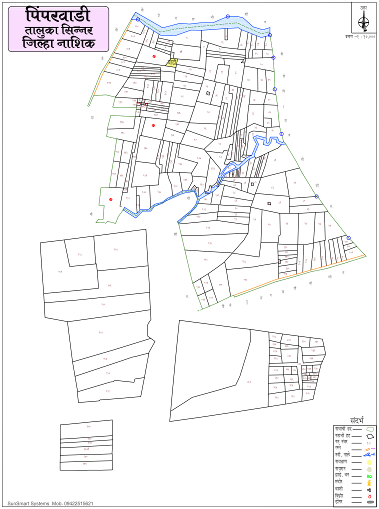
Water and Development

Minor Structures

Milind Sohoni
www.cse.iitb.ac.in/∼sohoni
email: sohoni@cse.iitb.ac.in

So far...



- The organization of the village.
- Farmlands and crops -Kharif, Rabi and Summer
- The demand for water. The deficit or the surplus.
- How do we meet it?

Watershed interventions

- Different types-Drain and Area.
- Larger - Percolation tanks and KT weirs

The Design Cycle

Development Outcomes ⇒ Bio-physical Outcomes ⇒ Designs and Plans

Development Outcomes

- Socio-economic, concerns such as equity, access.
- More cropping area. More certain and more secure water.
- Good quality drinking water. easy to maintain systems.

Bio-physical Outcomes

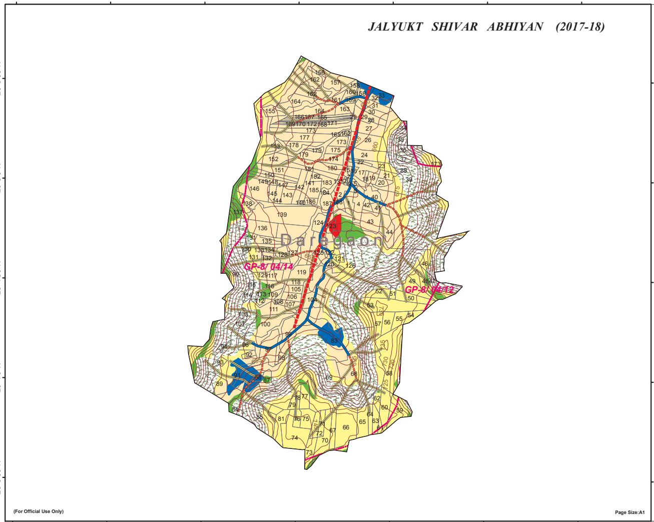
- Science and Technology Choice, Sustainability.
- Water requirements, norms.

Design and Plans

- Interventions, Efficiency. Cost-Benefit: Metric, Rs./TCM, Labour, Social contribution.
- Overall plans. Major and minor structures. Where to do.

ACTIONPLAN MAP (Watershed No:- GP-8/4/14)

Village-Daregaon ,Taluka -Fulambari, District -Aurangabad



N
W E
S

0 0.225 0.45 0.9
Kilometers

SCALE - 1:20,000

In Map Show Existing Activities with Red Colour and Proposed Activities with Green Colour

Legend

- Linaments/Dyke
- Contour 5 Meter
- Watershed Boundary
- Survey/Gat No. Boundary
- Village Boundary

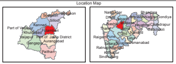
Drainage Line Treatment

- Gully Plug or LBS
- Earthen Nalla Bund/ Gabian Bandhara
- Nala Desilting/C.N.B./K.T.

Area Treatment

- Dry land Agriculture/Contour Bunding/ Farmpond
- Afforestation/ Dry Land Horticulture/Plantation
- CCT/Deep CCT/WAT/Forest Pond
- Compartment Bunding/Graded Bunding/Fram Pond/Well Recharge
- River/ Waterbody
- Village Area

Location Map



DATA SOURCES::

Village Map:Directorate of Land Records
Linaments/Dyke:Derived from SatelliteData MRSAC,
Actionplan: MRSAC
Contour 5mt:Derived from SRTM data MRSAC,
Watershed -AISLUS & GSDA,
Drainage:GSDA,Pune

PREPARED FOR::

