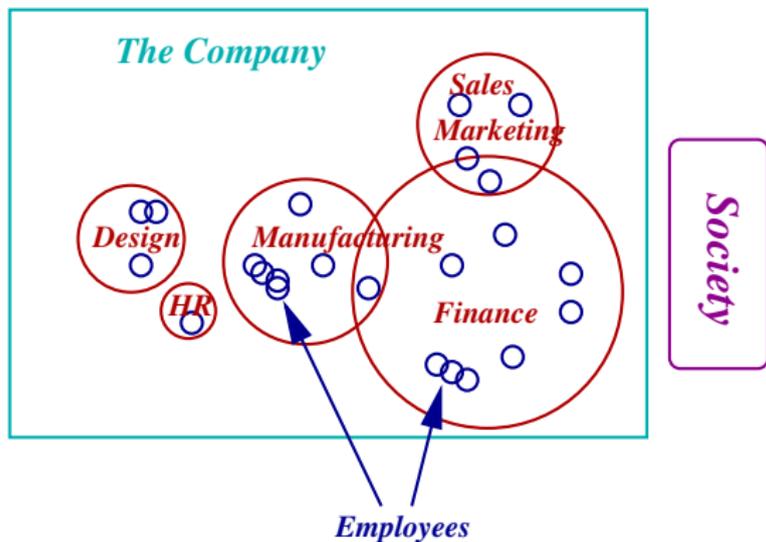
# The ideal engineer



- The true engineer is *inter-disciplinary*
- Engineering R&D usually takes place at the domains. It is *useless* unless there is a stakeholder.

