Water and Development

Part 4a: Minor Structures

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

The Design Cycle

Development Outcomes $\Rightarrow$ Bio-physical Outcomes $\Rightarrow$ Designs and Plans

Development Outcomes

- Socio-economic, normative 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. Specific flows and stcoks. Distribution Policy.

Design and Plans

- Interventions, Efficiency.
- Overall plans. Major and minor structures.

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

Village-Daregaon ,Taluka -Fulambari, District -Aurangabad

75°26'0"E 75°26'30"E 75°27'0"E 75°27'30"E 75°28'0"E 75°28'30"E 75°29'0"E

20°5'30"N 20°5'0"N 20°4'30"N 20°4'0"N 20°3'30"N

JALYUKT SHIVAR ABHIYAN (2017-18)

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.

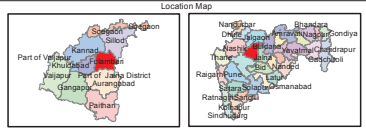
Area Treatment

- 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

(For Official Use Only)

Page Size:A1

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::

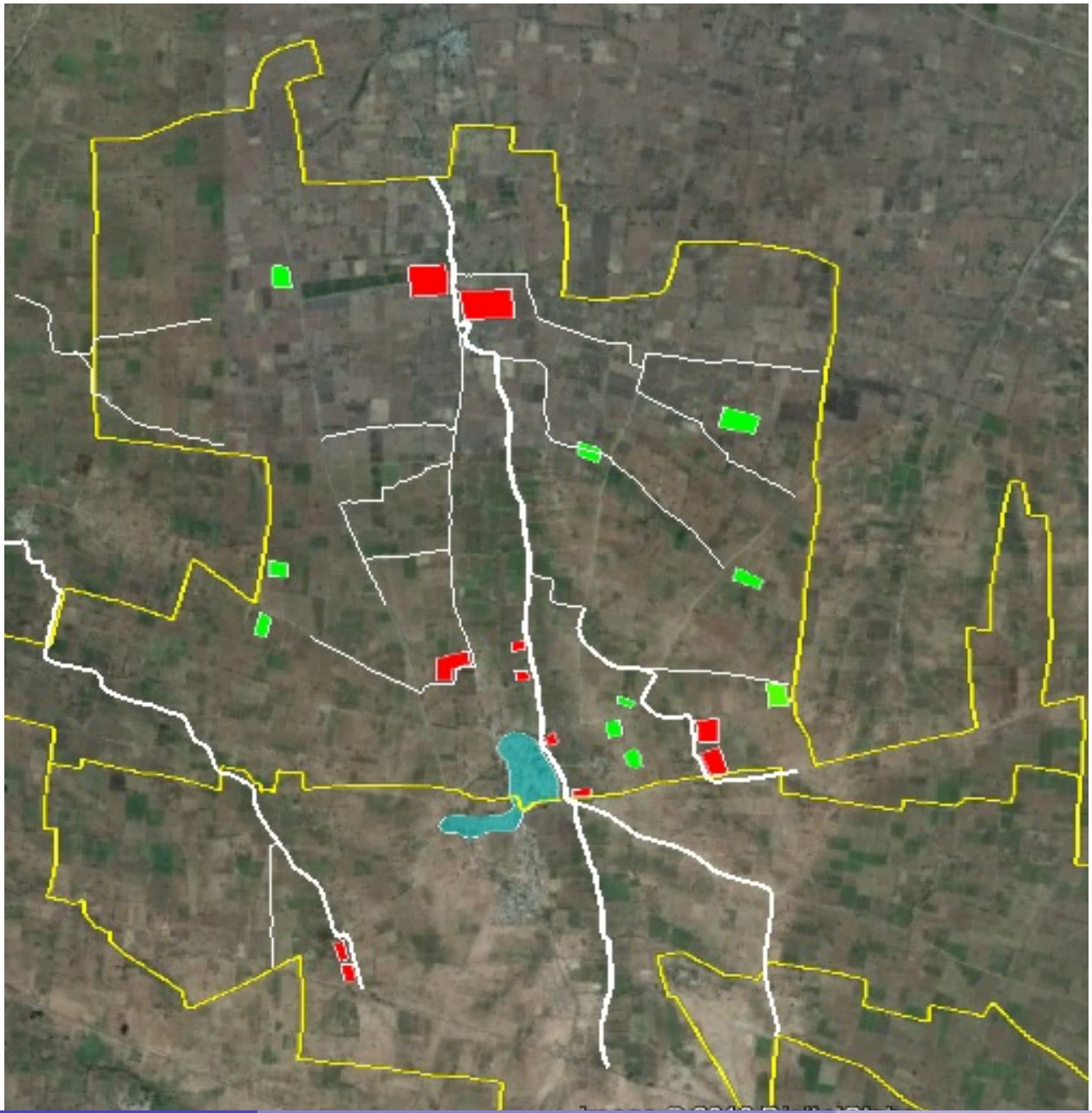
Vasundhara Watershed Development Agency, Maharashtra, Pune-1
And
Director of Soil and Water Conservation Maharashtra, Pune-1