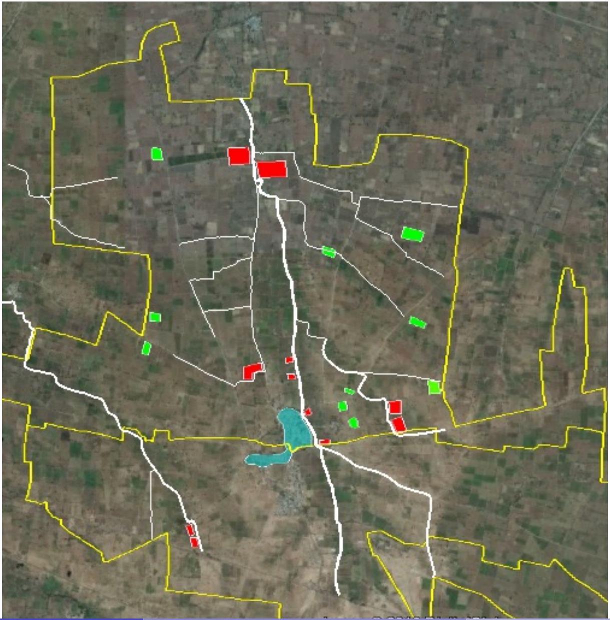
Vasundhara Watershed Development Agency, Maharashtra, Pune-1
And
Director of Soil and Water Conservation Maharashtra, Pune-1

MRSAC

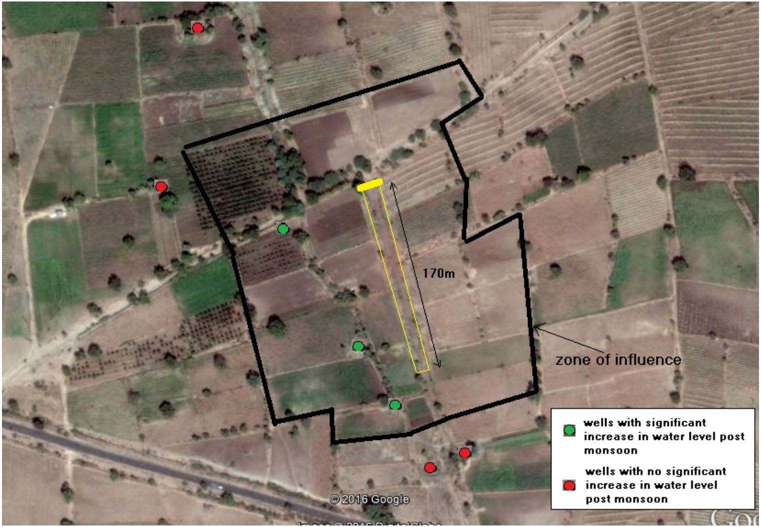
PREPARED BY::

Maharashtra Remote Sensing Applications Centre,
Dept. of Planning,Nagpur,
Govt. of Maharashtra.
And GSDA,Pune

Variable Access to Water



Interventions and their influence



Classification by Purpose

We may classify structures/procedures by their primary objective.

Groundwater Recharge: To enhance the recharge of groundwater or to improve soil moisture. Usually done either by

(i) reducing the velocity of water-flow

(ii) increasing the infiltration coefficient

(iii) explicit groundwater recharge structure

Examples: Contour bunding, furrowing, well-recharge structures, percolation tanks.

Reducing Soil Erosion: To improve agriculture, protect building etc., or to protect downstream water structures. Examples:

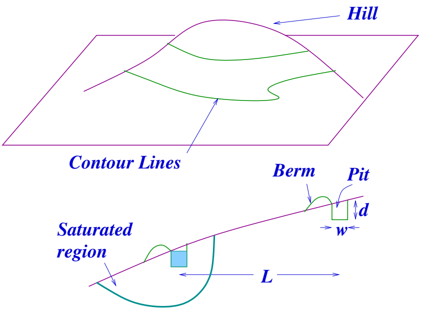
- Terracing, contour bunds.
- Gabions and gully plugs.

Surface Storage: To store water on the surface. Some examples are:

- Check-Dams, Weirs
- Rainwater harvesting

Contour Trenches

source:FAO



Parameters L, d, w depend on the slope, rainfall etc.
Working: Pits fill with water and remain so till the end of monsoon. This creates a local saturated layer which helps percolation. Also used alongside tree-plantation.

Contour Trenches

source:FAO

- On forest and common lands. Slope less than 20%. Risk of lanslides.
- Intercept sliding sheet of water and capture and infiltrate.
- 2-3 fillings per season. 1000 running meters per hectare. Roughly 2000-3000 cu.m. infiltration. Rs. 60-120 /cu.m.

Hill-sides

Baner, Pune. source:http://stuffido.wordpress.com/2009/07/

Contour-bunds

This is formed by firming the berms to create obstructions to water flow. It is especially useful for tree-planting.