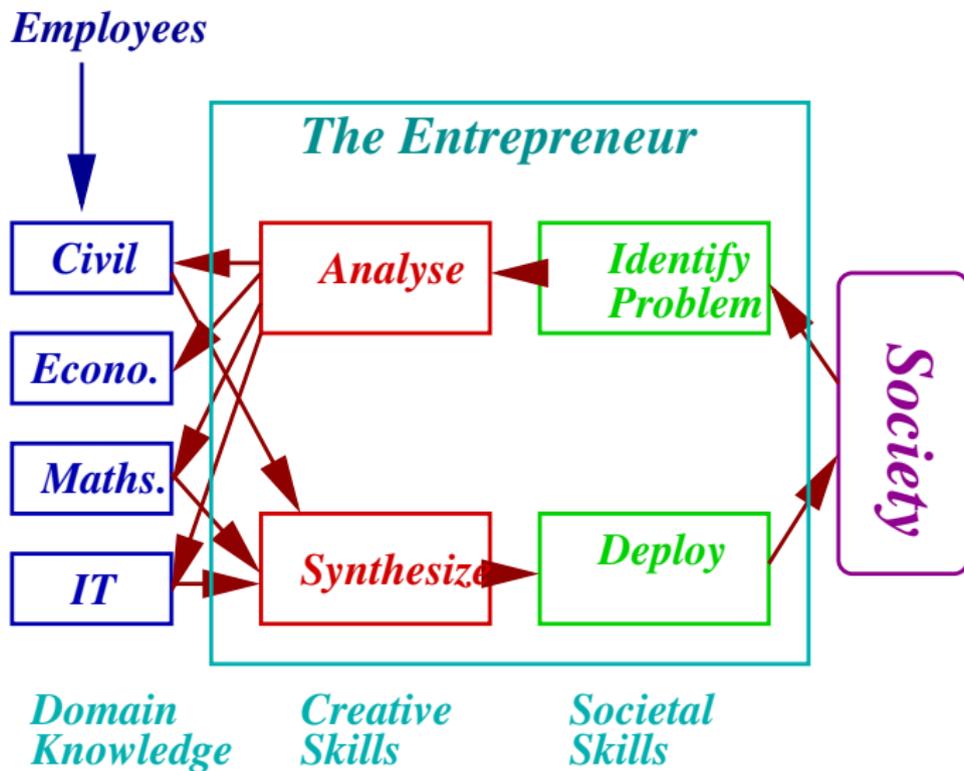
# One model—The company

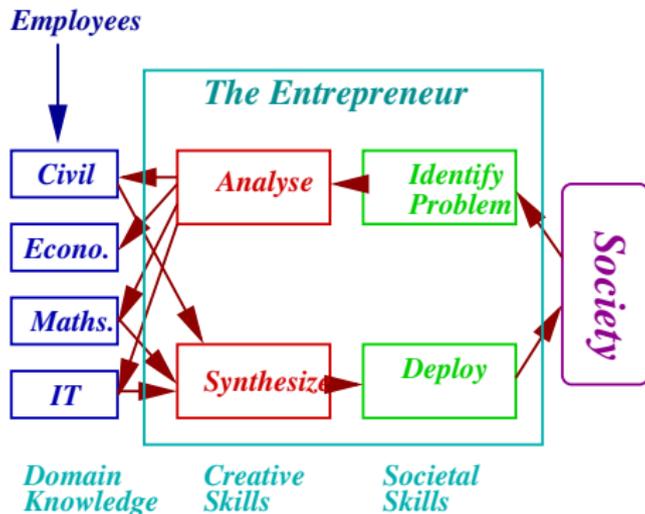




- The employee need not be inter-disciplinary.
- The problems taken for solution by a company are those which give the highest return. *Thus IT, Pharma, Telecom. find attention while drinking water, solid waste do not.*
- Why is it that our young engineers do not start companies in the development sectors?

# Another model—The Entrepreneur





- Entrepreneurs have low cost of entry!
- Development problems such as water, agriculture, public health, energy etc. pose unique opportunities for our young engineers.
- *However, our engineering colleges must teach interdisciplinarity.*
- *Remark: There are other models as well*, e.g., the state model.

## A key observation (see my article in *Current Science*, June 2012)

- There is a huge development deficit which needs attention. This needs both trained engineers and the research to back it up.
- Current set of companies may not have sufficient incentives to address these problems.
- These companies also do not have the need for the 5,00,000 p.a. or so engineering aspirants.
- Our current training of engineers is biased to employee-training and not towards inter-disciplinarity and entrepreneurship.
- Our knowledge base in the development sector is poor.

Thus there is a supply-demand mismatch in both the corporate and the development sector!

# A possible solution

## Attempt both problems at the same time

- University participation in regional development problem —formulation and solution.
- Curriculum modification to allow students to take projects with local content and a focus on R&D for regional needs.
- **University as an important mediator.**

This is not easy and I present a case study from **drinking water**.

- How do we identify the problem and break it up into sub-problems.
- Where do we get the relevant data? Who are our stake-holders and who should we report the solutions?
- **Are there sufficient incentives for students and faculty members?**

# Rural Drinking Water

- Much of rural India depends on groundwater for their domestic water needs.
- This water comes from bore-wells, handpumps or dug-wells.
- Gol calls a village *safe* if there is 40 liters per capita per day (lpcd) of safe water within 1 km of home.
- The urban norm is about 150 lpcd.



# Stress



# When that happens...



- Women have to walk long distances, spend substantial time and effort.
- In some cases, tankers may be used by the district administration to supply water.
- access may reduce to 10-15 lpcd!
- adverse impact on incomes and well-being

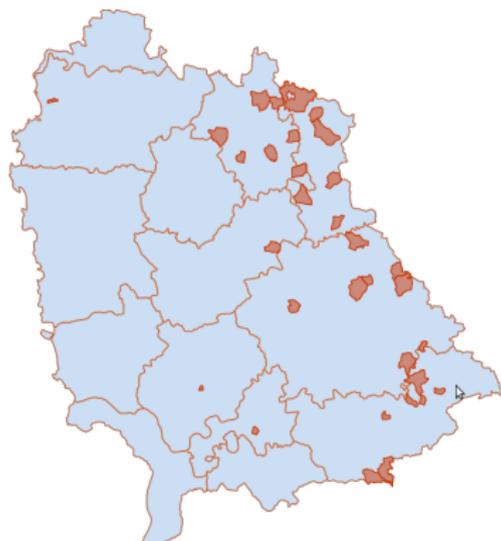
Area	9000 sq km.
Pop. (Rural)	81 (23) lakhs
Taluka (Tribal)	15 (5)
Habitations (GPs)	8000 (900)
Cities (Mun. Coun.)	37 (12)

- Roughly one rural drinking water engineer and one surface/groundwater engineer for every 20,000 people, 40 habitations and 50 sq.km.
- Huge development agenda-groundwater security, drinking water systems, institution building

## Thane



# Tanker-fed villages



160 out of 1700 were tanker fed. **60 repeatedly so!**

Largely in the 4 tribal talukas:  
*Jawhar, Mokhada, Murbad* and  
*Shahpur.*

Fraction of ST population.