MRSAC

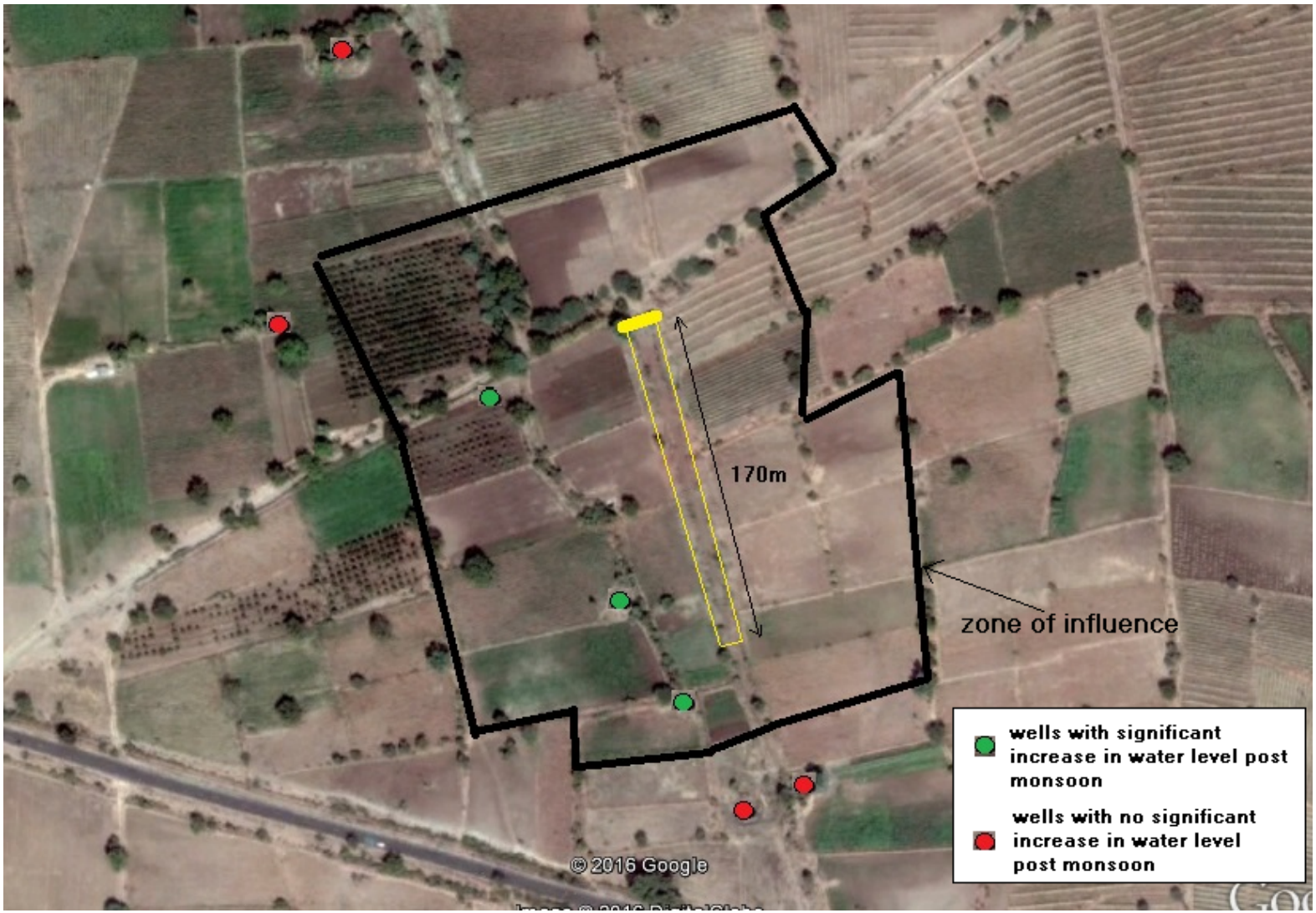
PREPARED BY::

