Development Engineering

TD 463

Lecture 2

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What is engineering?

and how do we measure it?

- Number of scientific instruments in schools.
- Number of buses per 1000 people.
- Number of liters of water per person per day?
- Number of factories. Number of manufacturing jobs.
- Length of roads per 1000 people.
- Units of electricity per person per year.

material well-being of society-sustainable, equitable and efficient. But what about:

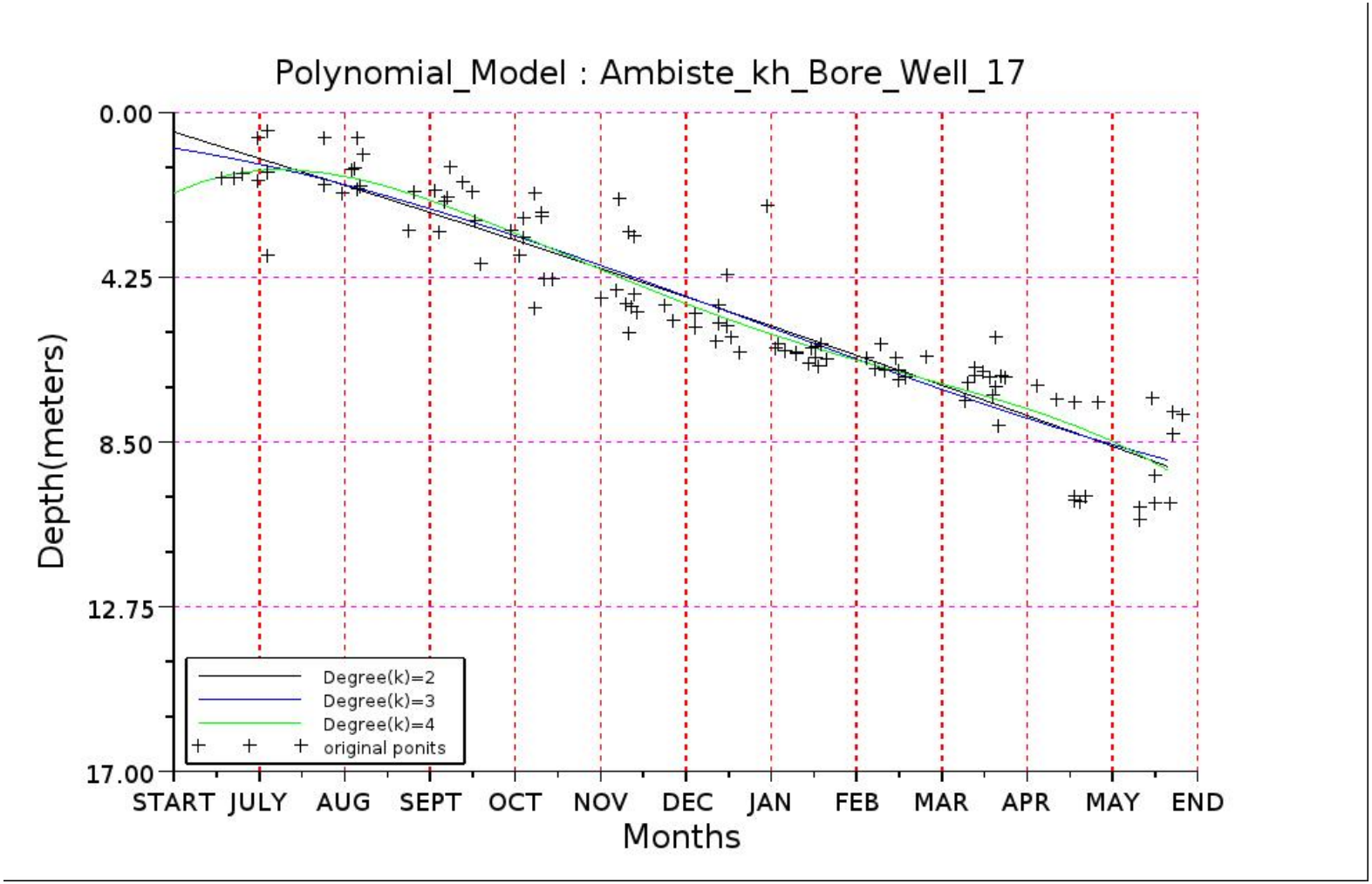
- Number of inter-caste marriages? Number of rape cases?
- Number of books per 1000? Number of Nobel prizes?
- Number of bird-watchers? Number of languages?

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.

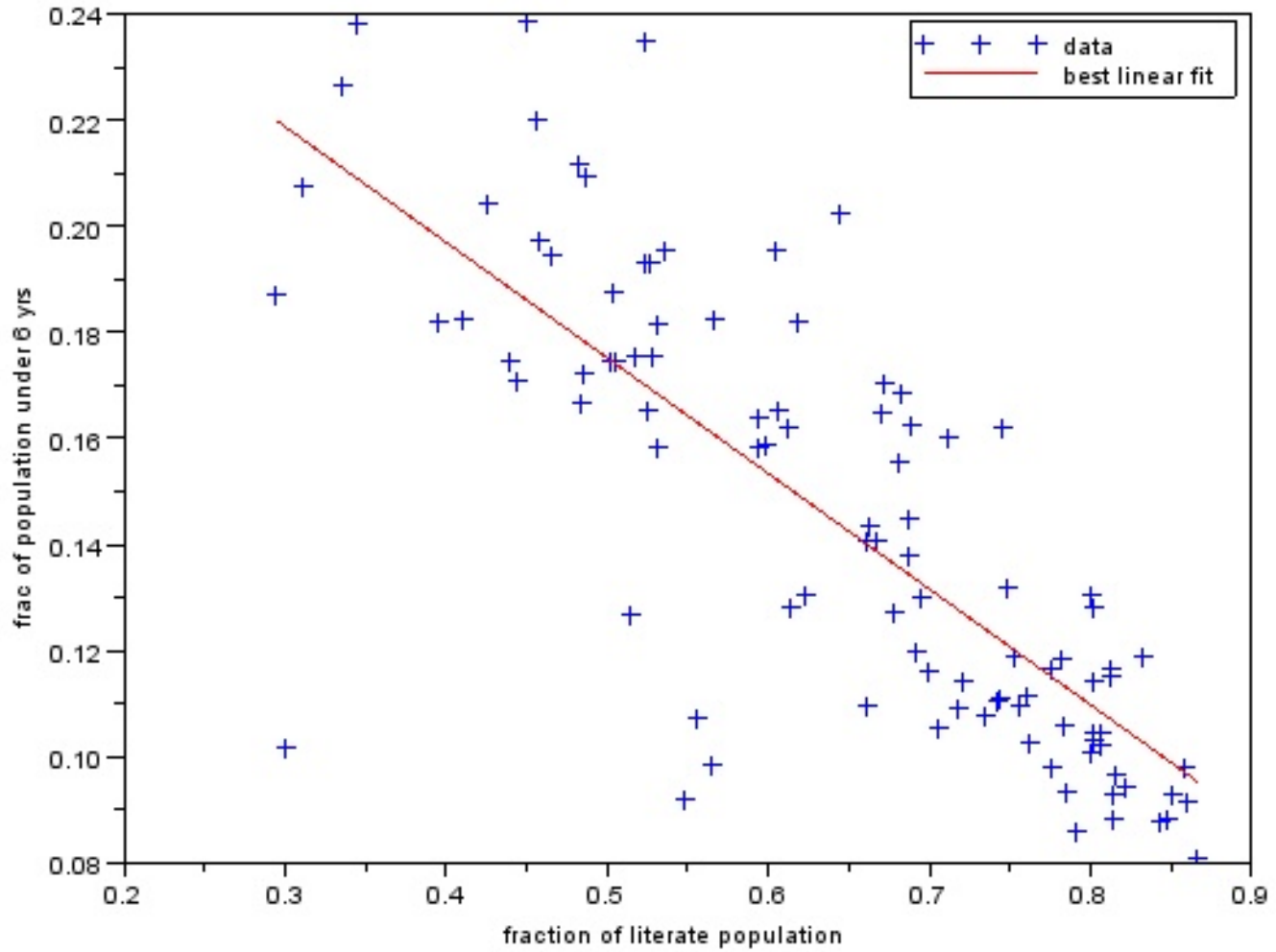
The above steps are repeated till a satisfactory model/theory is obtained.