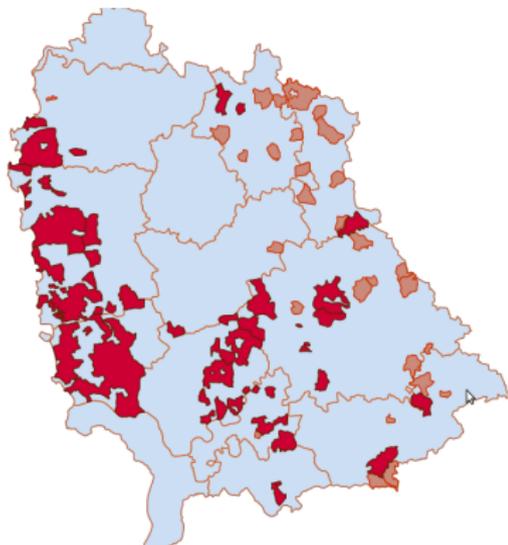
	Ja.	Mo.	Mu.	Sh.
Tanker	0.97	0.93	<b>0.74</b>	<b>0.62</b>
Taluka	0.97	0.91	0.24	0.35

Mean elevation (in *m.*):

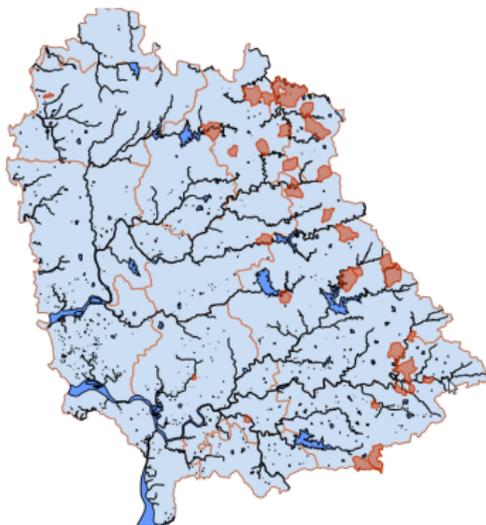
	Ja.	Mo.	Mu.	Sh.
Tanker	344	361	<b>123</b>	<b>197</b>
Taluka	320	350	126	132