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:

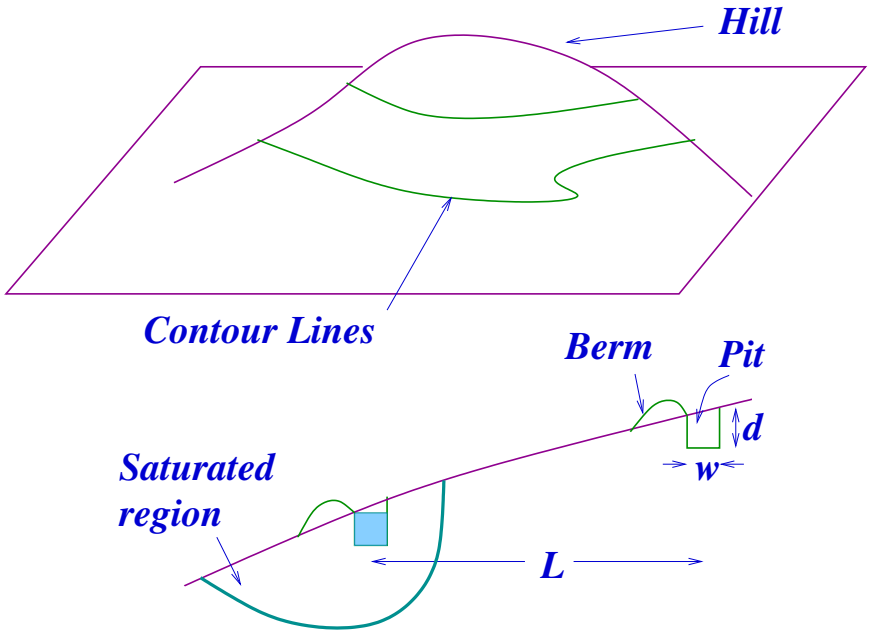
- Terracing, contour bunds.
- Gabions and gully plugs.

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.

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.

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.