An Example-water level in a borewell



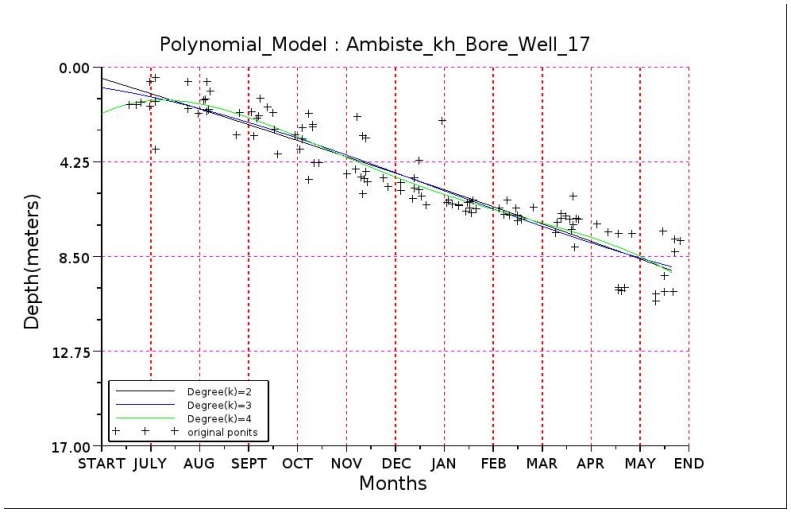
An Example from Social Sciences-Shahpur taluka, Thane

Population fraction under 6 yrs vs. literate fraction

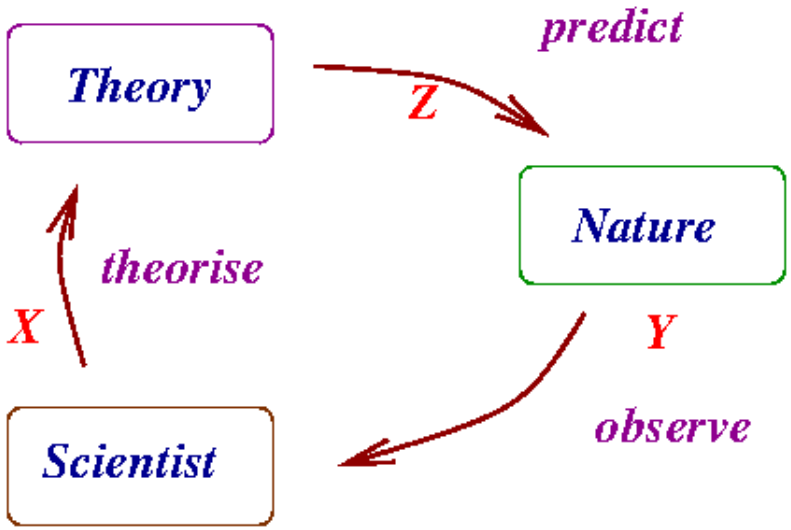


Science - the loop

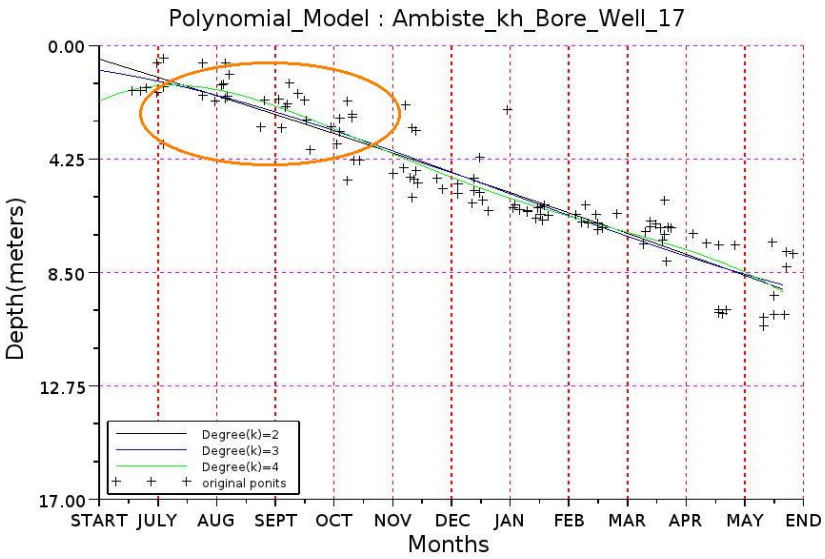
Y	y_1	y_2	y_3	y_4	y^*
X	x_1	x_2	x_3	x_4	x^*
$f(X)$	z_1	z_2	z_3	z_4	z^*

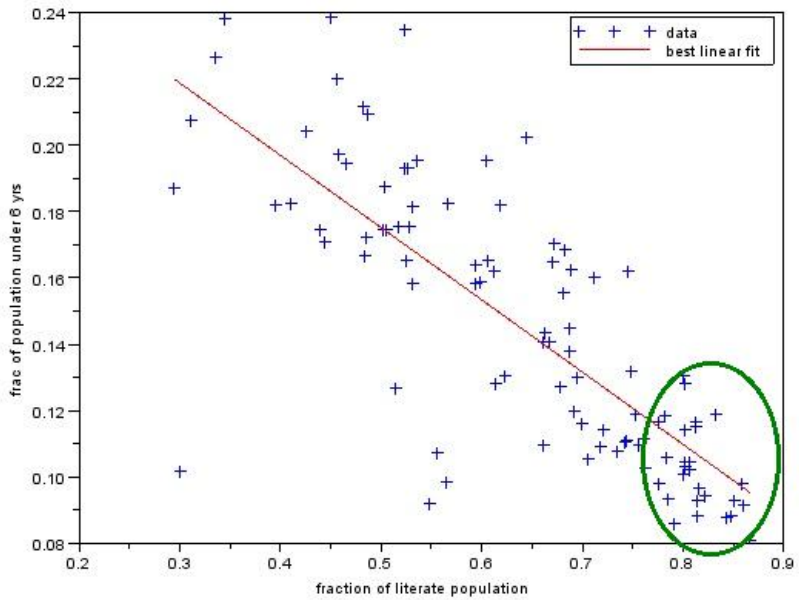


- Causality and Determination
- Aesthetically pleasing laws, i.e., functions f, and argumentation.
- Falsifiable and repeatable.



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?**

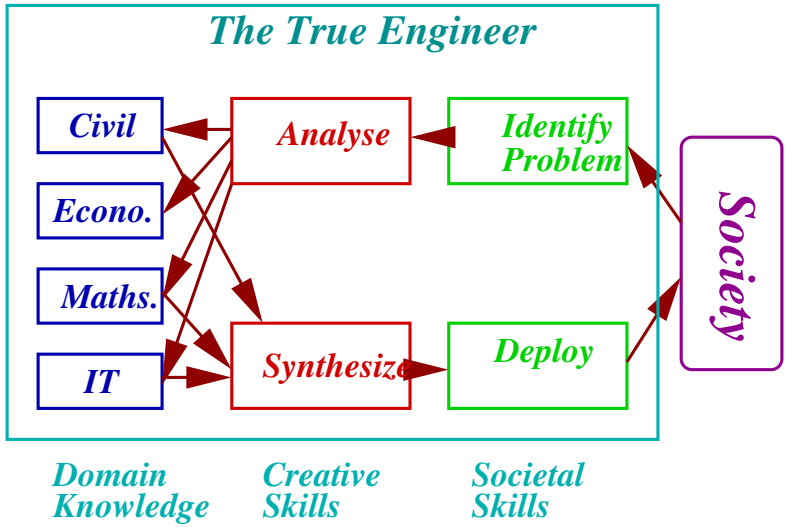
The Engineering Cycle

- 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...

