Insertion of Exogenous Development Measures on an Endogenous System:

A Case Study of the Gangewadi Water Resources Management

Ravi Deshpande

Watershed Organisation Trust

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Pune 411009, India.
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Foreword

The urgency for progress has compelled governments and development agencies to introduce various interventions into the rural sphere. The general understanding is that the people out there have missed the boat of modernization and need to be brought to date. As a result, the agencies, with enthusiasm, move into making a difference in the lives of the rural poor. The attitude is, '*we know it*'. '*We will show them the way*'. And when road-blocks are met, the blame is put on '*those illiterate people*'. '*They do not know what is best for them*'.

We present this paper with humility. While the Indo-German Watershed Development Programme was being implemented, we and the project implementing agency were so caught up with the good work that we were doing, that we were blind to the local *dharan* (irrigation) system that was functioning each year. We were lucky in that the watershed development project was beneficial to the local community. We were lucky too that the local people were able to adapt and integrate their system to our intervention.

Without romanticizing the traditional practices, we need to go in with an open mind and learn of the what, why and how of the systems that local communities have carried on over generations. This will help us accept what is relevant of the tradtional systems and make appropriate adaptations to our socio-technological interventions. Of particular importance is the need to study the irrigation systems in the light of weather variation? What are the modifications these would need in instances of less or excess rainfall? While working out with the community, we need too to place before them the challenge of likely climatic scenarios and together prepare ourselves for these conditions. The local community and we together can work out mutually acceptable approaches and interventions that will address the contemporary context.

Do send us your comments, critique and suggestions regarding this study. Do write to us at publications@wotr.org

Marcella D'Souza
Executive Director – WOTR

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Abstract

Various systems have been developed by local communities in their attempt to address common needs particularly that of food and water security. The design of these takes the local socio-ecological space into consideration. Simultaneously, exogenous development interventions are widely promoted by external agencies. These, in one way of the other, affect the endogenous systems. Many useful traditional systems get lost, while some systems adapt and continue to function.

The Ganagewadi dharan (irrigation) system has withstood two major exogenous interventions – four check dams constructed by the agriculture

Ravi Deshpande has done his Masters in History from University of Mumbai and currently he is persuing his Ph d. He has been an activist since his college days and is involved in advocacy work among the tribals of Thane district. He worked as lecturer in a reputed degree college of University of Mumbai for five years. He has been associated with development sector as research consultant since 2000. As a researcher he has worked on various issues such as, migration and trafficking, Panchayati Raj, watershed development, and National Rural Employment Guarantee Scheme (NREGS) etc. His area of interests includes traditional knowledge, systems and role of caste and locational factors in development process. In WOTR at present, he is working on scoping and documenting of Indigenous Knowledge around water and agriculture in the context of climate change adaptation.

department and the implementation of the Indo-German Watershed Development Program. The study brings to fore the adaptativeness of this traditional system despite the significant changes that were caused in the local social bio-physical sphere. Using qualitative data collection tools, the paper describes the functioning of dharan system and located the settings where exogenous interventions were introduced. It reveals the delicate and intricate relationship of the local system with socio-ecological resources. It describes the interplay between the endogenous system and exogenous interventions and how the latter affected the former. The paper highlights the importance of identifying and acknowledging the existence of prevailing local systems and of blending their strengths with the development and adaptive process. The paper concludes that recognising and anticipating the unintended though unavoidable impacts of a development or adaptation intervention on different local systems, it is necessary to weigh the benefits, blend with the strengths of the endogenous systems and integrate the newer learnings of the planned exogenous intervention.

Key words: *traditional local irrigation systems; watershed development; socio-ecological system; indigenous technology; local adaptation*

Introduction

In the context of climate change or change in general, adaptation has no alternative. Adaptation however occurs in various forms: coping, adjusting, improving, closing, and even by mal-adaptation. While adaptation occurs more easily (often unknowningly) at the individual level, communities may willingly or they may be compelled to make changes in the strategies and socio-ecological

systems*[1], which they have followed since long. Exogenous initiatives that are aimed at "improvement" in the flow of natural resources of a micro eco-system such as water and soil are bound to interact with the operation of prevalent local endogenous systems and will affect the latter's complex intricate relationship with the resources. The challenge is to contemporise traditional practices, so that knowledge and experience gained over of centuries is retained while meeting the demands of the current, changed context.

Scholars for several decades have been fascinated by the varied patterns of locally evolved and managed irrigation systems found throughout the world[2]. However, the real interest in these systems grew ever since questions first surfaced over capital intensive large scale irrigation[3] and micro level approaches such as watershed development that began to be viewed as panacea. Such systems are increasingly being documented and appreciated.[4] Diverse socio-ecological systems[5], such as local irrigation systems based on traditional technologies thrived in the past and some still exist in rural India. They exhibit variety of technologies developed by the people over the centuries based on the local ecological conditions and needs.[6]

In the emerging contexts of climate variability and change these systems merit a re-look as they often exemplify local adaptation since they include water harvesting and irrigation systems that people have evolved to cope with dry spells, especially in the arid and semi arid zones. These may be viewed as coping mechanisms of the people in response to climatic conditions. As micro level approaches gained importance, concerned government and development agencies began to initiate resource management measures with bio-physical impacts to enhance the carrying capacity of local eco-system. Consequently,

* "Social-ecological systems are linked systems of people and nature. The term emphasizes that humans must be seen as part of, not apart from nature – that the delineation between social and ecological systems is artificial and arbitrary. Scholars have also used concepts like 'coupled human-environment systems´, 'eco-social systems´ and 'socio-ecological systems´ to illustrate the interplay between social and ecological systems. The term social-ecological system was coined by Fikret Berkes and Carl Folke because they did not want to treat the social or ecological dimension as a prefix, but rather give the two same weight during their analysis.

endogenous local informal systems, especially those that evolved around the socio-ecological resources of the villages became exposed to externally driven developmental or planned adaptation initiatives.