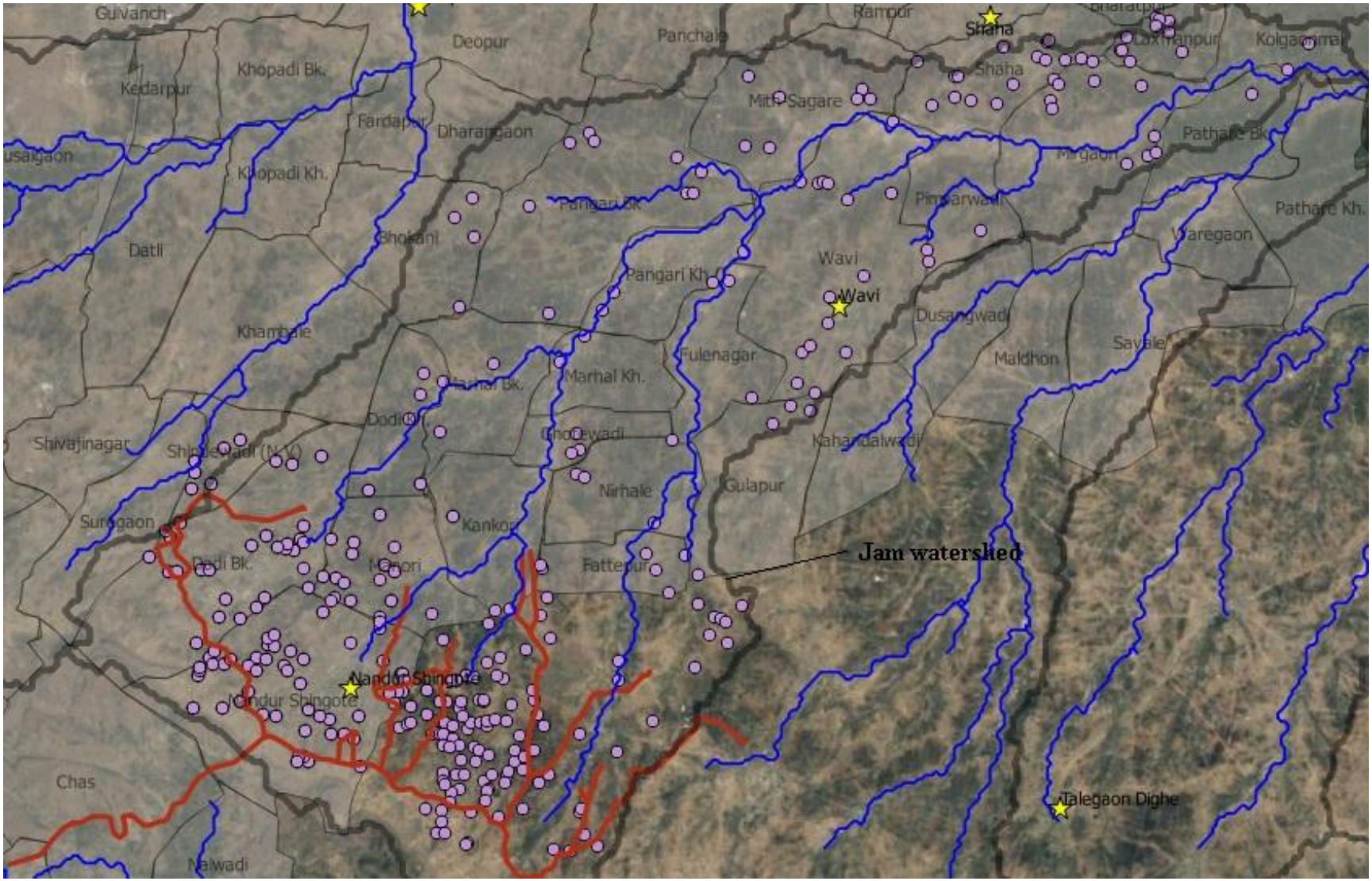
Locations

Detail

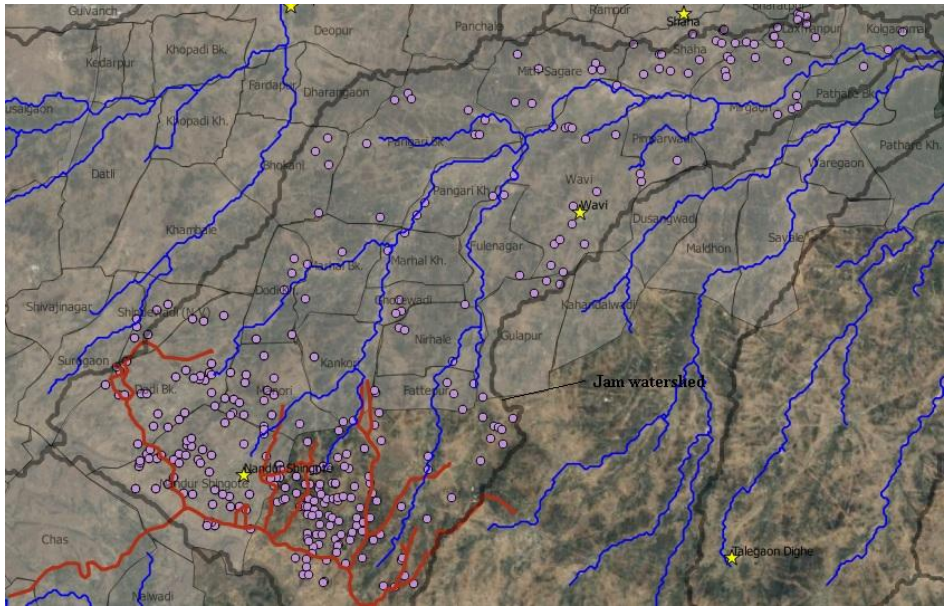
Count Them!


60
45
60
60
45
Airtel Banking
Hotel Jayraj
45
Secondary School
Nandur Shingote
45
Renuka Steel
And Furniture
Sangle
Rsproduction
45
Chas Rd
Chas Rd
Chas Rd

This needs analysis



Up1, Up2, Dn



	C	B	G
Up1	+1	+2	-1
Up2	0	0	-1
Dn	-1	-1	0

Up1 Upstream with FP
Up2 Upstream, no FP
Dn Downstream

Ways of filling: Canal, Baseflow, GW

- Substantial investment both for construction and for filling it up.
- Rarely used for Kharif. Soil-moisture + Rabi.
- Annual horticulture.
- Improved Security. Increased losses.