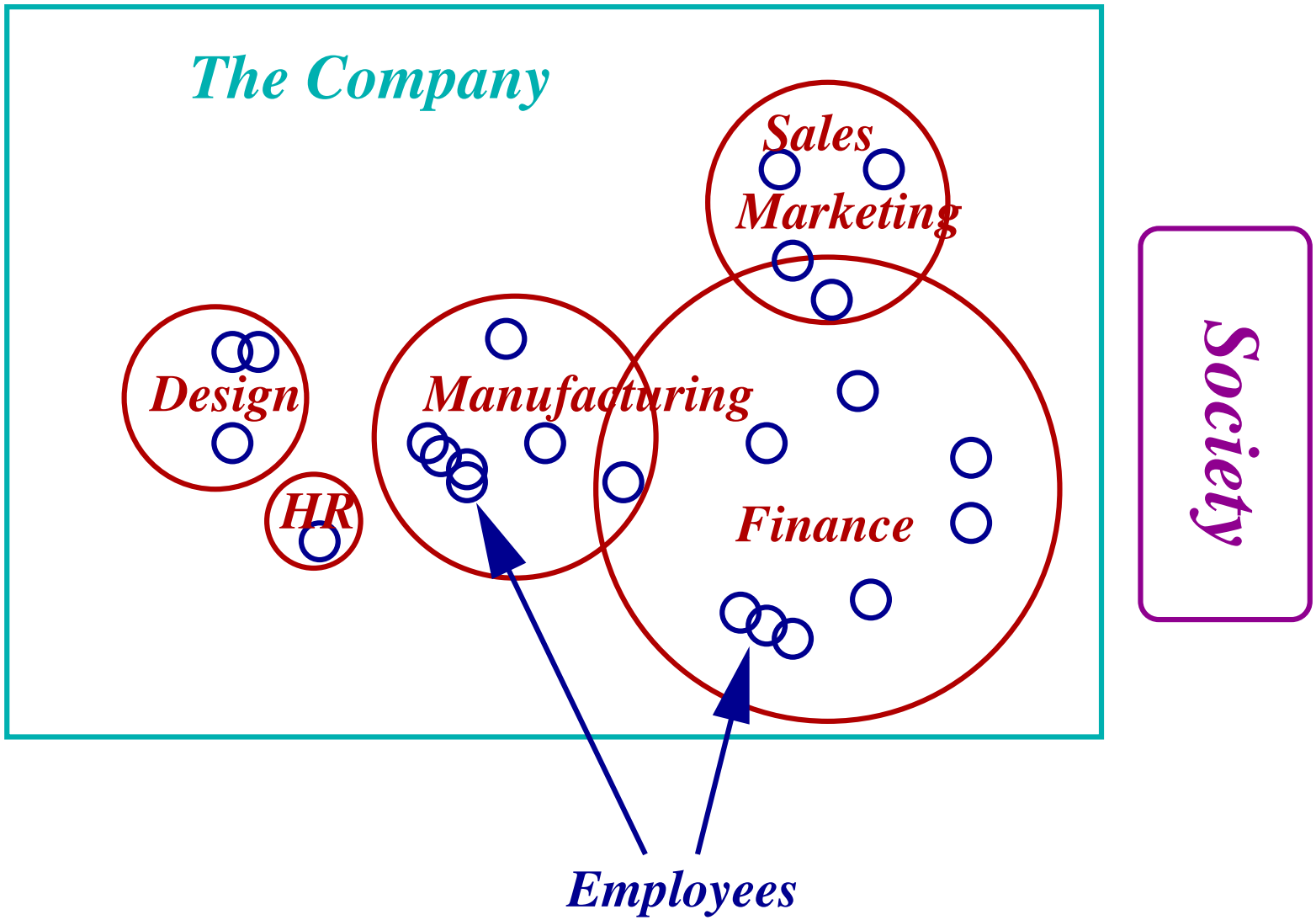
- Science tries to describe reality while Engineering wants to *change* it.
- *Delivering Change* is the key engineering function.
- *Modelling and Design* are the processes by which this is achieved.

