Watershed Management for Disaster Risk Reduction and Climate Change Adaptation - A Case Study of Kadwanchi Watershed Project[1]

by

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Abstract

Watershed management has long been accepted as the approach for regeneration and utilisation of land and water resources for ensuring sustainable livelihoods of rural population. It has assumed more significance in today's context of increasing variability of climate and resultant disasters like droughts and floods. While increasing the ability of rural population to cope with these vagaries, watershed management approach simultaneously ensures continuing productivity of land and water for sustenance and growth of people dependent on these resources.

Village Kadwanchi falls in District Jalna of Maharashtra state in central India, which is a semi arid tropics characterised by low and erratic rainfall, hot summers with desiccating winds, and dry winters. The village population comprised mostly smallholder farmers and landless labourers, eking out their living of single crop rainy season agriculture, which was always at risk due to uncertain rainfall and recurring droughts. Marathwada Sheti Sahayya Mandal, a local not-for-profit civil society organisation, worked in this village for drought proofing by regenerating the land, water and biomass resources under a Indo-German Watershed Development Programme (IGWDP) during 1997-2001. The interventions were planned and implemented with people's participation in planning, implementation and quality monitoring, with critical techno-managerial inputs coming from MSSM. The activities included soil and water conservation, water use planning, and capacity building of the communities and their organisations.

Within a few years, the project resulted in all round prosperity by increased production, employment opportunities and stabilised incomes. Even in times of droughts in subsequent years, the production levels were sustained, thereby providing livelihood security to both farmers and landless labourers. Once the basic survival needs of the villagers were met, they sought higher goals towards prosperity and human development (overall wellbeing). This development momentum gradually covered the neighbouring villages, and it emerged as a national example of value chain cluster in horticulture, especially grapes.

Lessons from this case study, which is projected as a success story of drought proofing, have far reaching consequences for reducing risks of both droughts and floods, as these are two sides of the same coin. It assumes even more importance in fragile ecosystems and degraded ecologies like large parts of Afghanistan. This paper argues that watershed management approach can not only increase the capacity of local people to cope with floods and landslides, but also improve their livelihoods security, which is a strong influence on coping ability of the communities. The paper presents the possibilities of adapting the watershed approach to address challenges faced by Afghan communities in a few provinces in the central area.

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Structure of the paper : This paper is divided in three main sections; namely, the case study; second, the concept of watershed management; and implications for eco-DRR in Afghanistan.

Section 1 : Case Study

1.0 Introduction : Village Kadwanchi falls in District Jalna of Maharashtra state in central India, which is a semi arid tropics characterised by low and erratic rainfall, hot summers with desiccating winds, and dry winters. It is located in Upper Purna basin of River Godavari at about 19^{O}53' N and 76^{O}47'E lying at an altitude of 498 m MSL - 648 m MSL. Out of 1888 ha geographic area of the watershed, about 1366 ha (72.3%) was under cultivation. The village population of 2639 (455 households) comprised mostly smallholder farmers and landless labourers, eking out their living of single crop rainy season agriculture, which was always at risk due to uncertain rainfall and recurring droughts. The village received an annual average rainfall of 685.4 mm, of which about 78% was received during SW monsoon from June-September.

Marathwada Sheti Sahayya Mandal, a local not-for-profit civil society organisation, worked in this village for drought proofing by regenerating the land, water and biomass resources under Indo-German Watershed Development Programme (IGWDP) during 1997-2001. The interventions were planned and implemented with people's participation in planning, implementation and quality monitoring, with critical techno-managerial inputs coming from MSSM. The activities included soil and water conservation, water use planning, and capacity building of the communities and their organisations. The main conservation activities are summarised in the following table (Table 1). Overall investment of the project was INR 6,467 (USD 185) per hectare or INR 4,626 (USD 132) per person (at 1197-2001 prices).

