Watershed Management

An integrated approach to the restoration of degraded lands
WATERSHED MANAGEMENT

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Foreword

This manual is about integrated watershed management or the management of all the areas that fall within a watershed. Often the first question to such an approach is whether it really makes sense? Surely if agriculture, community development, soil and water conservation, afforestation and rural development were to be addressed separately they would receive greater attention and would therefore be better managed. This is, after all, the rationale followed by the Government and its various departments. Yet, repeatedly it has been shown that integration is the key to the long term success of all these efforts.

Think about it more closely and it is easy to see why. Take agriculture for example. We can, and do, implement a lot of interventions to increase yields. However, if the soil on which we grow crops is not conserved but allowed to wash away, yields will drop. Similarly, if we do not conserve water, there will be less recharge of our heavily exploited aquifers and tanks. There would be less water for agriculture and ultimately there would be lower yields. Or, thinking of trees, ever tried to grow one without watering it? How likely is a tree to survive on a barren piece of land?

Can you visualise a village with no forests, degraded lands and no water in the tanks or in the wells? Would you expect such a village to be prosperous and the villagers to be happy? Many of our villages are headed towards such a crisis. Women spend hours each day trying to collect fuel, fodder and drinking water. Men toil the soil
to get meagre returns. Making ends meet is an increasingly difficult task. The quality of life keeps going down. Need the link between rural development and the development of the environment be stressed any further? And finally the question, who will take up the task? If watershed development is necessary, so is the involvement of the community. The local people know their needs, their surroundings and there is always a pool of local knowledge based on local experiences. Put these together with modern techniques and methods and we have the basic ingredients for managing our watersheds.

These are only some of the reasons why an integrated approach is needed. This manual is not intended to be a complete technical handbook. There are already many of those. It has been written with the aim of putting forth ideas for people interested in doing something about the environmental problems around them.

Many ideas and several suggestions of how work could be planned have been presented. Yet finally, the decision as a community, lies in your hands.

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**Definition**

A watershed is a topographically delineated area that is drained by a stream system into a tank or water-catchment.

It is all the land and water area, which contributes run-off to a common point. Thus it cannot be viewed in terms of political or administrative boundaries. It is entirely dependent on the topographical features of an area.

The scale of establishing a watershed area can be viewed from a micro to a macro scale. A watershed could thus be a major river basin draining millions of square kilometres or could be a few hectares draining into a small stream or tank area.

Let us look at the different features of a watershed more closely.
The Catchment

The catchment of a watershed is that area which "catches" or harvests all the water. This water could be from streams running through the area or it could be from the rainfall that it receives.

The catchment is able to play its role only if its environment is suitable to water being held and the flow being directed to a common collection point. The topography or the nature of slopes in the area is the main factor. The vegetation present acts like a sponge soaking the water into the ground. The roots bind the soil thereby ensuring that it is not washed away by the force of water.

All these factors combined influence the amount of water that can be retained, the manner of its flow and the speed of the flowing water.

The Water Bodies

The common collection point of water from a catchment area is most often a tank, lake or a stream. The tanks could be natural depressions in the topography or be man made. They may be used only for water storage or could be a major source of irrigation, drinking water etc.

How well a tank is able to perform the task of collecting and storing water is dependent on the condition of the catchment. If there is little or no vegetation in the catchment, then the tank receives a large amount of soil along with the water. Over time this reduces the storage capacity of the tank as it slowly fills up with soil.

Another problem is that the water rushes down at great force towards the tank. This could cause the tank bunds (walls) to break, the widening and deepening of the water channels leading to gully formation or also the diversion of water to other areas.
The Unseen Journey of Water

Most of us notice only that which we can see directly. The same is the case with water. We are aware only of the rains and the water that flows above the ground afterwards. What about the water which gets soaked or recharged into the ground?

All this water goes to form and maintain the ground water table. The earth is made up of layers of different soil materials. Some allow water to pass through while other layers resist the flow of water. This leads to the formation of large underground streams at different depths.

The water table of an area could be a continuous stream that runs for kilometres at a stretch. Where soil formations allow water to pass through, there are links between water tables. Thus water that is soaked into the ground at one point eventually finds its way several kilometres away.