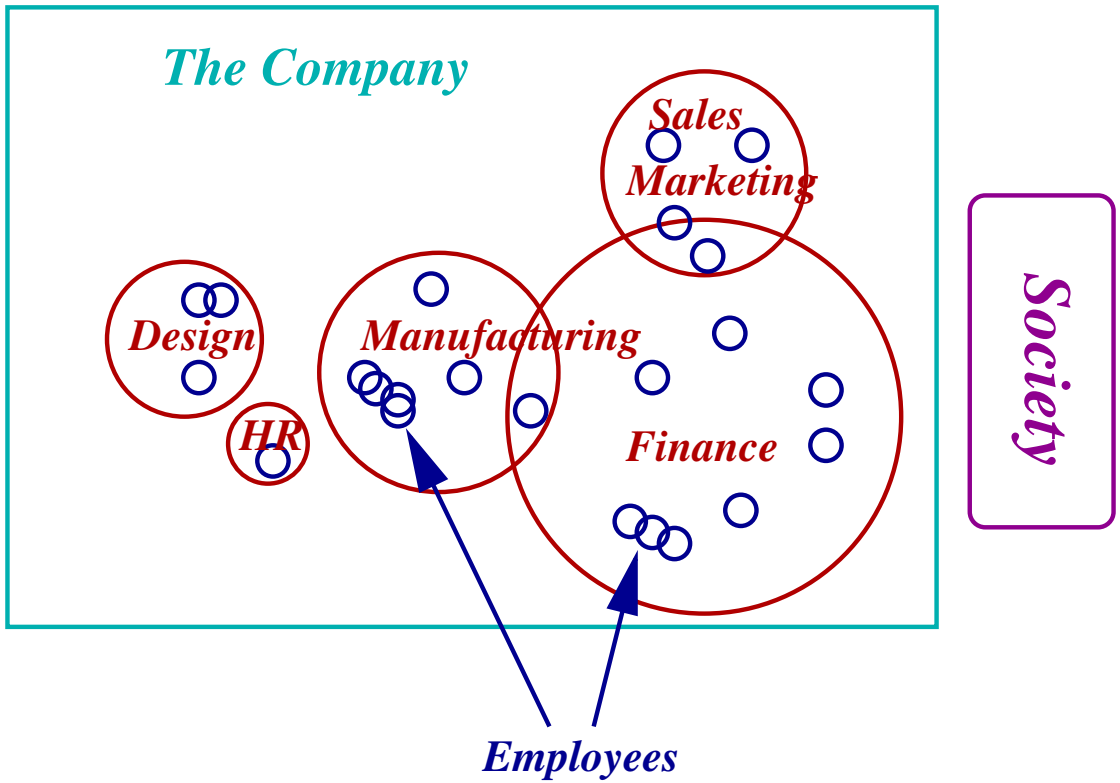
The ideal engineer



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

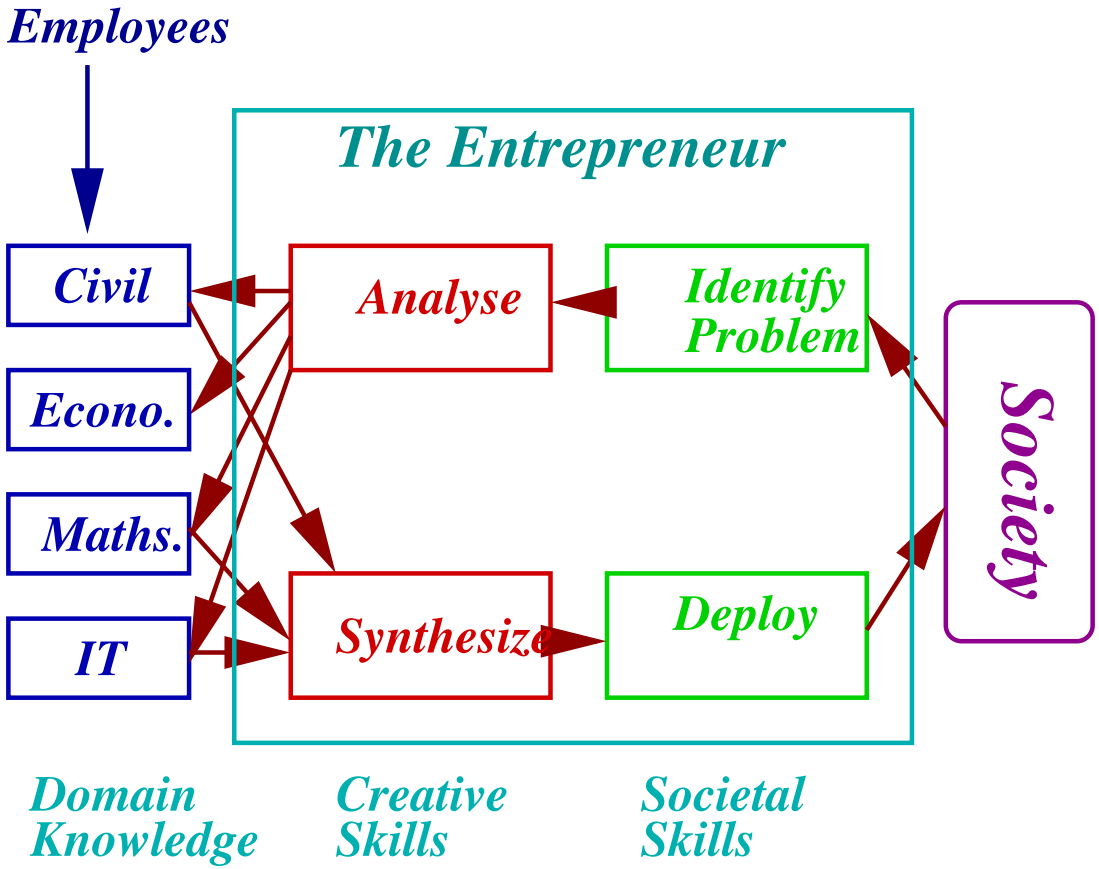
One model—The company

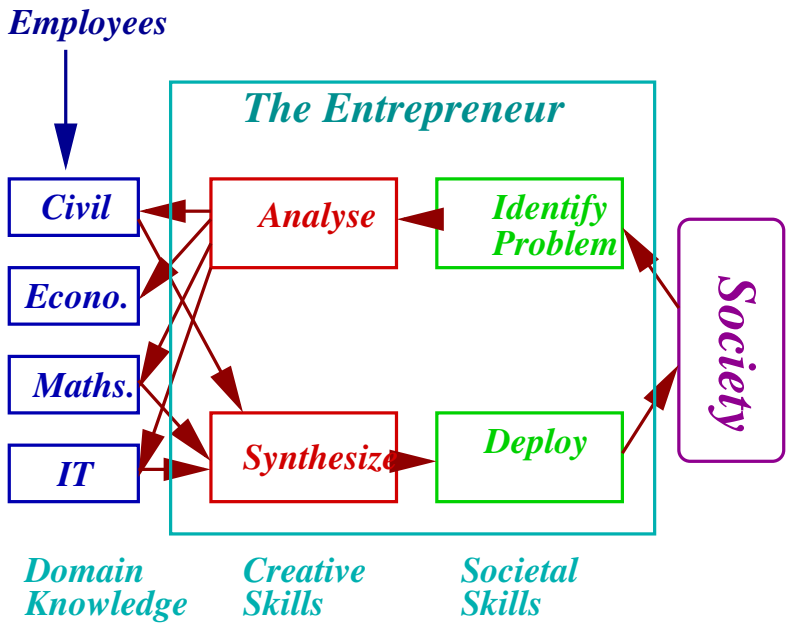




- The employee need not be inter-disciplinary.
- The problems taken for solution by a company are those which give the highest return. *Thus IT, Pharma, Telecom. find attention while drinking water, solid waste do not.*
- Why is it that our young engineers do not start companies in the development sectors?

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.*

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.
- GoI 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.

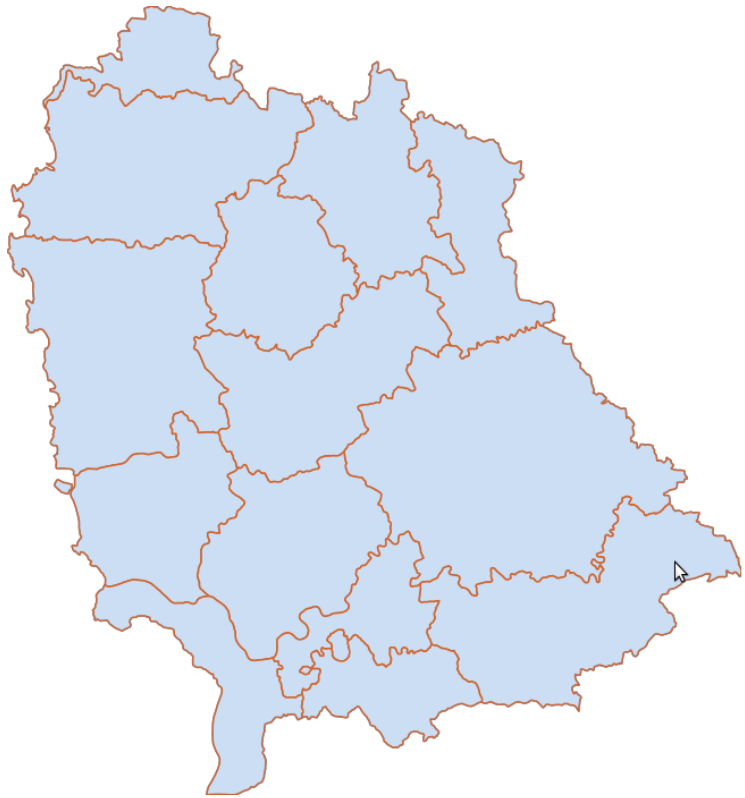
Stress

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

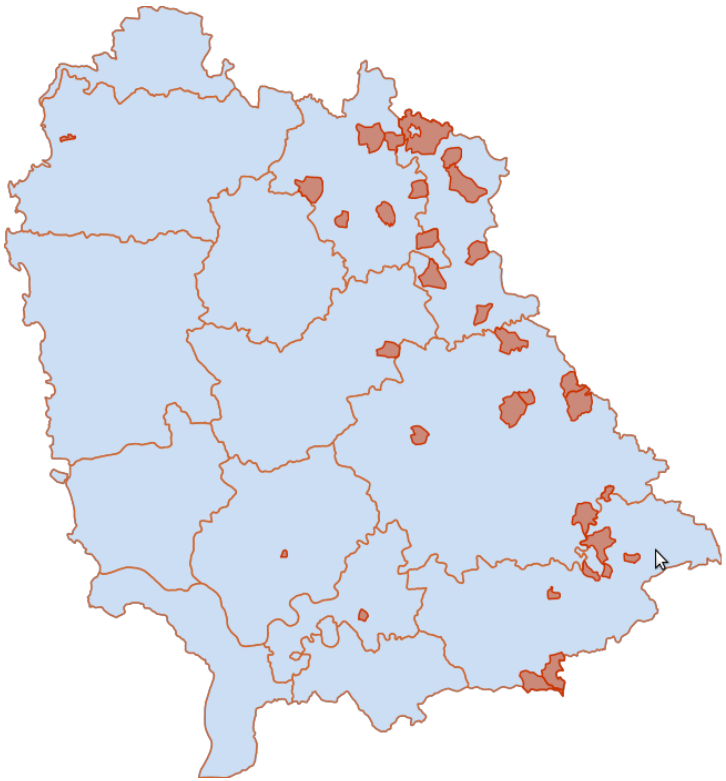
Area	9000 sq km.
Pop. (Rural)	81 (23) lakhs
Taluka (Tribal)	15 (5)
Habitations (GPs)	8000 (900)
Cities (Mun. Coun.)	37 (12)

Thane



- 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

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.