Table 1 : Soil Water Conservation Activities Implemented

S No	Land use and treatment	Unit	Quantity	Expenditure	Expenditure
A.	**Area Treatment**			**INR**	**USD**
1	Afforestation with CCT, plantation and seed sowing	ha	157.71	1219968	34856
2	Agro-forestry with CCT contour bunding, plantation and seed sowing	ha	211.00	907694	25934
3	Agro-horticulture, with farm bunding and tree plantation on bunds	ha	132.30	298465	8528
4	Crop cultivation with farm bunding and grass seeding on bunds	ha	995.34	3604239	102978
	Add : Supervision		0.08	389071	11116
	Area Treatment (Sub-Total)	**ha**	**1496.35**	**6419438**	**183413**
B.	**Drainage Line Treatment**				
1	Loose rubble gully plugs	m	4620	410076	11717
2	Gabions	m	54	36374	1039
3	Masonry gully plugs (small weirs)	no	10	909603	25989
4	Check weirs (in plumb concrete)	no	9	2719336	77695
5	Repairs of small earthen dams	no	11	53392	1526
	Add : Supervision		0.08	78273	2236
	Drainage Line Treatment (Sub-Total)			**4207052**	**120202**
C.	Project Management Costs (overheads)			1582370	43680
	Grand Total			**12208860**	**248825**

Source : MSSM Project Completion Reports. Conversion rate USD 1 = INR 35 (average during 1997-2001)

1.1 Immediate results : Benefits of soil water conservation activities started showing up while the implementation was still going on. Water availability increased suddenly, first in form of soil moisture and then, in form of shallow groundwater, leading to increase in double cropped area (winter cultivation). Increased cropping intensity resulted in demand for labour, which provided employment to the local landless and also inward seasonal migration. Increased productivity led to increased aspirations, which in turn brought in irrigation facilities (mainly, pumps) and high value crops like vegetables and fruits. However, it resulted in increased used of water, which was not really matching with the water conserved. It compelled the farmers to think, individually and collectively, about bridging the gap between increased demand and availability of water. This prompted them to bring in two technologies, namely, drip irrigation to reduce demand and farm ponds to increase supply. By year 2002-03, there was an increase of perennially irrigated area from 174 ha to 350ha and simultaneously, the winter crop area from 256 ha to 386 ha.

Table 2 : Changes in Land Use

S No	Particulars	Unit	1996 (Pre-)	2008-09	2017-18
1	Net cultivated area	ha	1366	1488	1517
2	Fallow area	ha	147	-	62
3	Two seasonal irrigated area	ha	256	386	897
4	Perennially irrigated area	ha	174	312	330
5	Area under vegetable cultivation	aa	57	107	257
6	Area under orchards (fruit crops)	ha	3	172	532

Source : Compiled by author from MSSM Project Reports and IIMA RIM Reports (2009).

Increase in yield : Yield of crops was a prominent result most farmers reported during the implementation. A rapid assessment carried out in 2002-03 (immediately after the project completion) showed an increase in yields of 12% to 46 % in the common field crops. Cotton yield increased from 6.7 Q/ha to 7.0 Q/ha, green gram from 4.1 Q/ha to 5.7 Q/ha, black gram from 5.0 Q/ha to 8.0 Q/ha. It could be achieved due to increased availability of soil moisture in the farms (root zone) and retention of fertile soil (erosion control) due to farm bunding.

Fodder and livestock : Livestock has a significant role in increasing resilience of dryland farming in stress prone ecologies, influenced by fodder availability. Another immediate effect of watershed project was that the fodder availability increased by over 500 MT – most of it came from the common land brought under agro-forestry. There was also an increase of about 10%-20% fodder production from field crops, mainly as a bye product of cereal crops like sorghum and pearl millet. This helped increase in livestock holding from 161 to 236 and productivity from 2.42 litres per day to 3.23 litres per day in terms of milk yield. Moreover, increased fodder availability served as a boon to the small ruminant (goat and sheep) farmers, who were mostly landless or marginal farmers.

1.2 Long term impacts

Over the years, the farmers shifted from conventional cereal (pearl millet, sorghum), pulses (pigeon pea, chick pea), and cotton to more remunerative fruit and vegetable crops. Technological advances were proactively searched and assimilated, in terms of structures like shed nets and green houses, machinery like orchard tractors and electrostatic sprayers, semi-automated drip irrigation, and secondary processing for value addition.