In this light, the study delves into a traditional and informal irrigation system located within the current settings where exogenous interventions have been introduced. In Gangewadi village, an informal traditional gravity based irrigation system is still operative though in a significantly altered form, despite two major exogenous development interventions. By exploring and elaborating on the dynamic interplay between the endogenous socio-ecological system and the exogenous measures initiated, the paper highlights the importance of identifying and acknowledging the existence of prevailing local systems, particularly for designing a more harmonious and effectual model of development and adaptive practices.

The paper is divided into three sections. The first section presents the methodology of the study and the profile of the study area. The second section contains findings, analysis and discussions. The third section – implications and conclusions.

Methodology

About the village

The study village Gangewadi is located in the Beed district of Maharashtra, which falls in a drought prone region. Gangewadi is a small village of 110 households having a largely, homogenous population of the Maratha caste (102 hhs). Gangewadi village receives an annual average rainfall of 528.90 mm, which places it well in the chronic water scarcity Deccan area. The topography of the village is undulating with the highest elevation of 892 m and the lowest elevation of 685 m above mean sea level. The slope is towards the south. The slope in the upper reaches of the micro watershed ranges from 10% to 25%, while that in the lower reaches ranges between 5% and 10%. The village is drained by a single stream, which meets river Seena. The drainage system of the watershed is part of the Krishna River basin.

Major exogenous interventions in the area

The village had two major exogenous interventions in the past. Between 1992-1994 the state agricultural department constructed four check-dams on the Bokadi stream in Gangewadi village. Later, during the years 2001 and 2006, Indo German Watershed Development Programme (IGWDP) was implemented. Adopting the 'ridge to valley' approach, the IGWDP treated the whole area – with soil and water conservation measures such as continuous contour trenches, water absorption trenches, stone bunds, farm bunds, afforestation, gully plugs, nala bunds, gabions, and check dams. There was a fundamental difference between the two exogenous interventions. The check dams constructed by the agriculture department followed an activity approach, while the watershed development project followed a holistic and participative approach. However, both interventions were strong on technology. Incidently, it appears that both exogenous agencies were unaware of the prevailing traditional irrigation system. Significantly, the system continued to function in the altered situation by changing its design and rules according to the context and needs.

This study was carried out between the months of July and October 2010. A photo-documentation was done by me earlier in 2006 while conducting another assignment. At this time an on-site interview was conducted with the women who were involved in the construction work of the *dharan.* Till then, this irrigation system had not been identified, or had not been considered relevant by the implementing agency. Adopting a case study approach, exploratory field work was carried out in June 2010 to check if the system was still in use. Between July and October 2010, two on-site focus group discussions (FGDs), where 19 participants of all user groups were involved, were conducted. One FGD with 10 participants included a transect walk through the sites of the local irrigation system. The participants of the FGDs were selected by asking the people to select theri representatives who best knew about the *dharan* sytem and who would best represent them. Two in-depth interviews were conducted with the most senior and active members - Shri Mahadev Gange and Shri Bapu Ganage, from the users group. Mahadev Ganage was the most knowledgeable and is the main expert who guides the construction of the system since many years. Shri Bapu Ganage too is one of the other experts. They provided information on the details of various aspects of the

system. They filled in the gaps in detail. Qualitative data was collected through a one day workshop of representatives of the different user groups. Nine members of all user groups, including the defunct one, were involved in the workshop that was held at Ahmednagar. The nine members were the leaders and key members of the respecitive *local dharans.* Various participatory tools were used to capture the information. The user group members of the respective *dharan*s drew their section of the local irrigation system. It is from their work that the map was generated. The limitation was that only male members participated in the various discussions. The women were obvious by their absence during the interviews in 2010. While they were invited to participate in the FGDs, they somehow seemed to have been more engaged in the agriculture work. For the workshop, as only the key members who best knew about the *dharan* were invited, women were not involved. In hindsight, the absence of women in the discussions is a lacuna. A separate FGD with the women would have thrown more light on this case study.

Findings, Analysis and Discussion

This section presents the findings to cover important features of the local system and issues related to its adaptation to the significant exogenous measures.

The 'dharan' system

Understanding how this local irrigation system evolved and works is necessary before looking into its interplay with exogenous interventions.

Origin and nature

A traditional irrigation system is operative on the Bokadi stream which flows through the village. Though villagers call Bokadi a river, it is actually a seasonal stream which originates in the hills that form part of the ridgeline of the Gangewadi micro watershed. Since generations farmers

This system is informal and not codified, but the water rights of the user group are well defined and protected by tradition.

PRA exercise conducted during the study

have been using this seasonal stream for *rabi* cultivation through a gravity based irrigation system. The villagers call it *dharan* (a water storage and distribution system). Users were unable to specify the exact period when the system originated. The oldest person in the village states that is has been in use since earlier generations. This system is informal and not codified, but the water rights of the user group are well defined and protected by tradition.