The Cyclic Nature of Degradation

The degradation or deterioration of any one feature of the watershed has a compounding and cyclic effect on all the others. Without sufficient vegetation, water is not harvested to its maximum potential within the catchment. This results in less water in the tanks and also less recharge to the water tables. In turn, this results in less biomass or vegetation above ground.

In coastal areas another danger is that of sea water moving into the water table. This is due to reducing amounts of water flow within the water table which then cannot withstand the pressure of inwardly moving sea water.
Establishing an Overall Strategy

Watershed management tries to bring together different aspects of improving and managing the environment within a single framework. It attempts to identify the factors that have led to the present degraded state and then to establish the manner in which they have combined.

For example, degradation could have been initiated due to mismanagement of agricultural land. This leads to decreasing productivity of the land. So the farmer would leave the land fallow. This land is now prone to soil erosion which could worsen with the formation of gullies. All the washed away soil ends up in the water bodies which then have a decreased capacity.

All this takes place within the socio-cultural context of changing lifestyles and varying demands from the resources around us. The key lies in understanding the various processes, physical and biological, that are taking place within the context of the social cultures of the area.

Thus watershed management is the integration of the

BIO-PHYSICAL UNIT
Soil, Water and forest conservation

with

SOCIO-ECONOMIC UNIT
Human communities and their social and economic problems

Objectives of WM

The basic objectives of a watershed management program would be to

* Reclaim and regenerate wastelands
* Ensure optimal use of the natural resources available; land, water and biomass
* Increase the availability and quality of natural resources
* Identify local skills and knowledge and to use them in resource management
* Develop further the knowledge base and expertise of the local people in the use of other relevant technologies
* Ensure sustained community action for the continuation of activities
* Provide a framework of institutional support by linking up with the various government departments involved in development activities in the area.
Steps Involved in Watershed Management

How can we achieve a maximum of these objectives? Where do we start?

* The first step is in knowing the area thoroughly; its people and what they do for a living
  - the communities they belong to;
  - pastoral, agricultural, artisans etc.
  - their livelihood practices
  - the current availability of resources; water, fuel, fodder
  - how dependent are they on these resources
  - is any form of resource management practised

* Next learn about the history of the area
  - what was the nature of vegetation in the area and how was it utilised
  - how was animal husbandry practised
  - the quality of the natural resources available
  - the productivity in agriculture

* Understand the processes that have led to these changes.
  - how have peoples lifestyles changed
  - what crops do they grow now
  - the nature of changes in the availability of resources, both in quantity and quality
  - what have been the changes in their management of these resources

* Finally, develop your strategy. There will be a need to prioritise the problems to be addressed. This can be done with the co-operation of the local people. It would also be dependent on the expertise and resources available with you.
**Need for Soil and Water Conservation**

A key factor in the restoration or rehabilitation of land is the good management of all the water it receives. The need for water is felt acutely in areas with low rainfall, erratic monsoon rains or frequent monsoon failures. Taking care of the soil is the other factor that goes hand in hand with water management. Soil erosion also erodes away the fertility of the soil which in turn affects the vegetation that the land can support.

Thus the pressure on the remaining patches of resources keeps increasing.

A simple chain of events could be as follows:

1. Rainwater run-off without having enough time for seeping into the soil
2. Soil erosion in the catchment areas leading to degradation of soil health and fertility
3. Reduction in the storage capacity of water bodies due to increasing silt deposits
4. Less water available in both surface and underground water sources
5. Resulting barren lands which cannot support any form of productive use

**Soil and Water Conservation**

Let us now look at some of the techniques and methods used to conserve our natural resources and thus our watersheds as a whole. Please remember that what is described here is just an outline of the various methods. They need to be developed to suit your specific needs and environment.

**MECHANICAL METHODS**

**A) BUNDING**

The first step towards watershed management is the construction of bunds in order to check soil and water run-off.

What are bunds?

They are earth banks usually built along the contour of the land. These structures prevent flooding and at the same time ensure groundwater infiltration.

**STEPS INVOLVED**

1. **Study the flow** of water during the rainy season.
2. Decide on the **number and height** of the bunds. This will depend on the slope and intensity of rainfall, soil type, penetration of water into the soil, the logistics of funds and labour availability.
3. Construct the bund walls using subsoil dug out preferably from within the bund area (so that this structure will serve as a water storage tank). Further compact the bund walls using top soil and by planting trees / grasses / herbs.
4. Construct on **Overflow** at an appropriate point to allow surplus water to escape by extending or reducing the length of the bund walls.
5. Construct **Percolation ponds**, further down the watershed, to store surplus water which escapes from the bunded area.
6. **Plant trees** along the bunds and the contour of the land to strengthen the bunds and prevent further soil and water erosion.