Coping strategies : Kadwanchi presents a case of continuous improvement in nature and quality of community's response to rapidly increasing challenges associated with technological challenges. The community learnt to manage their limited water resources through collective planning and governance. Over the years, the farmers augmented water resources through shallow open wells and farm ponds. Although the number of open wells increased from 206 in year 1996 to 398 in year 2008, the farmers refrained from getting into deep borewells. – their strategy was to pump up water during surplus (rainy season) and store it for use in the post-rainy season. As this required some "storage space”, they went for farm ponds – by 2012, there were 503 farm ponds in the village; almost every farmer had one of her/his own.

Most importantly, they maintained the soil conservation structures (farm bunds, trenches, and gully plugs) in good working order, so as to gain from their groundwater recharge benefits. They took good care of check weirs by regular silt removal and of plantation around.

In semi arid regions with high climate variability, livelihood resilience is perhaps the most important factor determining sustainability and success. Kadwanchi continued to experience droughts, and uneven distribution of rainfall across seasons. Yet, economic gains continued to grow, instead of the community suffering from the droughts. This is singularly most important indicator of success.

Table 3 : Rainfall and Production

Year	Rainfall, mm	As % of AAR	Farm Pond Storage, TCM	Agri Production, INR	Agri Production, USD
2012-13	198.5	29%	500	270000000	7714286
2014-15	352.7	51%	900	320000000	9142857
2015-16	412.0	60%	1050	520000000	14857143
2017-18	411.0	60%	2500	480000000	13714286

Investments : The impressive figures of production or income and prosperity naturally raise a question about investments, without which, the results were not possible. While the project started with an investment of INR 12 Million during 1997-2001, the state government invested INR 120 million in the next 10-15 years. More importantly, the farmers invested INR 418 million during the same period, out of which about 40% came as bank loans (INR 150 million).

S.N	Particular	Implementing agency	Investment, INR	Investment, USD
1	Watershed Development	NABARD and KVK MSSM	12000000	342857
2	Watershed Plus Activities	State Agril. Dept, ZP		-
	Farm ponds	400 @ Rs. 200,000	80000000	2285714
	Bio gas plants	500 @ Rs. 30,000	15000000	428571
	Shed net house	15 @ Rs. 200,000	10000000	285714
	Green (poly) house	50 @ Rs. 200,000	12000000	342857
3	Investment by farmers	(Bank Loan Rs 60 Million)		
	Well Excavation	600 @ Rs. 200,000	120000000	3428571
	Grape Gardening	1200 @ Rs 150,000	180000000	5142857
	Small Tractors and Implements	200 @ Rs. 400,000	80000000	2285714
	Gen Set	200 @ Rs. 50,000	10000000	285714
	Pipeline and Farm roads	2800 @ Rs. 50,000.	28000000	800000

Sourse : Compiled from MSSM periodic progress reports.

1.3 Key Lessons

Kadwanchi watershed project and its follow up over nearly two decades brought out some interesting lessons for sustainable development and climate change adaptation. Prominent among them are:

- **Participatory planning :** Scientific planning, with involvement of community, itself is a factor contributing to sustained interest of and ownership by community.
- **Changing land use :** Major shift from food and fibre (cotton) crops to fruits and vegetables gave significant impetus to agricultural economy.
- **Livelihood resilience :** Farmers developed ability to cope with vagaries of climate change through mutual help and scientific handholding support by institutions like KVK.

- **Credit worthiness :** All farmers shifted from non-institutional credit (private money lenders) to banks, who have offered credit to Kadwanchi farmers at special rates (1% lower than the market rate).
- **Ability to pay for services :** Farmers pay for agricultural extension and other development services . They got their electricity connections converted to "industrial" from "agricultural" for assured power supply. The rates are INR 8 per kWh, as against INR 1.50 per kWh.
- **Community Institutions :** Relevance of Village Watershed Committee and Self Help Groups set up during the project period became evident while dealing with the development administration and banks for mobilising credit linkages and subsidies. Several commodity groups emerged during the last 10-15 years.

Part 2 : Watershed Management

2.1 Definition : Watershed is a term first used by American foresters for an area of land which sheds water from rain (snowfall inclusive) into a single outlet of a stream. "Watershed is a geographic area drained by stream or a system of connecting streams such that all the surface runoff originating due the precipitation in this area leaves the area in a concentrated flow through a single outlet". In other words, watershed is defined as a drainage area whose runoff flows past one point. It is an entity from which water flows into a stream, lake or other point of drainage. Watershed may also be defined as the geographic area of over land (surface) drainage that contributes water to the flow of a particular stream at a chosen point. Therefore, watershed is a water collecting and water handling unit.