# More analysis

Location of large rural regional drinking water schemes



Location of rivers and lakes



*Data from MRSAC, Census 2001, District administrative offices*

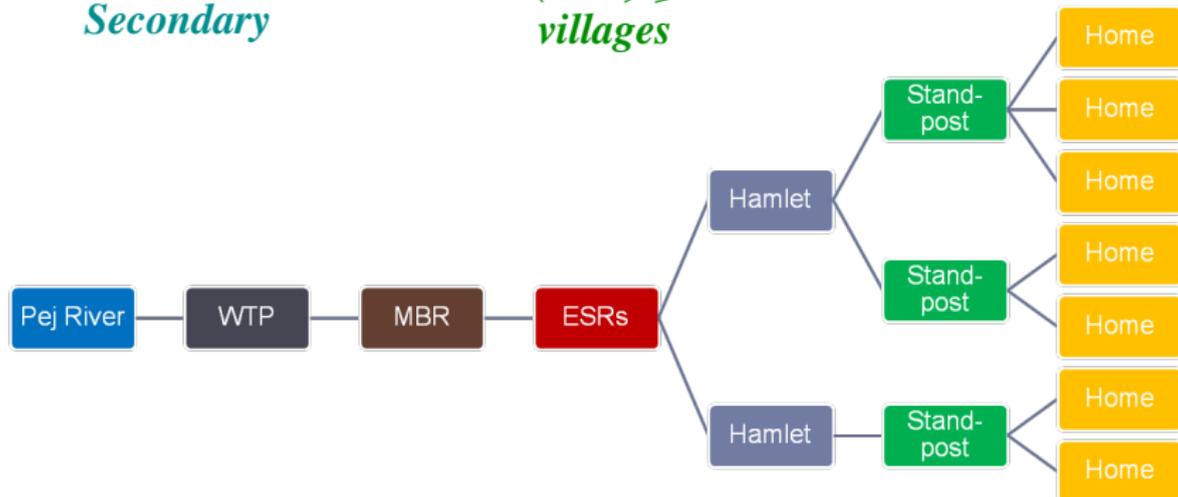
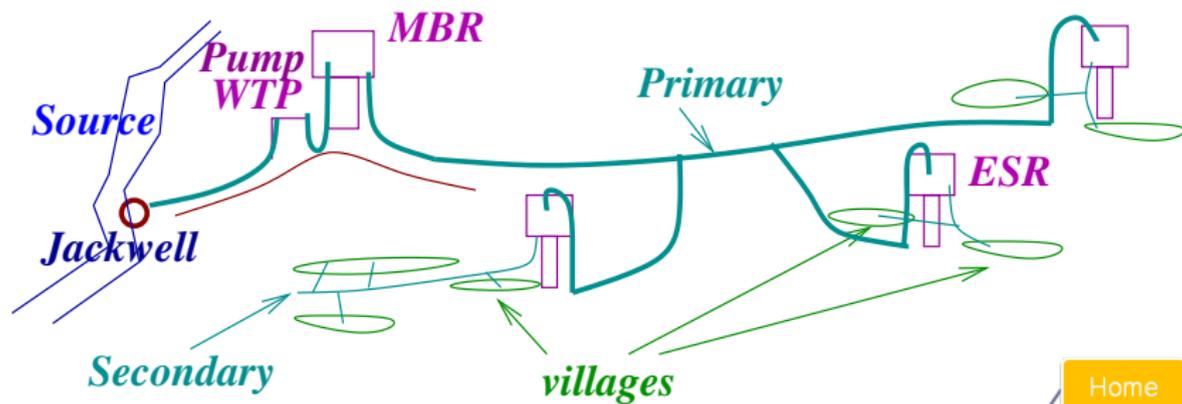
# Obvious questions...

- Why cant we have more of rural regional drinking water schemes?
- Basic issues:
  - ▶ **Technical issues** : tricky design, suitable water source.
  - ▶ **Economic issues** : capital and running costs. Benefits.
  - ▶ **Social/Governance issues** : Ownership, collection of bills, who is to invest?
- **Essentially a techno-economic problem which we must understand!**

## IITB Karjat taluka (Raigad dist.) feasibility study

- feasibility of a rural regional scheme for 70 habitations.
- Using PWD norms and procedures
- reporting back to PWD, local MLA and officials.
- **team of 3 students over 6 months.**