Terracing

This is largely about preventing soil-erosion and utilizing the land for agriculture. It is used when the gradients are small.

source: FAO

Terracing and gullies

Top view source: FAO

Terracing: Delicate construction. Special care must be taken for the inlet and outlet of water.

Example of gully formation in an agricultural field. Gullies may form in a single monsoon in fields with even a small gradient. These get reinforced and cause substantial damage.

source: FAO

Bunds and channels

- Rice-fields have bunds to maintain submergence.
- Fields in Black Cotton soils have channels to drain excess water, esp. for cotton or soyabean.
- Water management: must for dry-spells. Ensure soil moisture.

Contour Bunds

- To bring fallow land into agriculture, esp. horticulture.
- Broad trences of 2-3m and bunds of 1m in height.
- Moves about 20-30mm of run-off into infiltration. Rs. 7000/Ha.

Furrowing

Soil may get compacted by overgrazing and animal/human use. This reduces infiltration coefficients substantially. For level lands, furrowing is a useful technique for increasing infiltration. In fact, agricultural land is excellent for recharge.

source: FAO

Farm Ponds

from TN agri. univ.

Farm Ponds-Design

Need

- Protective irrigation during Kharif
- Support for critical Rabi/Crop crop
- Recharge and Storage
- How is it filled? Is it lined?

- Ideal Use: Fill from run-off/base-flow or from canal-side wells. Not from groundwater.
- Lined if protective, unlined if community recharge.
- Rs. 1 lakhs, if unlined, Rs. 2 lakhs if lined.

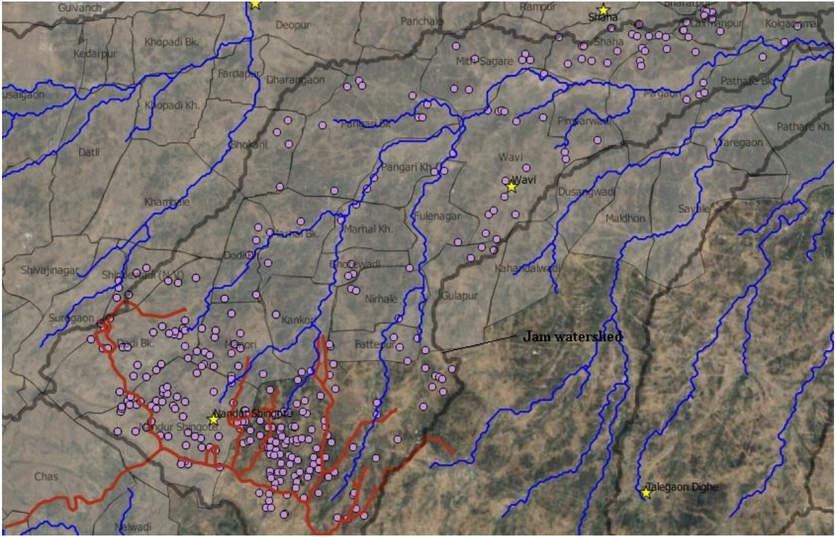
Locations

Detail

Count Them!


Airtel Banking
Hotel Jayraj
Secondary School
Nandur Shingote
Renuka Steel
And Furniture
Sangle
Rsproduction
Chas Rd
Chas Rd
Chas Rd

This needs analysis



Tanks and Bunds

source:
`http://forest.ap.nic.in/Sparks of Success APFD-02-05/007-Nallavally.htm`

- Dug-outs or obtained by bunding an existing flow to create a pond.
- If bunded, then the design of the bund needs some care. It should have a spillway, and usually a foundation.
- Primary objective is to recharge groundwater by holding it during the monsoons and after it.
- Also serves as farm-ponds to *protect* kharif crops.
- Periodic de-silting important.

Tanks and Check-Dams

source: http://test1.icrisat.org/ satrends/ jan2006.htm

- Note the spillways and pitching.
- Most dry up in 3 months.

source: http://washim.nic.in/DOC/ Egs_ files/image007.jpg

- A *check-dam* is designed differently.
- The bund is deeper with a clay core.

Vanrai Bandhara

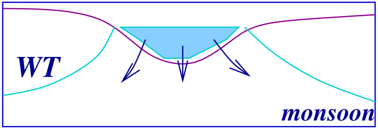
- Temporary, must be installed after every monsoon.
- $<$ 2m in height, and may be used on top of existing bunds.
- Installed just after monsoons get over, but stream flows remain.
- Mainly to achieve/increment some recharge and some storage.