The five dharans (the dam, water storage and distribution system) – and their User groups
A total of 62 farmer households (56% hhs) have their lands in the *dharan* system that irrigates a total of 52 acres of land in village Gangewadi.

Customarily each year, five water storage and diversion weirs called *konda* (a check-weir that includes the pond created by the weir) are constructed on the stream by a group of farmers who have a portion of their land on the banks of the stream. The users, as well as the command area to be irrigated are well defined. Each '*dharan'* is named after the user family group. The first dharan is named after the user family group Moharkar. The Moharkars are said to have come into the village by marrying into the original dominant Gange family group, who belong to the Maratha caste. The remaining four are the Umberbet dharan (a grove of *umber* trees), Mavlai dharan (named after the local deity Mavlai), the Munja dharan (of the ghost living on a tree), the system is also called the Malekaranche dharan (of farmers with irrigated land) and the fifth is the Thadgyache dharan (of the tomb). Of these five original '*dharans*', only four are still in operation and Malekaranch dharan is in disuse since the past few years.

Physical structures and technology
The user community builds *kondas* at the well-demarcated respective sites on the stream to store and divert water from the stream. The water stored in these structures are then released through an outlet provided at the bottom called '*mori'*. The water flowed into another structure called '*palan'*, which is a water-transporting structure. *Palans* are constructed wherever water had to be carried through intervening small streams or slopes. They act like bridges carrying water across those streams or slopes. The water is then delivered to the fields through canals, called '*pat'*, utilising gravity.

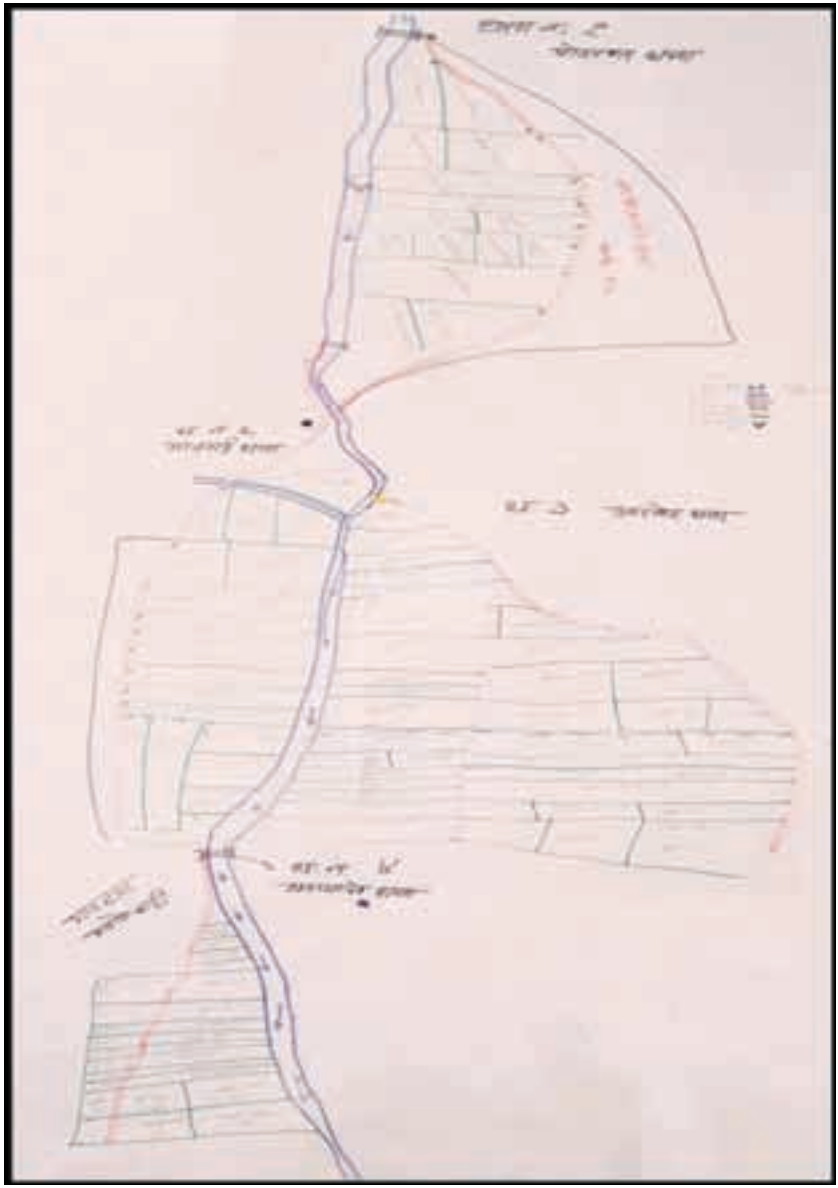
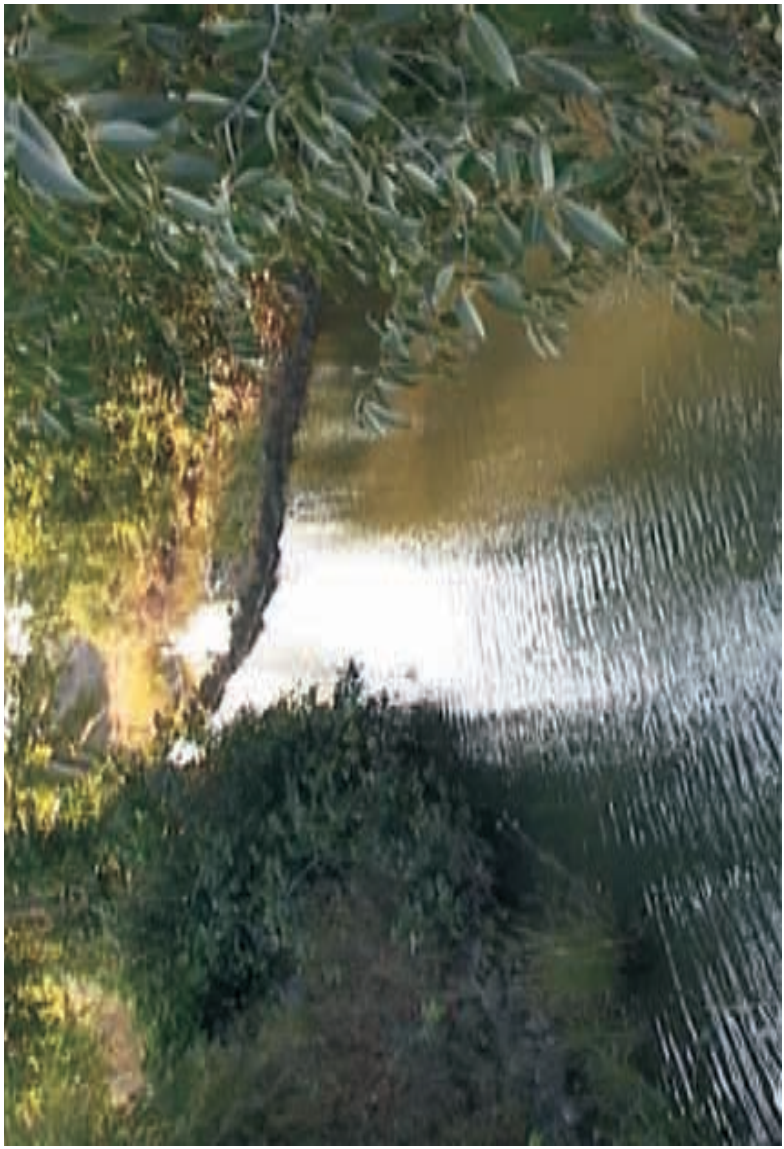