# What all does a scheme have?



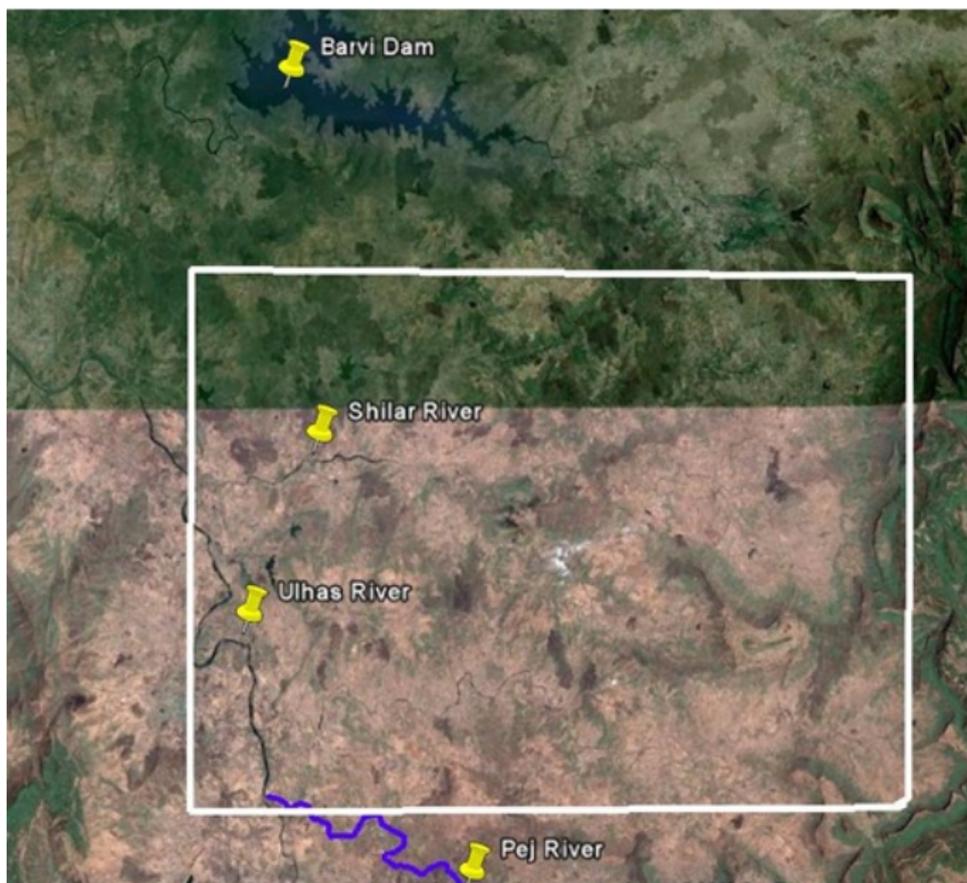
# Basic Steps

- Assess need, severity and extent of problem. **Meeting with all stake-holders.**
- Locate a source and judge feasibility and clearances required.
- Through population data and topo-sheet, create a demand scenario. **Governance**
- Do the network design-**Optimization loop**
  - ▶ Clustering of villages for ESR.
  - ▶ Pipe diameter and head calculation.
  - ▶ Compute costs as per PWD schedule.
- Do ground-truthing and take stake-holder feedback.
- Write a final report and present in appropriate fora. **Documentation and Reporting**