The line which divides the surface runoff between two adjacent basins is called water divide or simply divide. The terms Catchment Area, Drainage Basin, River Basin, Watershed and Catchment area are synonymous.

2.1 Watershed Management : It is a framework for an integrated, viable, and decentralized pattern of development of people living in a degraded area where water is a scarce and mismanaged resource, and where exploitation of resources and people have resulted in overall degradation leading to growing poverty, inequality, and inability to cope up with stress (as defined MYRADA, an Indian NGO).

Technically speaking it is "management of the natural resources of a small watershed primarily to strengthen basic life support system of a community by production and protection of water-based resources, including control of erosion and floods".

The <u>ultimate objective</u> of watershed management is to improve the standard of living for the men and women in the basin by increasing their earning capacity through increased productivity of land and water. Good farming practices, rational land use, and efficient management of soil water, crops and livestock results in sustained high yields, which provide the best basis for ensuring adequate returns to the farmer and the country as a whole. Under the natural conditions, the rainfall, vegetation, animals, soil, and water regimes attain a natural equilibrium. In an effort to being more areas under cultivation, we disturb one or more of these factors and thereby disturbing the equilibrium. Watershed management needs to take into account the interrelation of these factors lands then plan for the adequate returns. That is, management of topography for making the best possible use of available land and water resources.

Watershed Programmes : The programmes that can be taken in a watershed may be broadly categorised into three groups; namely, resource regeneration, resource management, and supportive programmes.

Resource regeneration

a) <u>Rainwater harvesting</u> and developing of surface water resources through a series of ;storage structures like earthen bunds and check-weirs.
b) <u>Soil Conservation</u> through gully-plugging, contour bunding and trenching, contour tilling and through vegetative methods.
c) <u>Afforestation</u> to meet basic food, fodder, firewood and fibre requirements of the community.
d) <u>Dryland farming</u> and capability based land use development and adoption of improved appropriate techniques.

Resource management

a) Water management by socially just and technically efficient water and land use systems.

b) Development of alternate sources of energy like bio-gas efficient wood-stoves, wind powered and solar powered devices.

Supportive Programmes

a) WASH - Drinking water, rural sanitation, community health and hygiene

b) Community organisation, extension education, vocational training and informal education - particularly for landless and women.

2.3 Components of Kadwanchi Watershed Project

Soil conservation : Soil conservation treatments were carried out with priority in order to conserve soil, enhance soil moisture, support vegetative growth, check sedimentation, control run-off velocity, strengthen ground water regime, create employment opportunities, etc. Major soil conservation treatments are trenching and bunding with vegetative cover.

- ***Trenching***: Firstly, all hilly area in the watershed was treated with continuous contour trenches (CCT) followed by plantation, grass seed sowing on the soil mount. Water absorption trenches (WAT) were excavated between CCTs. They controlled erosive velocity of water along with an opportunity to infiltrate the water resulting in recharging of ground water. Private wastelands were also treated with contour bunding and contour continuous trenches and dry horticulture. In all 157.71 hectares of area was treated under trenching.
- ***Bunding***: Land under crop cultivation was treated by proper peripheral and compartmental bunding, plantation, grass seeding on bunds and proper spillway installation to drain out excess run-off to natural drains. Compartmental and peripheral bunds serve the purpose of soil and water conservation equally and are socially acceptable. Agro-forestry, agro-horticulture was adopted along with seasonal crops.

Water conservation treatments: These treatments were implemented step by step from ridge to outlet of watershed drain in congruency with hydraulic conditions.

Water velocity retarding structures:

- ***Gully plug***: Gullies on hill-slopes were treated by constructing loose rubble gully plugs to control erosive velocity of water. Gully plugs were done also in agricultural farms, where gully formation had begun.
- ***Gabion***: This structure is compact enmeshed rubble gully plug constructed in gullies at those positions where ordinary rubble gully plug cannot sustain the force of flowing water, in order to retard the velocity of runoff.