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KEEP IN MIND

* Work should be started at the highest point of the watershed. This is to ensure that the speed of flowing water is slowed down. Else soil structures downstream can be easily washed away.

* The lowest point of each bunded section should be stronger and more reinforced. It is at these points that the pressure of the stored water is greatest.

* Overflows, especially of check dams need to be sturdy and in some cases have to be reinforced using granite stones and cement. As water overflows it can constantly cut back into the soil and thereby weaken the bunds or check dams.

* In the case of large areas, ideally, bunds should run along contour lines. In the case of small land holdings the bunds are usually along the perimeter of the property.

CONSTRUCTION OF BUNDS

1. Bund wall is built using subsoil, dug out from within the bunded area.

2. The first layer is deposited and compacted by walking on it. The second layer of subsoil is added and again compacted. A third layer is added over the compacted topsoil.

3. The trench dug out for the subsoil should not be close to the bund wall.
CROSS-SECTION OF THE BUND

Trees may be planted directly into the trench

CONSTRUCTION OF SMALL BUNDS

To protect the corner walls
(a) Either deepen the trenches
(b) Or build a hole towards the interior of the bund.

A series of trenches excavated for the construction of the bund

(B) EARTHDAMS

What are Earth-Dams or Check-Dams?
An earth-dam controls and helps to store water. It reduces siltation of lower lying larger tank catchments and facilitates water storage where it is constructed. It makes additional areas of land cultivable by helping to redirect the flow of surplus water from areas which otherwise get flooded. It drains out excess water safely and prevents water stagnation by draining out the water in protected watercourses.

STEPS INVOLVED

1. Defining the purpose of the dam will decide the site and storage capacity of the dam.

2. It is difficult to construct a dam big enough to store all the run-off. Some provision is required to pass on the surplus flood water after the dam has filled. The spillway is the channel or pipe or waste-weir designed to do this.

a. Cut spillways: For small conservation dams, a solution is an open-channel spillway which cuts into the bank at the side of the dam wall.

The most vulnerable point on cut-spillways is where the water rejoins the stream. To prevent erosion at this point, the stream bank must be cut back to a gentle slope and planted with grass like the rest of the spillway.

Alternatively, a concrete or masonry drop structure may be provided at this point.

b. Natural spillways: These are used where the site conditions make it possible to divert the flood flow into a naturally existing waterway channel. The crest should be such that the flow is spread out, and the slope to the stream is gentle and has enough grass cover so that there is no risk of erosion.
**KEEP IN MIND**

* The site must have suitable soil conditions for constructing an earth-dam. The soil of the basin should not be porous, and the site for the wall should be free from boulders and termite mounds. Suitable soil for constructing the wall should be available nearby.

Certain soils are unsuitable for the construction of dams; they include:
- saline, alkaline, or sodic soils, or any soil with abnormal chemistry;
- peat or other soils high in organic matter;
- heavy clays subject to swelling, shrinking, and cracking;
- light sands;
- soils containing a high proportion of fine silt.

* The cost of small earth dams is greatly increased if spillways are built of concrete or similar materials. So a major factor in site selection is looking for sites where the overflow can be safely discharged over grass-covered spillways.

* Grassed channels require careful design and construction and it may be difficult to establish and maintain them in areas of poor rainfall. It is wise to limit the maximum size of catchments for dams with grassed spillways to 500 ha in semi-arid areas.

* It is undesirable for grass spillways to be constantly saturated. This makes them more vulnerable to erosion because the types of grass which are best for spillways do not like continually wet conditions. If a stream is likely to
have a small constant flow, a trickle-flow outlet should be provided. This can take the form of a small brick-lined or concrete channel set in the spillways, or it can be a small diameter pipe going through the dam wall, preferably on the opposite side of the stream from the spillway.

* If it is not practical to protect a cut spillway with grass, it may be necessary to protect it, or perhaps the most vulnerable parts, with stone pitching or concrete.