# Stakeholders!



# Karjat Tribal Block

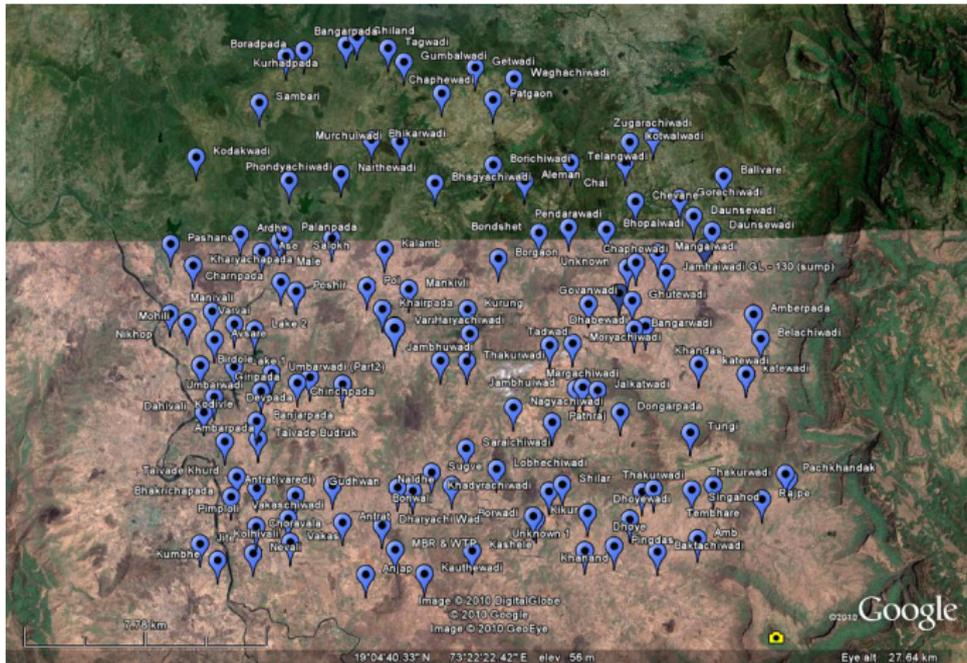


# The source-*Pej river*



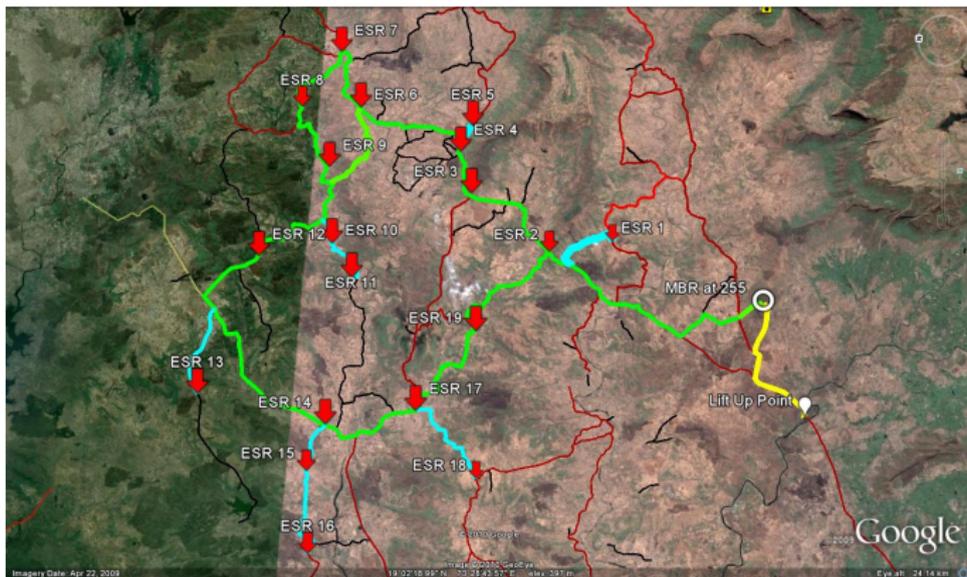
Discharge from Bhivpuri Hydel station-hence perennial

# Understanding the demand



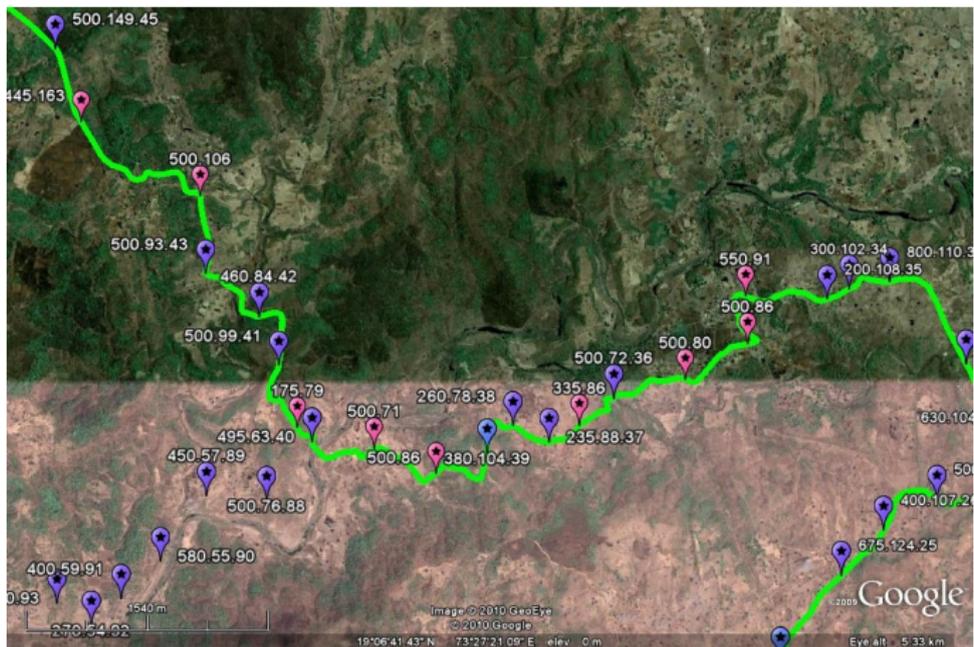
Latitude, longitude, elevation, population and growth rate.