Percolation 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

Percolation Tank 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

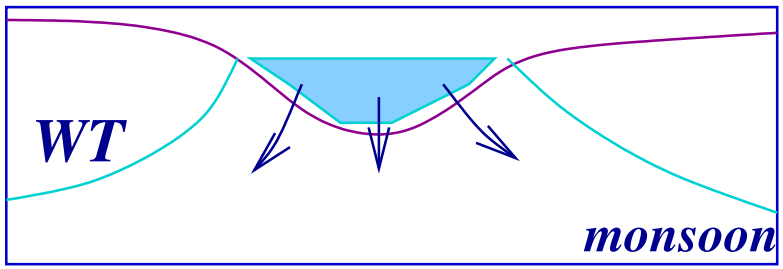
- Temporary, must be installed after every monsoon.
- $<$ 2m in height, and may be used on top of existing bunds.
- Installed just after monsoons get over, but stream flows remain.
- Mainly to achieve/increment some recharge and some storage.

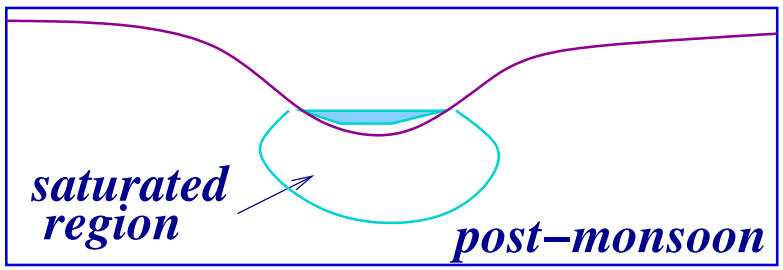
source: `http://washim.nic.in/DOC/ Egs_ files/image010.jpg`

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 $\Longrightarrow$ Wet longer

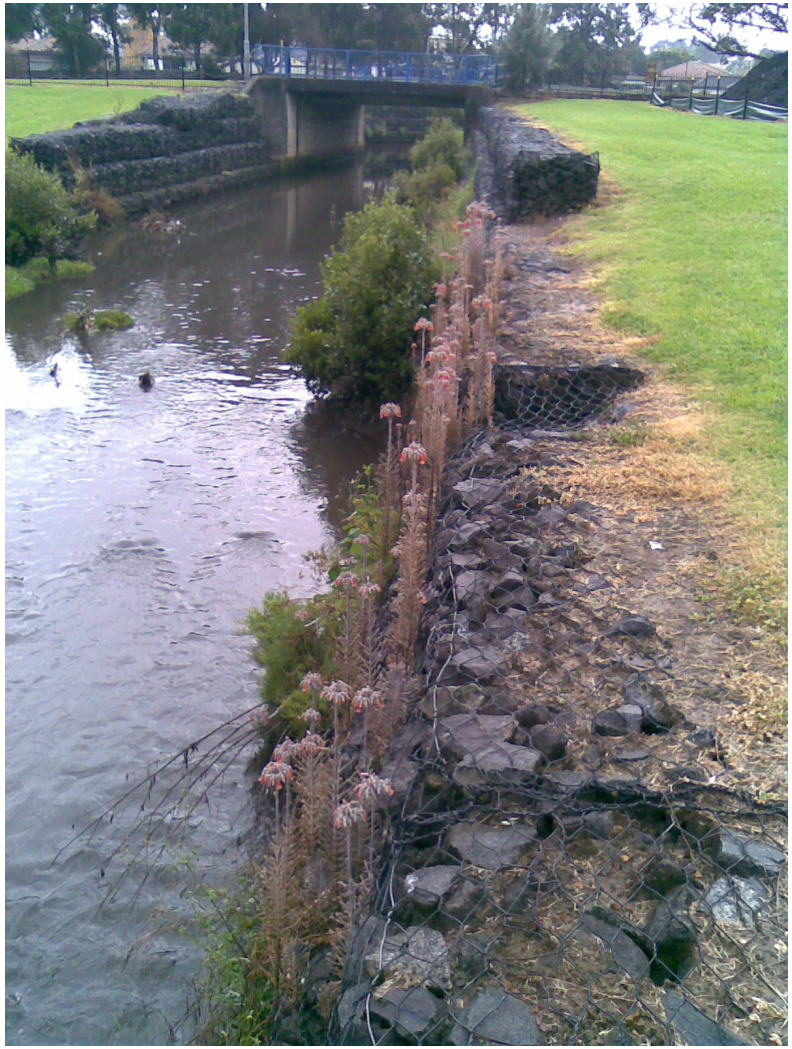




Gabions

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.