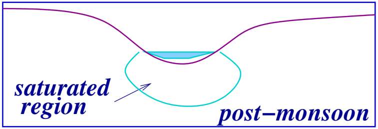
source: `http://washim.nic.in/DOC/ Egs_ files/image010.jpg`

The principle

- During the monsoons, connect the WT and the pond.
- Increase recharge during the monsoons.
- Helps reduce crop stress in lean periods.
- Post-monsoon, a perched WT.
- Increases soil moisture.
- Silts have low conductivity. Must be removed from tank bottoms to aid percolation.

- Evaporation losses about 5mm/day.
- Poor ambient conductivity $\implies$ Wet longer





Gabions

Gabions are loose rock structures to prevent soil erosion.

- Located along/across gullies or stream banks.
- They trap soil and reduce water velocities.
- They help maintain and control stream flow.
- Typically built using wire-meshes.
- A cage is built which encloses rocks suitably arranged.
- Manual construction.
- Porous, does not hold water.

source:

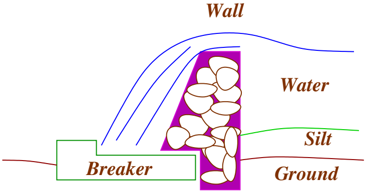
http://lh4.ggpht.com/_KsQX_i

Across streams: an overflowing gabion

source: http://www.bridgetrust.org/images/Gabion (1).jpg

Masonry Structures

source: http://www.gomukh.org/images/index_02.jpg



- Boulder and concrete wall with a concrete breaker.
- Foundation and Key-wall to prevent leakage around the wall.
- Overflow structure, used as storage and silt trap.

Concrete Nala Bunds

Vented structure at Adoshi.

Design Principles

- Storage/Recharge. To create small storages within river beds.
- Soil Conservation. To obstruct water and reduce velocity of water. To trap silt.

- Design: RCC Overflow structure, compact and with foundation. 3-4m high, with apron. Roughly Rs 1-2 lakhs per meter.
- Storage created: 3m $\times$ 20m $\times$300m = 18000 Cu.m. Adequate for 18 Ha. protective irrigationthrough pumps or through well-recharge.
- Serious Issues : Flooding of banks!Silting. Cost: Rs. 5K-10K/cu.m.

Adoshi vents operating

Kurlod structure

Useful for agriculture.

Needing Repairs

Manipada

Manipada repiared: in Monsoons

Manipada Upstream

Nalla deepening and widening

- Create storage within river bed. Behind an existing or new CNB.
- Length $\times$ cross-section=10-20TCM.
- Make sure depth no more than 3m or less.
- Make sure that berms are made and that it doesnt close flows from farms into stream. *water-logging*.

Desilting

- Soil: 3 grades-Top to bottom. Sand. Silt. Clay.
- Move silt back to farms.
- Estimate silt to be removed. Estimate farm-lands to receive. 5cm thick layer is 500 cu.m., i.e., 50 trucks per Ha.
- About Rs. 60-100 per cu.m. for removal. Rs. 50 for transport.

Dams and Weirs-The Kolhapur Type Bandhara

source: `http://www.maharashtra.gov.in/english/ gazetteer/ Nanded/images/kholhapur-dam.jpg`

The principle

source: `http://ahmednagar.nic.in/html_docs/images Ralegan.png`

- Concrete structure within the river bed.
- Gates open in monsoons and shut *just after*.
- Creates a storage used for agriculture/DW.
- The storage is largely confined to the river bed. No land need be acquired.
- Used by upstream people!
- Appear in a sequence
- Fairly cheap and useful. Very popular in India.

A typical caluclation

.

- Height and length of KT weir: $30m \times 3m$.
- Length: 1000m and therefore volume: 100,000 cubic meter, i.e., 0.1MCM.
- At 10cm watering, we get 100 hectares of irrigation.
- About 30-40km of river gives us 4MCM per discharge.
- Dimbhe Storage is 375MCM.
- About 20-30 weeks of discharge gives about 100MCM through KT weir.

Reservoir+Earthen Dam

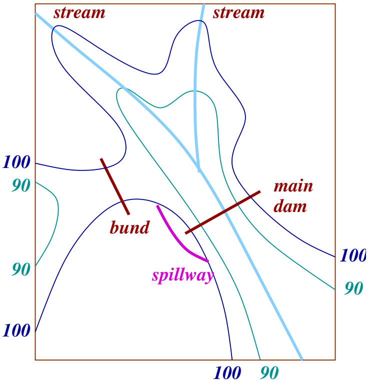
Objectives

- Increase surface storage in system. Increase recharge and total GW stored. Improve surface water flows.
- Improve drinking water security and allow for livelihood water.