Figure 1: Map of Current Status of Dharan System
Source: PRA exercise



A *konda* – water storage and diversion weir

A *palan* – water carrying structure

A *pat* – canal for delivering water

Construction process

Construction of these structures is carried out annually through a fixed labour contribution by the user group families. At least one person from each user household has to contribute labour in the construction of these structures. Labour contribution is fixed according to land holding. Those with more than an acre of land to be irrigated have to contribute one extra person for each additional acre of land. Each person is required to contribute a bundle of crop stalks of approximately 15 kilos each day until the construction is completed. The labourers work under guidance of an experienced group of persons, who are expert in the construction of the system. The construction process generally takes place in late October or early November, depending on the requirement of water for the r*abi* crops and the intensity of the monsoon rains. In the case of good and extended monsoon, the construction would be postponed to late November.

Those with more than an acre of land to be irrigated, have to contribute one extra person for each additional acre of land. Each person is required to contribute bundle of crop stalks of approximately 15 kilos each day until the construction is completed.

Materials used

These water storage (*Konda*) and water transporting (*Palan*) structures are made of locally available material such as stones, black soil, and crop stalks and straw. Black soil and stones are taken from the stream bed itself, which is a common resource, while crop stalks are not. Hence, every user has to contribute crop straw and stalks. It was important that the stream bed provided adequate quantity of black soil required for the construction of storage and diversion weirs (*Konda*) and water transporting structures (*Palan*).

Repairing and maintenance

Construction of structures and their repairs or maintenance is a group function. All farmers contribute equally both in labour and material. In the past, the kondas (weirs) and the palans (delivery structures) were constructed every year as the structures of previous year would be damaged or washed away completely with the early monsoon

rains. Repair and maintenance of these structures are required throughout its operation of three to four months. Both routine and special maintenance is done to keep the system functional. As the structures are made of clay and bio-stalks, crabs make cracks and holes, leading to major leakages. It requires almost daily monitoring to check leakages. Repairs required are carried out immediately to avoid major damage that would otherwise would jeopardize the whole structure. Further, the water delivery canals (*pat*) too require regular checks for leakages. Leakages not only mean less water for tail-end users, but also damages to crops through water logging in the fields around the leakage.

Water rights

The '*dharan'* system generally is hierarchical in the sharing of water but also is flexible in times of need. The head-end users have first rights to get the water and tail end users receive water only after requirement of the former is met. However, during times of water scarcity, the survival of crops of the fields of participating households of all the dharan systems, from head to tail-end users, is given importance and is done through protective irrigation.

Composition of user group

All users of the *dharan* system belong to the Maratha caste, a majority community of this homogenous village (93% households). Further, the users have close kinship ties as they belong either to a particular family group of the village or to the family group which has the matrimonial relationship with it (ie the Moharkars). This system is operational in Gangewadi without much change, probably for a very long time (the elders do not remember when it was started) until the introduction of the external interventions in the village.