Water disposal treatments:

- ***Ceramic pipe bund spill way***: To dispose excess run-off of field, ceramic pipes were installed under bund at proper height and location.
- ***Stone bund spill way***: To dispose excess run-off from large area instead of ceramic pipes the stone spill ways were constructed at the proper location of fields.
- ***Water ways***: To assure safe disposal of excess water of field, artificial water ways were excavated to connect with natural drains and subsequently either it was pitched by stone or covered with grasses.

Water harvesting structures:

- ***Earthen Nalla Bund***: Wastelands liable to come under submergence are utilised for water harvesting by making earthen embankment across the waterways. These locations provide soil for embankment. To ensure safety to nalla bund by-pass spillway is created to join upstream and down stream of NB in U.C.R. masonry work.
- ***Masonry Gully Plug (small check weir):*** Matured gullies with minimum grade and maximum depth were installed with masonry gully plug in order to retain and to harvest water. Retaining of water for longer duration recharges the wells in surrounding and increases ground water table. In all 10 MGPs are constructed.
- ***Check Weirs***: On large drains because of its high discharge, it is advisable to install cement concrete water harvesting structure, to sustain thrust of voluminous storage of water. It is

particular to select the site with hard strata for strong foundation of check dam, or also pervious strata on upstream for recharge. Such nine check dams are constructed in the watershed area.

Biomass strategies: Cattle proofing trench surrounding the vast area of fallow land, waste land and pasture land, subsequently brought under plantation in a wake of interruption to grazing the field by cattle. The trenches were reinforced by planting those varieties of vegetation that are abhorrent to cattle such as Prosopis, Agave, parkinsonia, etc.

Part 3 : Relevance to Afghanistan

Soil and water conservation activities using watershed approach not only helps livelihood security through drought proofing, but also prevent floods and landslides. Afghanistan has diverse agro-climatic conditions across regions, but the main challenge is aridity. It is complicated due to undulated topography; geological formations; and high elevations. Yet, Afghanistan presents great potential due to high per capita land availability (>2 ha) and water availability (>2000 cum per year). While only 12% land (~8 million ha) is available for cultivation, the so called non-agricultural land has potential for alternative biomass strategies like silvi-pasture and multi-tier vegetation.

3.1 Scope in Eco-DRR : UNEP and other members of Afghanistan Resilience Consortium are already working on Community Based Ecosystem-based Disaster Risk Reduction (Eco-DRR), addressing two main concerns of flood and landslide (and avalanche in some areas). Watershed approach would help increase community's preparedness against these disaster. In the context of Afghanistan, a three-pronged strategy could be effective in this direction.

3.2 Three-pronged approach : The most important way to control a problem is to stop it where it begins. Firstly, an appropriate combination of engineering and vegetative measures of soil conservation should be implemented in the upper reaches to reduce flow velocities and erosion. Secondly, augmentation of water (and snow, in high altitudes) and its channelisation to productive uses should be carried out for economic benefits. It would increase the involvement of community n the project activities. And simultaneously, implement suitable soil conservation and water diversion activities in the vulnerable areas (say, around stream banks and lower plains). These should be done on micro-watershed basis.

As a preparatory step for planning the above, it would be useful to divide the project area in vulnerability categories based on topography, geology and hydrology. The categorisation could be numerical (by defining a composite index) or visual (by making thematic maps using principles or methods of GIS).

3.3 Expanding the scope : Effectiveness or success of Eco-DRR could be increased significantly, if the community has secure and sustainable livelihoods. It is therefore strongly recommended that the focus of watershed activities should be broadened to encompass livelihoods strengthening, because livelihood resilience would enhance the capacity to tackle to challenges of all kinds of disasters. It would contribute to sustain the results of Eco-DRR project for a long time.

3.4 Lessons Learnt : The key lessons learnt from Kadwanchi Project (Section 1.3) hint at why watershed needs be planned and implemented perfectly from the start. Participatory planning in Kadwanchi project took nearly two years from 1995-97. MSSM allowed the community adequate time to understand the watershed technology and its implications adequately. It was primarily because if the planning is faulty, mistakes take a long time to identify, and by then, no time or resources are left to take corrective actions. Therefore, though there have been many watershed development programs in India as well as in the world, very few have achieved their desired impact, and sustained those impact over a long period of time. It is expected that the next phase of Communit-based Eco-DRR project will keep this aspect in mind while planning.