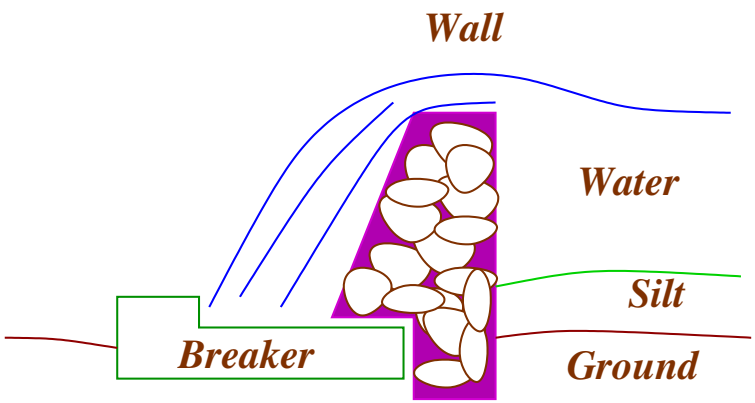
source:
http://lh4.ggpht.com/_KsQX_il

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.

Adoshi vents operating

Kurlod structure

Useful for agriculture.

Needing Repairs

Manipada

Manipada repiared: in Monsoons

Manipada Upstream

Rooftop Rainwater Harvesting

This is especially useful in urban residential situations.
Aim:

- To collect rainwater for domestic use.
- also to use it for recharging groundwater.
- Example from Bangalore. Small (250L?) since (i) frequent use, and (ii) frequent rains.
- Systems can be big, but cost Rs. 3-4 per liter!.
- At this price, highly