Adaptation of the 'Dharan' System to Exogenous measures

Perceived Impact of check dams built during 1992-94

According to the participants of the FGD, the government built four check dams during 1992-94 that *"changed the whole face of the system"*. This statement by villagers suggests that the changes caused were drastic and the operation of their system was altered. A major

change caused was in the sites and designs of the *konda* structures. Although the new check dams were not located on the exact sites of the traditional *konda* structures of the *dharan* system, they were built nearby. It appears that the coinciding of sites occurred due to similarity in the site selection criteria that were used for both the traditional and modern structures, without the external actors being aware of the traditional system. Nevertheless, the villagers adapted to the the check dam which they began to use as a water storage and diversion structure instead of their traditional *konda* in the four sites. As related by Mahadev Gange, "Though this helped, the traditional sites were changed by few meters in each case. Consequently, it also changed the lengths and sizes of each *palan* (water transporting structures) as these are designed according to the nature of the water flow at the respective sites.

Perceived Impact of integrated watershed development project (2001-2006)
In the Indo-German Watershed Development Programme (IGWDP) various land treatments were implemented right from the ridgeline of the watershed to the outlet. According to the perception of villagers as emerged during discussions, the changes caused due to the watershed development project had significant effect on the functioning of the system. The project built soil and water conservation structures across the micro-watershed. This included the catchment area that feeds the Bokadi stream. Because of wateshed development, as soil was conserved, more area was now taken up for agriculture. Further, the project developed social capital in the form various CBOs and women's SHGs. Access to micro-finance, the introduction of new methods of ploughing, productive farming; motivation of the people to change the livestock pattern from small ruminants to large ruminants were also introduced. Thus the project has in one way or another, affected all the five capitals viz. natural, physical, social, financial, and human. A change in the each capital stock has significance on the functioning of the system, but the side effects in ecological flows seem to be crucial.

Table 1 captures the changes, as perceived by the people, that have occured to the *'dharan'* system because of watershed development. According to the people, the changes are both encouraging and disheartening. Here the negative effects noted are exclusively on

Table 1: Perceived changes due to watershed development and its significance

Perceived changes	**Change in bio-physical resources**	**Significant Impact on the *dharan* system**
Enhanced land productivity through of reduction in soil erosion from individual farms and increase in soil moisture.	Flow of soil from fields to stream bed arrested.	Insufficient soil in river bed for building *Konda* and *Palan* structures.
	Less silting in check dams.	Less damage to the structures.
	Increased soil moisture	Timing for water requirement delayed and varied. Less water requirement for crops.
Increased ground water table	Greater water availability in individual wells	Less dependence on shared surface water. Increased up-stream area under irrigation. Greater capacity to withstand delay in receiving water from *dharan* system (for tail end users).
	Shift towards intensive and productive farming due to greater water availability.	Less enthusiasm to contribute labour for commons as farmers are more occupied in their individual fields.
	Greater ground water exploitation	Less dependence on shared surface water
	Shift towards cash crops and large ruminants	Greater dependence on well water irrigation
Increased agriculture related productivity and income	Savings and increased income with users	Ability and need to hire labour for commons
	Shift towards high input farming system.	Less labour available during the season.

Source: PRA exercise held with key *dharan* users

the *dharan* system without taking into account the overall impact of the project. Hence, even desirable impacts of the programme such as increased ground water table or greater soil retention in the individual lands appear to have negative effect on this particular system.

Thus, the implementation of integrated watershed project had three perceived impacts that altered the overall economic, ecological scenario of the village. (Refer table no. 1)

1. Enhanced land productivity through reduction of soil erosion from individual farms and increase in soil moisture.

2. Increase in ground water table and greater availability of water in wells.

3. Increased productivity and income.

These in turn led to changes that have significant bearing on the functioning of the system, as the dharan system rested on the delicate balance of the availability of labour (human resource), material (ecological resources) and collective initiative (social resources). It altered the nature of all three important resources and thereby forced changes in the operation of system.

Mixed Cumulative impact of two external interventions on different user groups

The cumulative impact of both interventions on the present status of the system is mixed. The system is still operational at four of the five sites, by using the check dams as water diversion sites *(konda*). On the part of users, this was an innovative blend of the traditional system with the externally built structures. Through this, the four user groups were able to reduce labour and material required for the construction of their respective check weirs. This made the traditional system more cost effective.

For one user group, however, it increased labour and material requirement for constructing both *konda* (water storage and diversion structure) and *palan* (water transporting structure) due to the disruption

caused by the change of locations of the other sites, which resulted in the impact on the water flow in the stream. The continuation of the system was no more beneficial considering the trade off between increased labour and material requirement in building structures and the increased water availability in wells due to watershed interventions. As was shared during discussions, the people now preferred to lift water from their wells (located even in the lower reaches) to their fields in the middle reaches as this requires less labour and material annually. That the overall benefit of the former is perceived greater than that of the traditional system is seen in that there was no grudge in the 4th *dharan* coming under disuse. Due to change in the traditional sites as well as the flow of water, the k*onda* structure needed to be of a greater height and width as compared to the past. The *Palan* structure too now required a greater length than was traditionally required. This means that these need more soil as compared to the past requirement. At the same time, due to soil conservation measures, there is less soil erosion. As these structures are built only by using soil of the streambed, and as little is now available, soil would have to be taken from the fields which no farmer would permit free of charge. Thus constructing this particular structure ceases to be cost effective. Building structures with greater height, width, and length means increased labour requirement. With greater well water availability due to project measures, there is a shift towards productive and intensive farming. In the post watershed period there is also a shift towards cash crops (onions) from the traditional cereal crops[8]. Labour requirement for farming is now increased. With greater demand for labour for commercial farming, there is a steady rise in wage rates too.