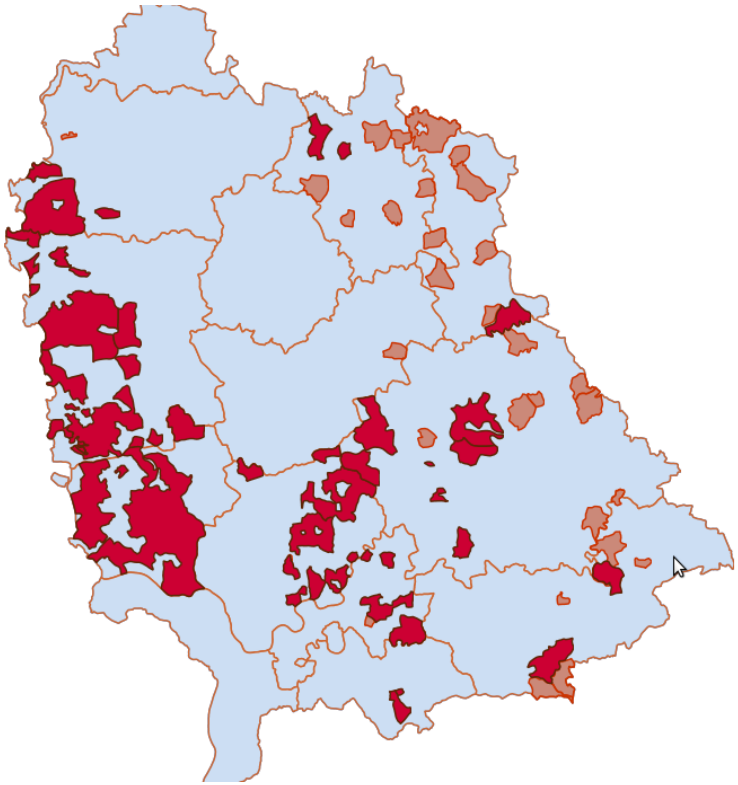
	Ja.	Mo.	Mu.	Sh.
Tanker	0.97	0.93	0.74	0.62
Taluka	0.97	0.91	0.24	0.35

Mean elevation (in *m.*):

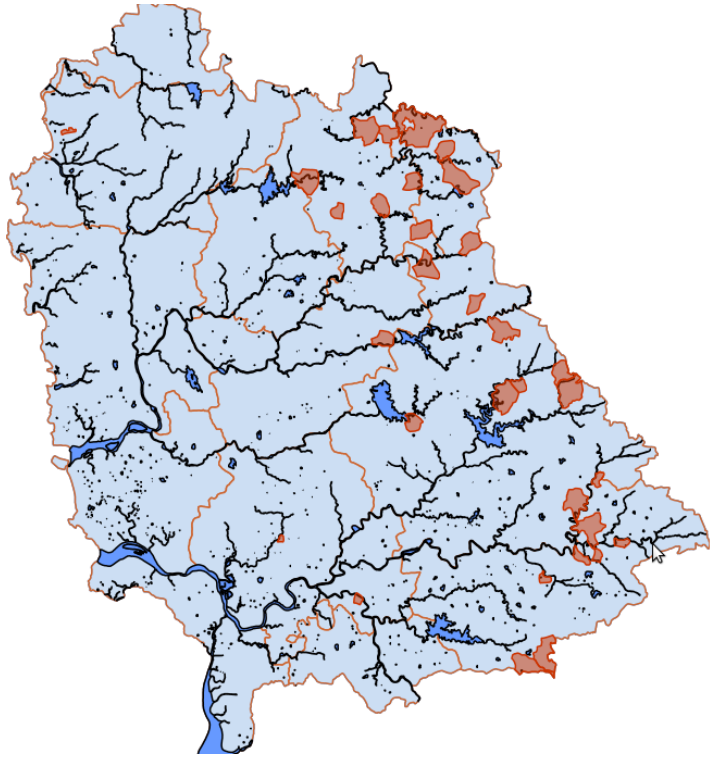
	Ja.	Mo.	Mu.	Sh.
Tanker	344	361	123	197
Taluka	320	350	126	132

More analysis

Location of large rural regional drinking water schemes



Location of rivers and lakes



Data from MRSAC, Census 2001, District administrative offices

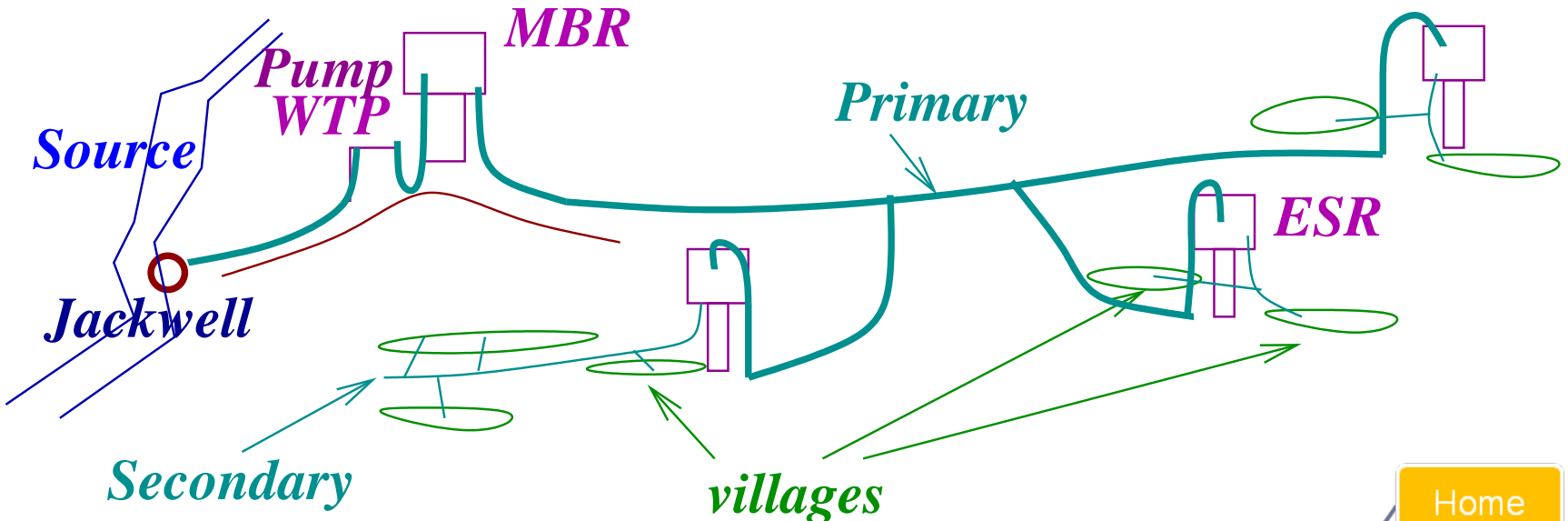
Obvious questions...