Costs

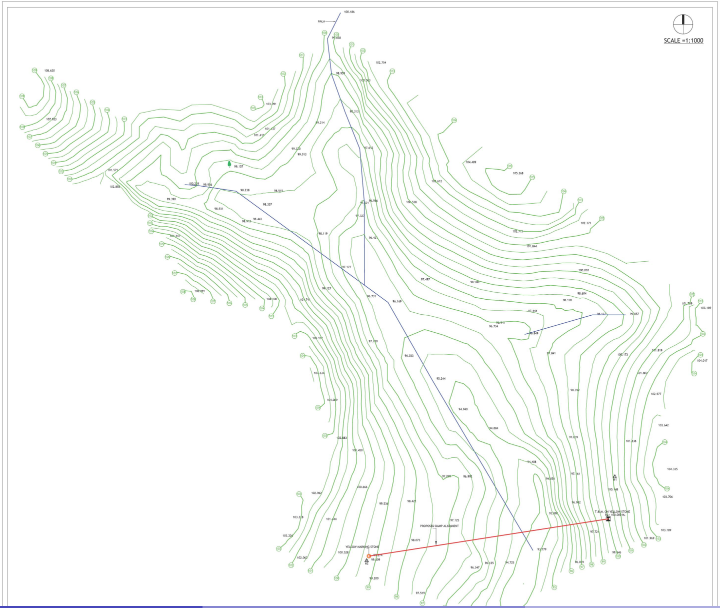
- Land acquisition, submergence. Considerable amount of earth.
- Sophisticated engineering design. Labour and fuel costs.

A Small Dam



- The FSL (full storage level) of the dam is the height at which water is stored, in this case, 100.
- The dam and the bund are higher. The bund was needed to achieve an FSL of 100.
- The storage is the modified contour at 100.
- The spillway is at 100 and cuts into the old contour at 100. Excess water overflows from here.
- The Key-wall protects the dam from the spillway.

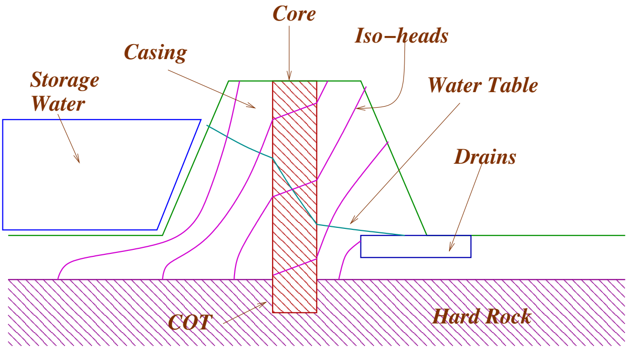
Alignment



Storage or Silt Calculation

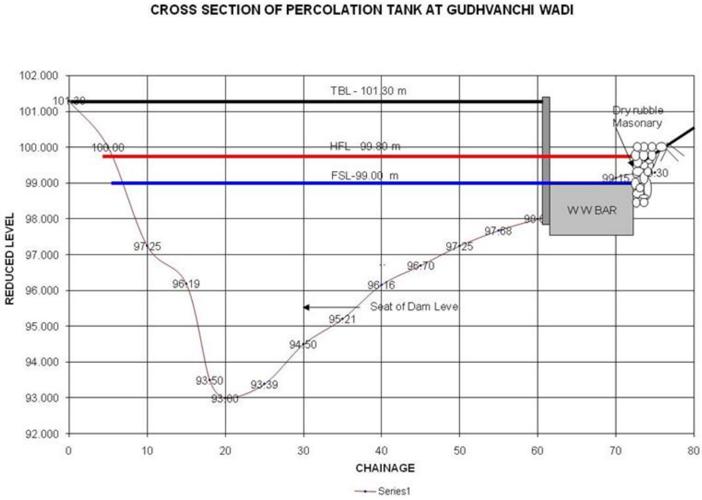
Storage=$A_{90} + \ldots + A_{95}$. Height of dam=6m+safety. Silt= $A_{90} + A_{91}$.

Cross-Section



- **Core** : a wall of clay/low conductivity soil.
- **COT** : To insert into hard-rock.
- **Drains** : To keep the dam dry and prevent seepage flows.
- **Casing** : Muram like soil, supports the core.
- Note the water-table and the iso-head lines.
- Note the rapid drop in the water table in the core.

Section at alignment



Gudwanwadi Dam

- 85m long, 8m high, earthen.
- Storage 2 acres, 20K cu.m.
- Cost: 24 lakhs.
- Construction time: 6 mo.

- Note Spillway, and Key-wall.
- Note Pitching (stones) on the dam walls.

Thanks