Due to change in the traditional sites as well as the flow of water, the konda needed to be of a greater height and width as compared to the past. The Palan, too, now required a greater length than was traditionally required.

Thus, increased labour and material requirement for the dharan system, and less availability of both, has led this group to abandon the Munja dharan (the ghost living on a tree), also called the Malekaranche dharan (of farmers with irrigated land).

Impact on collective action

Due to the soil and water conservation measures initiated by the integrated watershed development project, the usual loss of water and soil from individual fields to commons got arrested. It increased soil moisture in the fields and greater water became available in the private wells, which in turn enhanced land productivity. This also led to greatly reduced siltation in check dams and less damage to the structures. This was surely positive and desirable impacts on the adaptive capacity of the people. However, at the same time, as the flow of soil from fields to stream got arrested, it led to insufficient soil deposits in stream bed for building *konda* and *palan* structures, as discussed by Mahadev Gange. Further, due to the skewed nature of impacts on lands located at different sites in terms soil moisture, water availability, the timing of water requirement for crops of different users did not now match. This was also a result of change in the cropping pattern. There has been a shift towards commercial and high input agriculture because of the greater availability of water in individual wells. This has affected the timing for construction of structures, availability of labour and the need for collective action among users.

Perceived continued relevance of the system[1]

The question arises, "Why have the people adapted a local system to external interventions?" The first response was to maintain the tradition. Most felt that as the dharan system was in place since long (they do recall that it was in the village long before the elders were born), it should be continued. The *dharan system* was theirs. The homogenous user groups with their traditionally established right over stream water made them continue the system. More probing

The system was flexible enough to adapt to exogenous interventions like check dams. But, by replacing the kondas with check dams, it was possible to have benefits of both exogenous development measures and their own irrigation system.

1 Participatory workshop held at Ahmednagar of key users

made participants analyze further. Firstly, the system was flexible enough to adapt to exogenous interventions done by building check dams. Secondly, by replacing the *kondas* – a traditional structure – with check dams, it was possible to have benefits of both exogenous development measures and their own irrigation system. Moreover, the check dams did away with having to build the konda structure annually at four sites. This meant a drastic reduction annually in the labour requirement and maintenance. Above all, the system in the eyes of users still remains useful and relevant even after implementation of watershed development project.

Table 2: Annual savings through dharan system according to users' perception

	Dam 1	Dam 2	Dam 3	Dam 4	Total
Number of users	11	14	23	14	**62**
Land Irrigated (Acres)	10.2	12.2	18.2	10.2	**52 Acre**
Pipeline cost saved[1*2] (₹)	64,400	76,800	152,000	59,250	**352,450**
Electricity cost saved[2*3] (₹) per annum	22,000	22,880	33,582	19,360	**97,822**
Ground water saved[3*4] (Ltr.)	3,000,000	3,240,000	4,440,000	300,000	**10,980,000**
Ground water cost saved[4*5](₹)	41,000	47,000	59,000	41,000	**188,000**
Total Saving **(₹)**	**127,400**	**146,680**	**244,582**	**119,610**	**638,272**

Source: PRA exercise

1*2 While arriving at saved cost for the pipeline, the participants first made an approximate assessment of the number of pipes required for each user to irrigate land from the water source within his farmland. They took into account the current price per pipe and installation cost considering current local labour rates.

2*3 Participants calculated the amount spent when 176 motors of 5 hp ran for 1 hour.

3*4 Calculating saved ground water was most difficult part. The participants first calculated litres of water used per acre when it sourced from well for millet crop. Then they calculated how much groundwater they would have exploited if there was no surface water available through dharan system, assuming that as much ground water was available.

4*5 The participants arrived at water cost by considering current local rates if water is purchased in turns from the well from other well owners. They assumed that all the free water they get from dharan is charged at the same rates as any private sellers would charge for that much water.

The users quoted many benefits of the system and even calculated cash savings because of it. Table 2 shows, the savings enabled by the adaptation of the system as calculated by user group members in a participatory exercise. Non-availability of electricity for most part of the day, due to load shedding in the rural areas, makes this system useful not only from the point of view of saving but often is the only option. Watering the fields in daylight is always more convenient.

Complementarities with watershed development

Another reason quoted by users for continued relevance of the system was its complementarities with the benefits of watershed development. The *dharan* water covers only areas at the lower side of the stream as it operates using gravity. Increased water in wells due to watershed development enables the users to lift the additional water and take it to areas where water from the *dharan* system cannot reach due to the topography. Reportedly, increased income, access to credit and better returns from agriculture made it possible for farmers to invest in digging wells, buying electric engines and constructing the pipeline. The well water is used for irrigation of areas on the upper reaches, while the surface water from *the dharan* is used for lower areas.