# The designed network



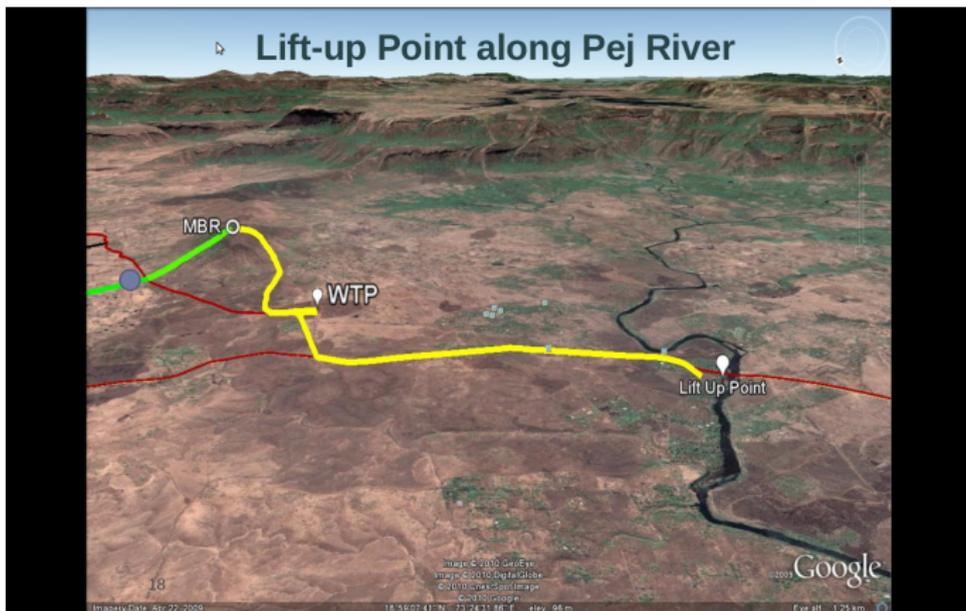
17 ESRs and a 2-loop network.

# A close-up



Hundreds of nodes and edges. Pipes along roads.

# Another close-up



## Finally...

Estimated Net Investment for design population of 81,400.

200 lpcd	Rs.7051 per capita	Rs. 57 crores
40 lpcd	Rs. 2119 per capita	Rs. 17 crores

Energy costs(at Rs. 5 per unit, pumping efficiency 75%)

- 200 lpcd - Rs.400 per capita per annum
- 40 lpcd - Rs. 79 per capita per annum
- Energy cost per 1000 litre Rs. 4.56

Net investment for piped water at both norms of 40/200 lpcd to north Karjat is economically feasible.

# Outcomes

## For Karjat: -Development

- Report adopted by 6 beneficiary gram panchayats in *gram sabha*.
- MLA Mr. Suresh Lad to take this up with ministry.

## For CTARA/IIT: -R&D and inter-disciplinary training

- Novel use of GIS and software tools. New optimization problems.
- Recognition in the *taluka* as a problem-solver. Excellent experience for students to work as consultants.