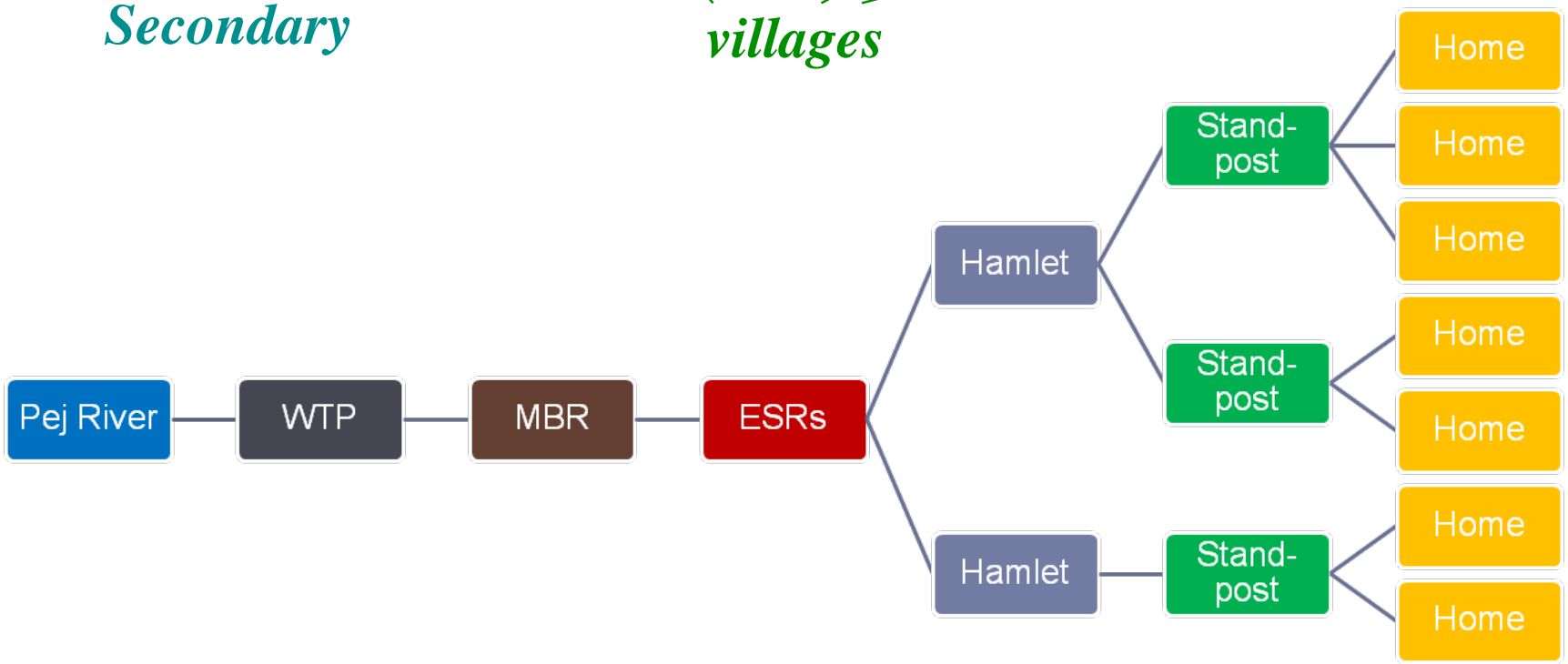
- Why cant we have more of rural regional drinking water schemes?
- Basic issues:
  - Technical issues : tricky design, suitable water source.
  - Economic issues : capital and running costs. Benefits.
  - Social/Governance issues : Ownership, collection of bills, who is to invest?
- Essentially a techno-economic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



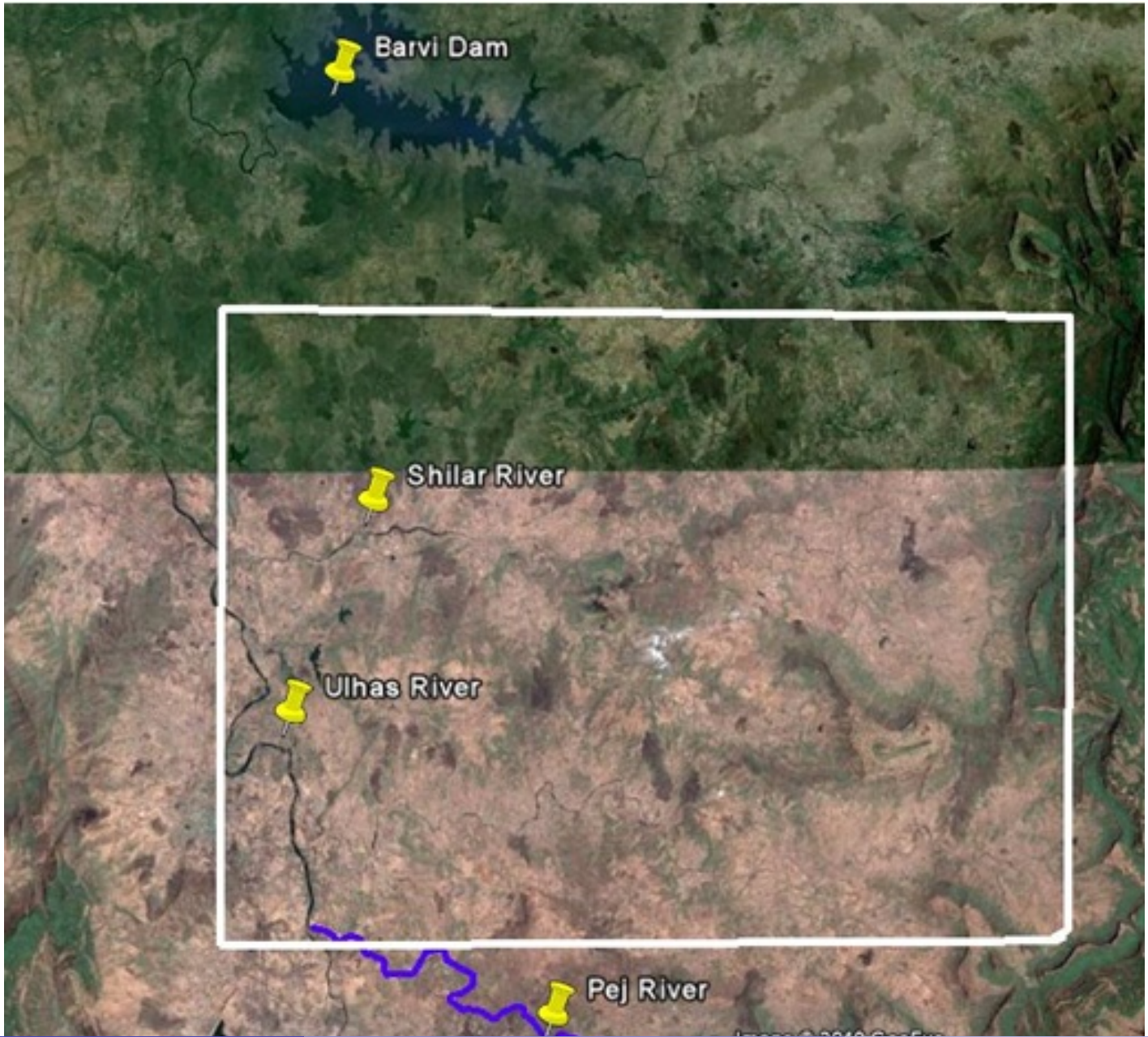


Basic Steps

- Assess need, severity and extend 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!