Perceived indispensability of external interventions

Another question that arises in this exploration is whether exogenous interventions are required in villages where such an adaptive and efficient water distribution systems exist. Majority of participants in FGDs regard external interventions indispensable for development. There are valid reasons for them to think so. In the first place, the *dharan* system does not cover all cultivable land of the watershed due to its inbuilt limitation, as it is based on the principle of gravity and also because of the location of the stream. Further, tradition had also restricted the user groups and the area to be irrigated by the system. The dominant group in the village had secured rights over the surface water through this system. Now this meant that the area and the farmers not covered by the system would be able to access water because of the exogenous intervention. Hence, the exogenous intervention appears necessary for the earlier traditionally excluded lands and households. Secondly, the dharan system is meant

for protective irrigation and survival of crops during times of water scarcity. Relying exclusively on the commonly controlled surface water for irrigation is not the best option for farmers. Therefore, even the users of this system found the exogenous intervention crucial for enhancing level of ground water and ultimately water in the wells. This suggests that the traditional and local system, however attractive they may be, do have limitations and locals are able to see this.

Why was there no conscious effort by the external actors towards fusion of the two systems?

Surprisingly such an important system in the village was never included in discussions with the NGO project staff, until it was discovered during a previous study conducted in 2003. No one considered it as related to the project objectives. The villagers also were amazed to see interest in this system, as no outsider had ever asked them about it. It was as if, the system remained invisible, hidden from outsiders. The FGD revealed that the villagers never revealed the system and its significance to their lives to the government engineers when the check dams were being built in 1992-94. The people had not even suggested sites for building check dams.. Similarly, during the watershed development process, the villagers were not explicit in communicating to the outside decision makers about the 'why' of the check dam at a particular site. They feared that if they do not accept external action, help would be stopped, as the norms of external actors were more fixed and inflexible then theirs.

The villagers considered exogenous interventions as something outside themselves, different though necessary and that they had to adjust with it as is planned and executed.

Discussions and Conclusion

This section presents a deeper analysis of the findings of the study of this adaptation process of the traditional local irrigation system of Gangewadi with the superimposed exogenous development measures. The findings have programmatic, research and policy implications.

Adaptability provoked through flexibility

The study first of all throws light on the aspects that make endogenous local systems adaptive and sustainable. Many useful traditional systems have been lost when they failed to adapt. Good systems continue to function when they are relevant in changing socio-ecological and economic situations. The *dharan* system of Gangewadi has survived and remains effective even after significant changes caused in the local social and bio-physical situation. It maybe because of an in-built flexibility in its functioning that the *dharan* system was protected from the fate of other similar systems.

In some aspects, this *dharan* system is similar to the traditional *phad* and *bandhara* system prevalent in other parts of Maharashtra and the *pat* system of the Bhils of Madhya Pradesh, which are well documented.[9] However, in some relevant aspects the *dharan* system of Gangewadi differs from other traditional local irrigation systems. The structures in the *dharan* system prior to key exogenous interventions were built annually. This is not the case with the *phad* and *bandhara* systems. This provides an opportunity for users of Gangewadi *dharan* system to accept the permanently build check dams in place of the temporary water storage and diversion structures (*konda)*. Further, the p*had* system prescribes and controls the cropping pattern in the command area,[10] while the d*haran* system of Gangewadi does not determine the crops taken up by its users.

Similarly, norms for water use and rights have prevailed since long in India in various community-based systems. In the *Phad system* there is an in-built element of flexibility to respond to seasonal variations in water supply, even as crop-water requirements were the basis for the determination of the water rights[11]. The dharan system exhibits the same flexibility in the sharing of water. However, each can take the water required according to the crop demands. Besides, the tail-end users have accepted getting less than the head-end users. And again, in times of goes water scarcity, protective irrigation is provided equally to all.

Thus, the flexibility in design and water rights made the *dharan* system more adaptive and responsive to externally introduced changes.

Watershed development and Collective Action

The case study throws light on the impact of watershed development and the collective action process. The need for collective action is indispensable for the survival and effectiveness of such systems. In any analysis of collective action, focus is on the conditions in "which collective action emerges, becomes effective, and is sustained over time".[12] Notably, there is a paradox in impacts of watershed development and the conditions required for emergence of collective action to sustain such systems. It is observed that the technical measures of watershed development lead to transfer of common resources to the private domain. Watershed development perceivably stymied the loss of soil and surface water from private lands to a common streambed. At the same time by arresting water in the private wells through percolation, it was prevented from reaching the common stream. This has also resulted in intensive and more productive farming by individuals now having greater water availability within their private domain. The thrust on localizing the natural resources in watershed development unintendedly reduces the dependence on commons and increase need of individual rather than collective action. Such paradoxes are inevitable as change in any variable within a complex local socio-ecological space tends to throw up multiple non-linear effects on other variables. Since exogenous interventions are indispensable to progress, such unintended but unavoidable impacts of development or adaptation interventions are also inevitable. However, recognising such impacts during the design stage would be desirable as it would incorporate the good elements of traditional systems owned by the community into contemporary interventions, which will thus reduce stress and damage.

Drivers of adaptive action

The continued relevance of such systems motivates people to sustain these by incorporating and adapting them to the new biophysical situation. One study of the "*pat*" system prevelant among Bhils in Jhabua district of Madhya Pradesh points out that the system is still operative because it is much cheaper than irrigation using electric

or diesel powered pumps.[13] This study also reveals perceived cost effectiveness of such systems, as villagers are even able to quantify the savings through it. This underscores the sense in sustaining the traditional endogenous systems. It is the rational choice of users and not romanticism attached with traditional, endogenous systems that inspires adaptive action on the part of users.