source:
http://bangalore.citizenmatters.i

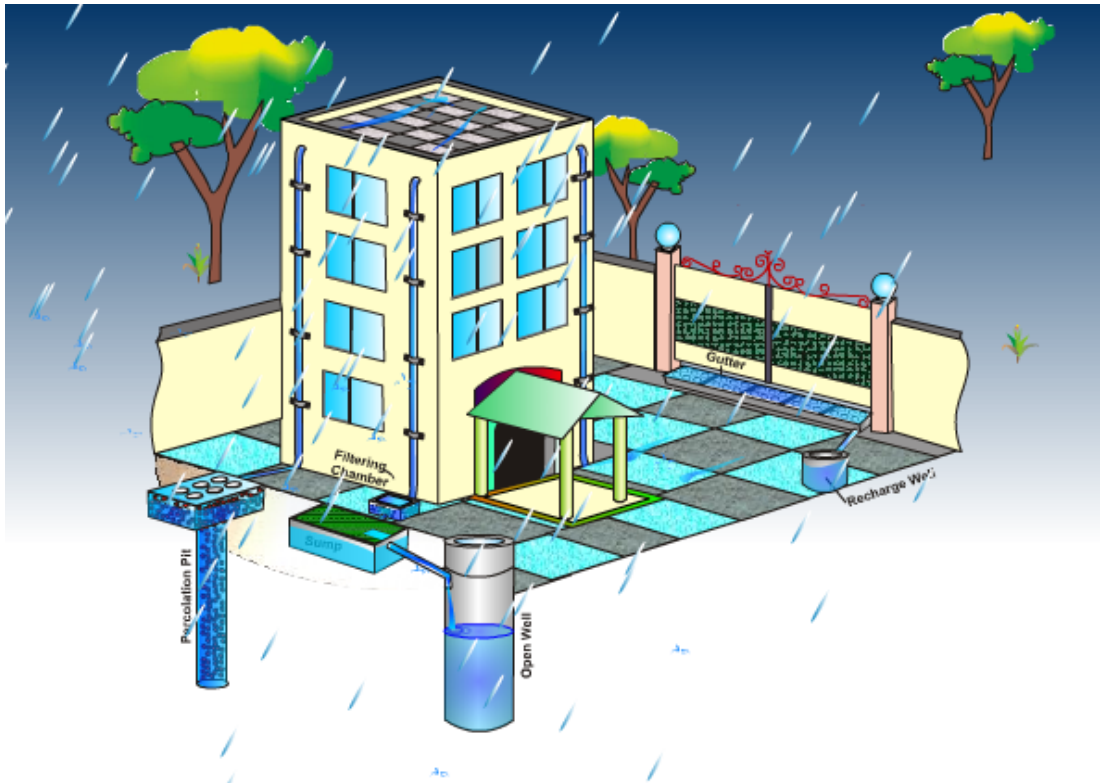
A novel idea: The TIDE polyhouse

Drip Irrigation, greenhouse and rainwater harvesting.

source: http://www.tide-india.org/products/06polyhouse.html

Urban Rainwater collection

- Compulsory in many cities.
- Collected water either (i) drains into existing wells, or (ii) into a specially designed percolation structure.
- In Chennai, used primarily to push back saline water.
- Percolation well: about 1m wide, 5-10m deep, unlined, and filled with boulders, stones and