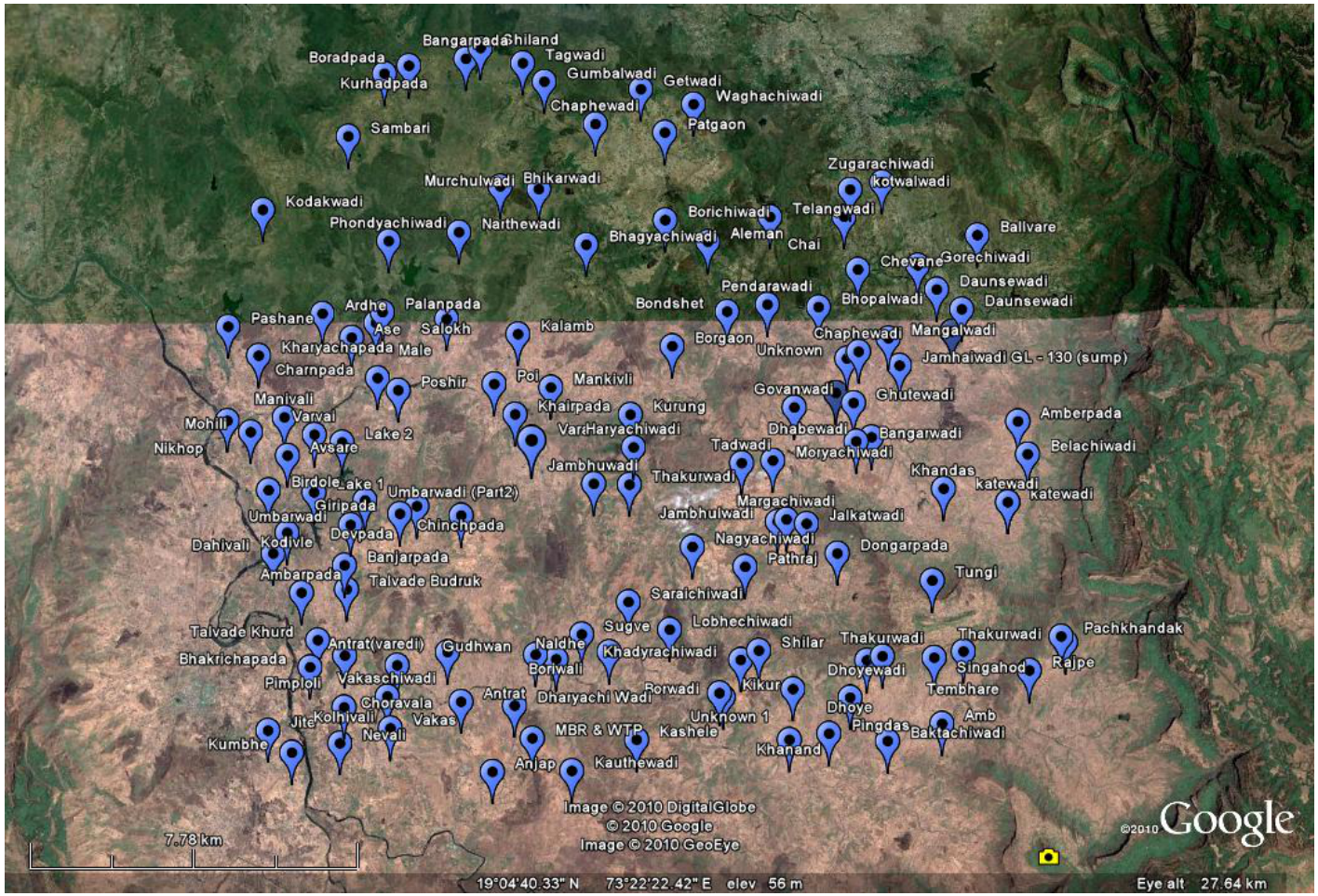
Karjat Tribal Block



The source-*Pej river*

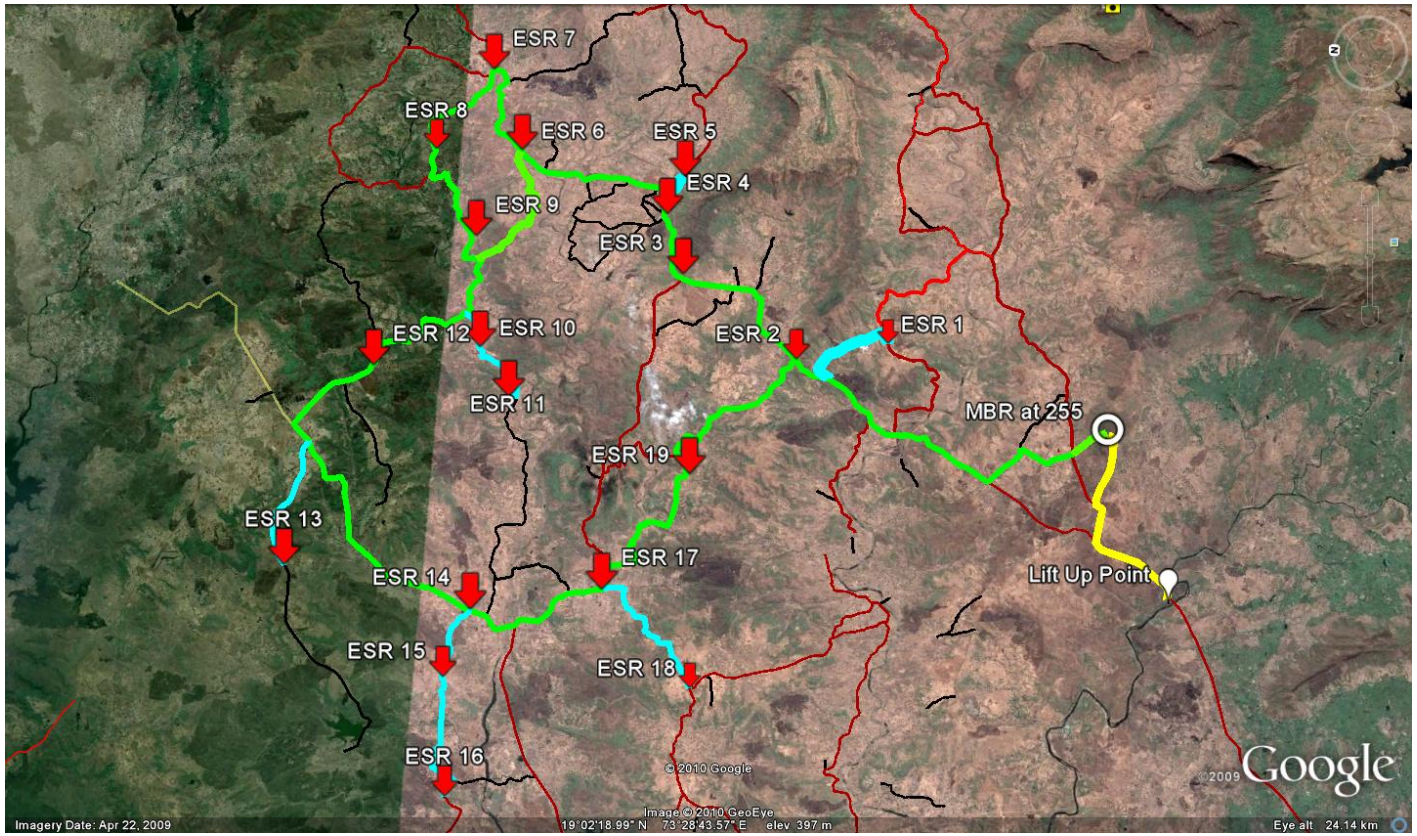
Discharge from Bhivpuri Hydel station-hence perennial