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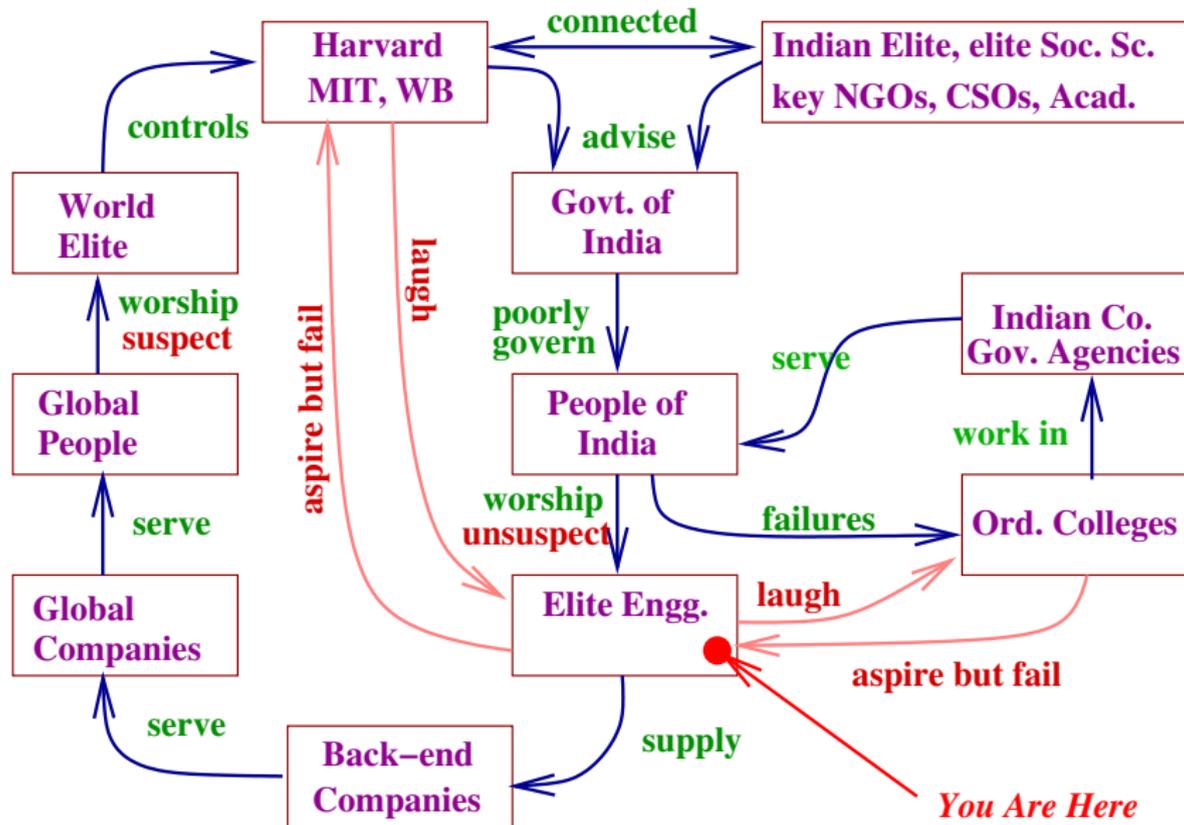
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## If this is so good...?

- why isnt it replicating? And why should I care?
- We must understand the **Knowledge Cycle** in which *you are the \$-note*.

# The Big Picture



# The workings of the Knowledge Cycle

- This is a *Knowledge Society*
  - ▶ A new commodity called knowledge, which is increasingly behaving like capital.
  - ▶ **And which, alas, is branded!!!** Your \$  $\neq$  My \$.
- Belief propagation that *only branded knowledge is true and can bring outcomes*
  - ▶ Knowledge classes (typically aligned with social classes)
  - ▶ Modification of indigenous<sup>1</sup> knowledge systems for migration
- **Devaluation, demoralization and eventual delegitimization of indigenous knowledge systems.**
  - ▶ knowledge poverty in governance and public systems
  - ▶ only external branded knowledge as policy inputs
- Eventually **Knowledge Capture**. Economic and Social servitude.

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<sup>1</sup>Not to be confused with *traditional*

# So where do I go?



# My 'blue-sky' picks! *Avoid Capture at all costs.*

- Stop doing stupid things
  - ▶ Stop building toys, wearing suits for placements, having 8-hour valfis, *party but dont chill*
- Go for the hard money—Build for and plan for the real situations. Remember its the long-haul which matters. Commit yourself to (your own) year-long projects. *Example: This is a drought year.*
- Intern with your district—we will help arrange. Then start a consultancy company—we will train you.
- Get data. Worship data. Draw your own conclusions. Visit *subzi* markets and engineering installations.
- Understand Economics, Sociology, Politics and History. Read. Understand Game Theory. Intellectualize. Behave like a 1-in-50.
- Go on a long long trek. Buy a ruck-sack and sleeping-bag and keep it packed. Go to *Himalayas, M.P., Sahyadri.*

# Start Climbing