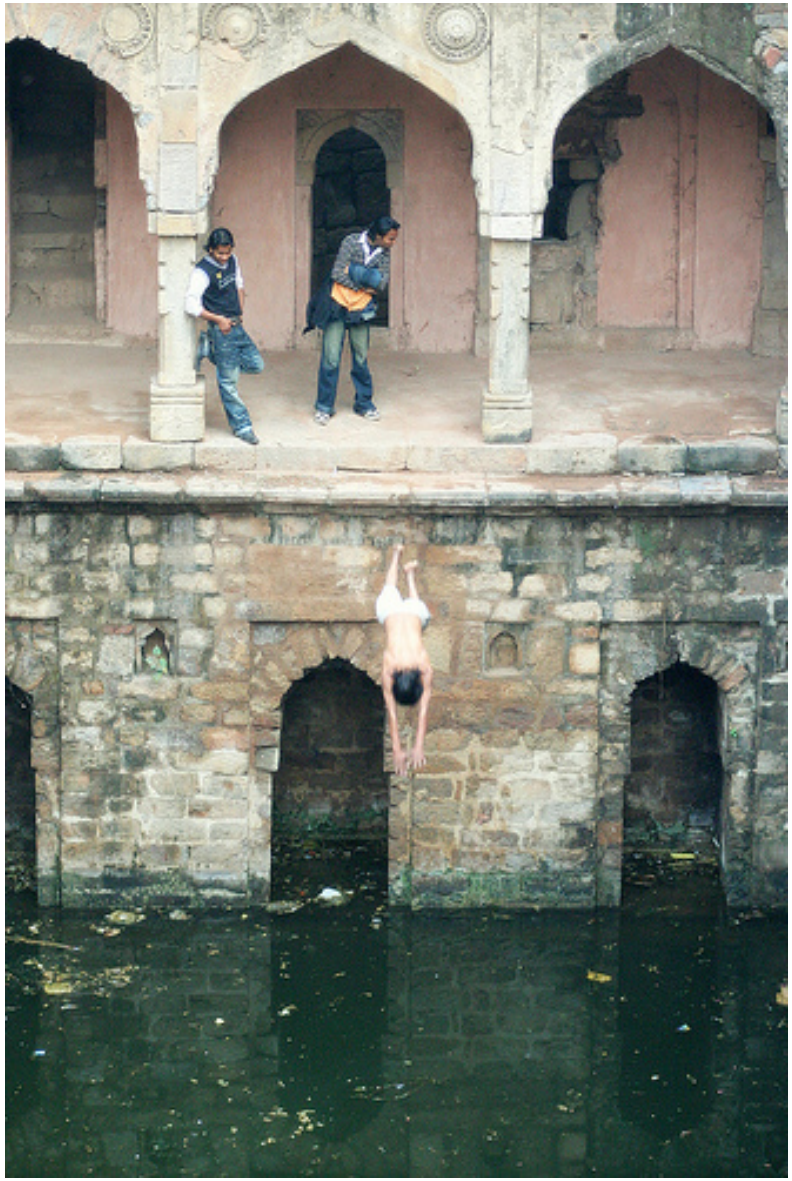


Rainwater Collection in Multistoried Roofs

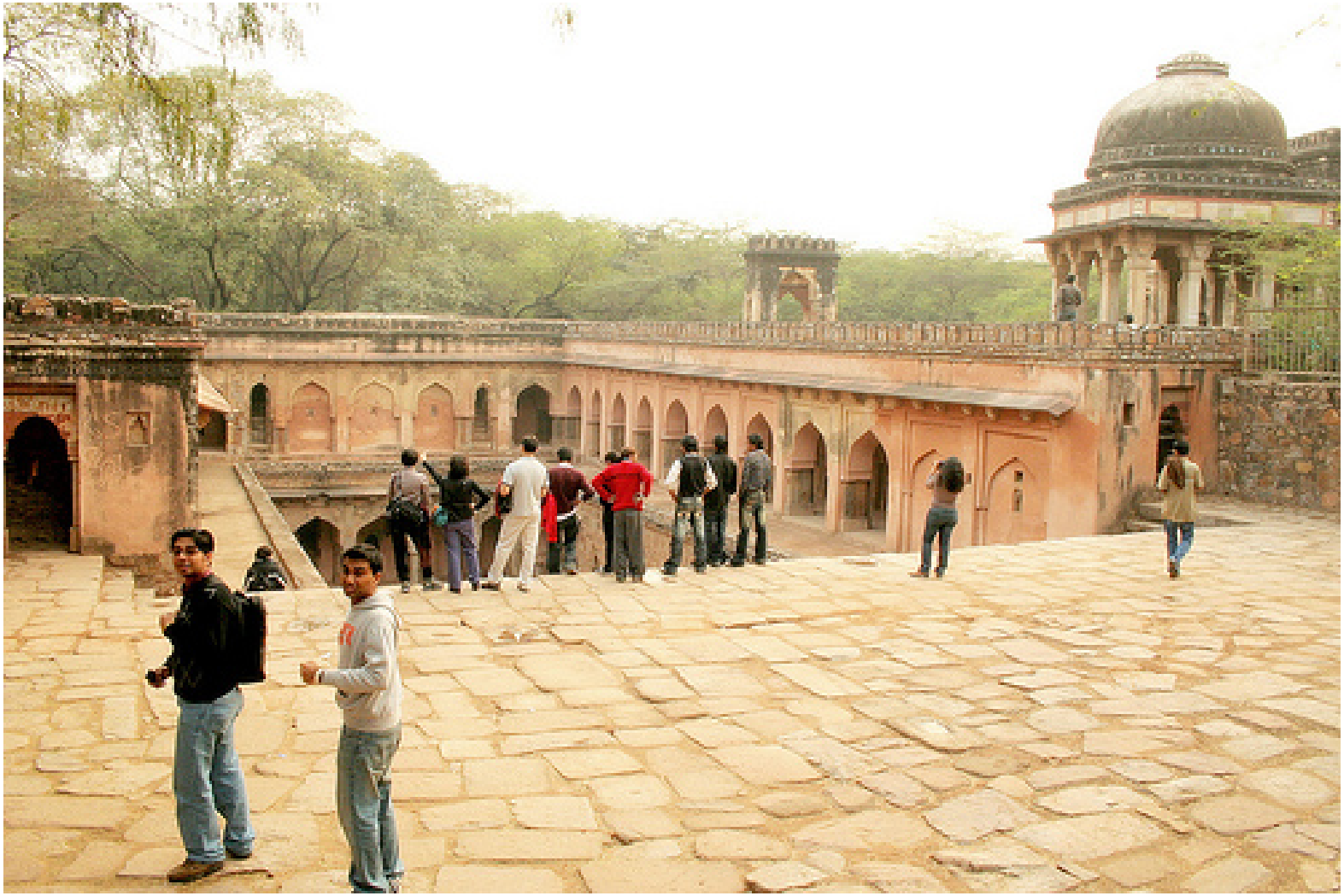
source: unknown!

Traditional: Baulis

- Historical examples of urban residential rainwater storage: *Baulis*.
- Storage in the basement of homes/special buildings.
- Intricate network of drains leading to the basement, and also tapping groundwater.
- Popular all over India, esp. Delhi, Rajasthan and also in the South.



Rajon ki Bauli from Outside



source: http://www.flickr.com/photos / saad/

Thanks