Understanding the demand



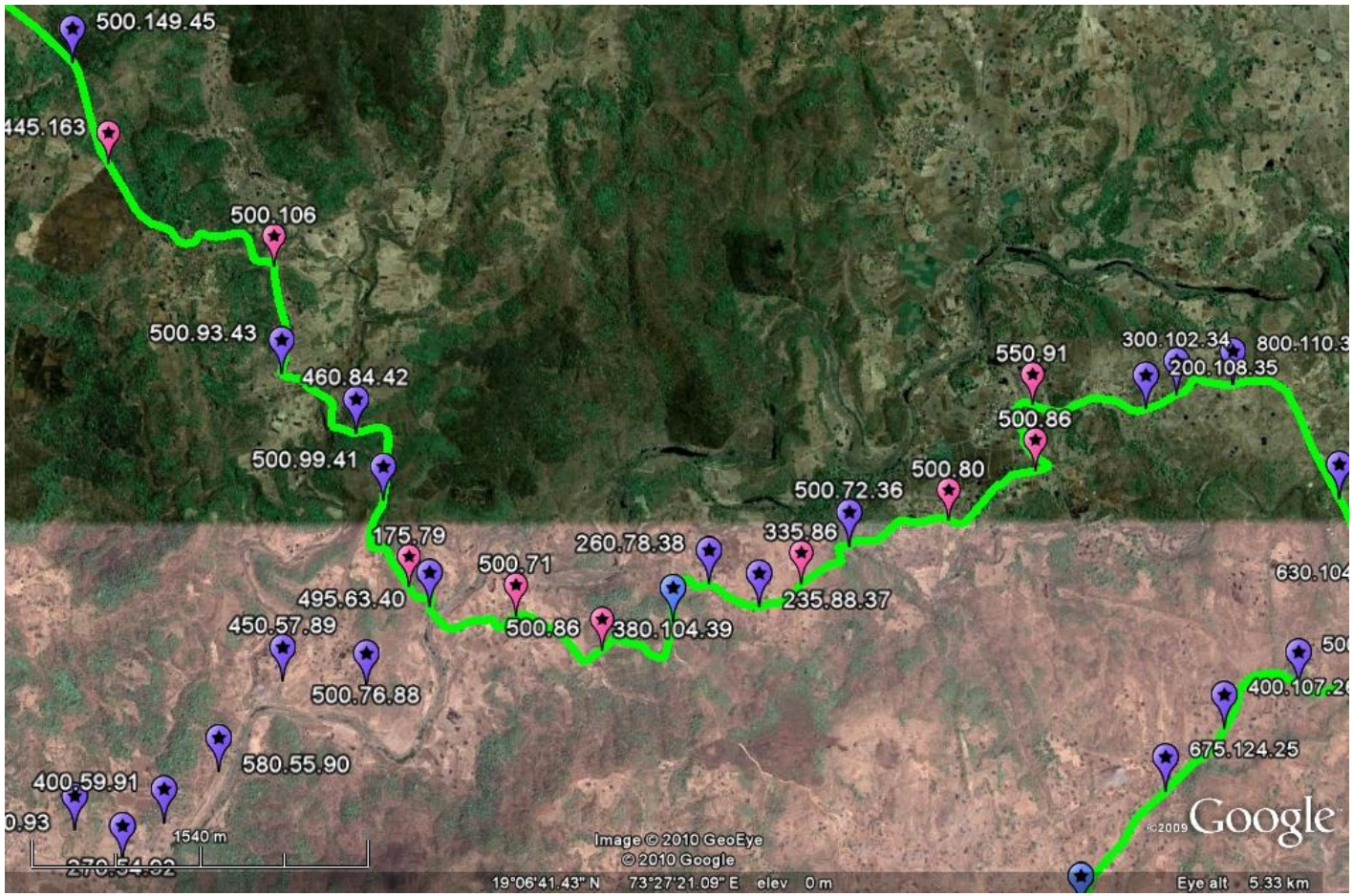
Latitude, longitude, elevation, population and growth rate.

The designed network



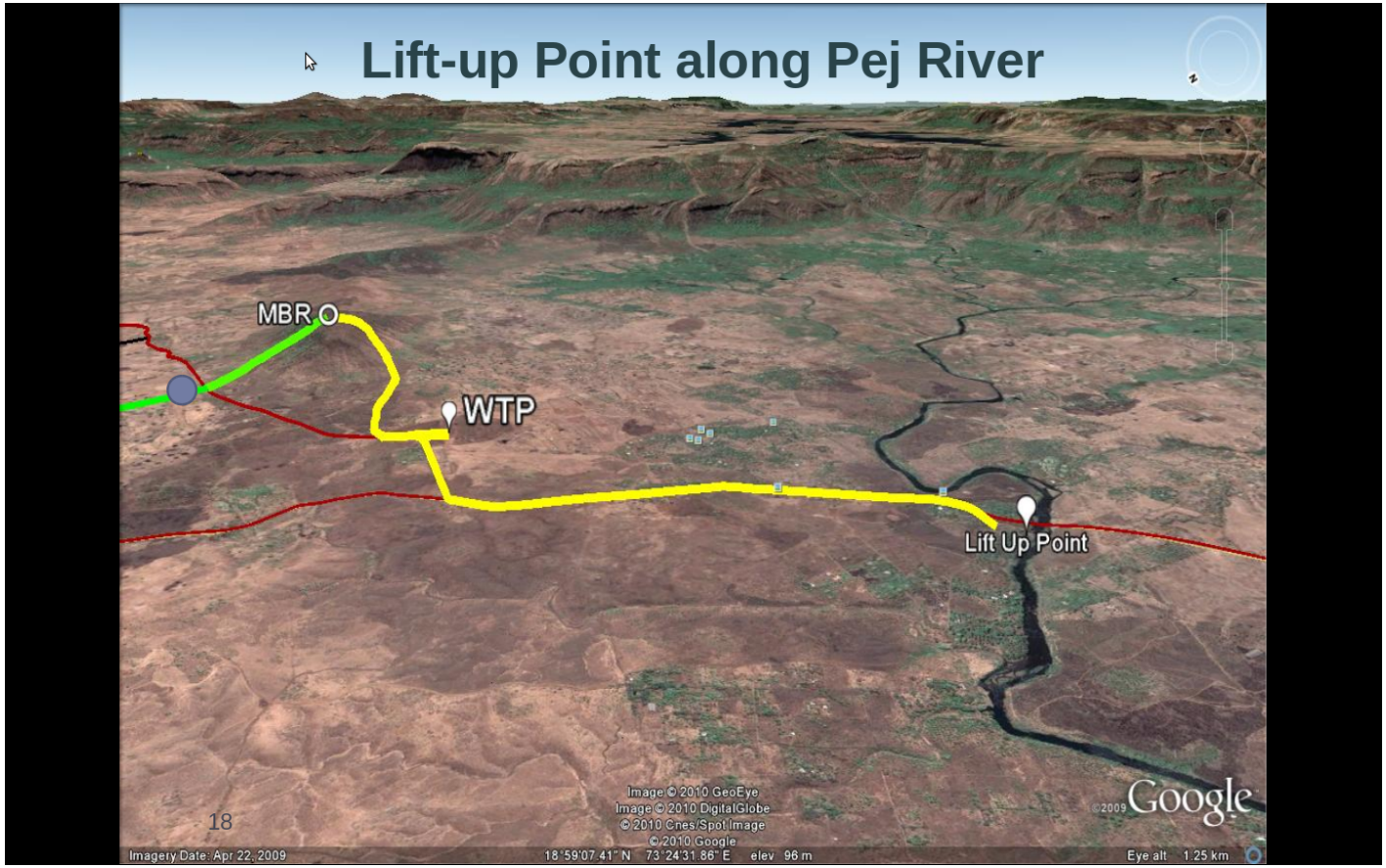
17 ESRs and a 2-loop network.

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 lcpd	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 lcpd - 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 presented and adopted by 6 beneficiary gram panchayats in *gram sabha*.
- Demand letter offically presented to district administration.
- MLA Mr. Suresh Lad to take this up with ministry.

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

- Novel use of GIS and Google Earth. New optimization problems.
- Expertise in network design and simulations. Use of Branch and LOOP softwares.
- Recognition in the *taluka* as a problem-solver. Excellent experience for students to work as consultants.

So, where do we go from here?

- There are examples from other fields as well:
  - Energy sector, public transport, more water, town planning,...
- Study TDSL in `www.ctara.iitb.ac.in` on how to design and offer projects for UGs. Adopt similar offering in your curriculum.
- Set aside some funding and have 2-3 coordinating faculty.
- Have your institution head meet with district collector.
- **CTARA can help!**

The Development Vision-Engineering colleges as regional solution providers

- close cooperation between field-level administrations and educational and research institutions
- movement of funds to local R&D and avenues for innovation
- training of a new engineer-social scientist-consultant

Engineering

- describes the material conditions of a society
- the analysis of desirable and undesirable changes
- the design of interventions,
- the processes of implementation.

Thanks