A male dominated system?

What stands out prominantly is that women were absent in the discussions in 2010. They did not participate either on-site nor during the workshops. While they are involved in constructing the dharans, and in the agriculture work, it appears that the technical expertise rests with the men. Hence women were not involved. Here a question arises, how would women look at it if they were given a more active role? What would they do differently?

Programmatic Implications

a. Sustainability of a traditional system is possible when it responds to a need and can be adapted to the changing contexts as in the case of Gangewadi. While designing community-based institutions, development actors emphasize more on stability / continuity rather than on responsiveness to needs. However, this case shows that sustainability comes from responsiveness and adaptability, and not from firmness. This case highlights the need of responsive, adaptive institutions that are preferably embedded in traditional customs, for the management of common property resource.[14]
b. Adaptation of this endogenous system with an externally driven development process validates further that adaptation takes place largely at local and community level. Recent views in adaptation parlance emphasise that since it is essentially local, attention to local institutions and systems are critically important in the design of adaptation projects and policies.[15]
c. The reasons behind abandoning one *dharan* site in the Gangewadi case throws light on the intricate links of various ecological

elements within such a traditional system. It suggests that such systems are sensitive to interactions from different resource components within the local ecosystem and that their sustainability is delicately entwined. Any change in the biophysical character can force them to adapt, survive or get extinct.

d. This further suggests that traditional irrigation systems are complex socio-ecological systems and should not be disturbed by sudden change or reversals, without proper understanding and analysis. Lately, many programmes have started taking note of this.[16]. Recent studies point out that a close integration of different institutional arrangements and interaction of internal and external institutions are critical for enhancing the effectiveness of adaptation practices.[17]
e. Though flow of material and labour stock gets reduced, the system will still sustain itself if the demand for the same is proportionately reduced. This means that the delicate balance of stock and flows of a socio-ecological system should be taken into account while planning exogenous interventions. This would minimise disruption that occur in such systems. In many cases, it would even be possible to blend the benefits of exogenous intervention with that of endogenous systems.
f. Recognising and anticipating the unintended though unavoidable impacts of a development/adaptation initiative on different local systems during planning or implementation can be useful in minimising damage and preparing solutions for side effects.

Research Implications

a. The case study highlights the significance, however small, of localized traditional irrigation systems. In the emerging context of climate change adaptation, it is important for researchers to unearth this hugely neglected area of innate adaptation practices, the forms of which are rooted in the ethos and cultural stock of the community."[18] Moreover, to be contextual, localized adaptive measures are needed, though such practices may not always be replicable.
b. It has largely been accepted that farmers on their own, manage, operate, regulate and distribute irrigation systems more efficiently

among users.[19] Such self-organized irrigation systems do tend on average to have performance levels higher than externally imposed or state-organized systems.[20] Study of such self-organised, adaptive systems can offer rich learning for enhancing the effectiveness of developmental initiatives.

c. The key finding in this case study is that no external intervention takes place on a clean slate. Rather it enters into the delicate and intricate web of local systems. Exogenous measures initiated are bound to have effect on the sensitive socio-ecological elements. The study of the Gangewadi *dharan* system shows that the exogenous interventions interfered with the delicate balance of various essential resources in the local socio-ecological space, which had earlier enabled the villagers to evolve and sustain the irrigation system. The watershed development exogenous system contributed significantly to reduction of soil erosion, although it altered the function of the *dharan* and forced changes in the design and rules. It was however accepted by the villagers as their lands on the upper reaches now became more productive as water was retained and captured in wells. *However, the flexibility to adapt was on the part of locals and not the external agencies.* The system remained largely invisible to external actors. Locating such systems and enabling their smooth adaptation would lessen the stress and costs for both internal and external actors. This would require different lenses for external actors to identify such systems in time and incorporate the primary users to take the appropriate action. This too would help the external actors understand better how the endogenous systems function.

d. It would be worth studying the socio-ecological and economic benefits of this system and the impacts of the two exogenous interventions. This is to assess better the overall benefits particularly from the long-term and climate change perspectives. On the one hand a gravitational system (for the 4th dharan) was sacrificed. This system earlier would lose much soil in the flow, which is now minimized due to wateshed development. From the people's perspective, the sacrifice was in favour of availability of lift irrigation from their wells to their fields in the middle reaches, which is less labour intensive. On the other hand, almost all users as also the other households in the village have their lands irrigated. With the prices of oil likely to increase, and given

that electricity is erratic, how will it impact these households in the long run?

Policy Implication

Despite growing calls, such autonomous adaptation is often overlooked in national and international efforts to manage the impacts of climate change.[21] The successful continuation of the system by locals in this case implies that such local and autonomous interventions in response to locally felt demands needs to be focussed on so as to unearth better and more sustainable adaptation practices.

From the policy perspective, we need to realize that as we look to adapt to climate change, we should not think of blanket solutions for all contexts. Rather, we need to discover the various local measures that have allowed our rural counterparts to survive against all odds, and incorporate these social and technical measures into development operations. What the Gangewadi *dharan* teaches is that flexibility is essential to adaptation.

Conclusion

Adaptation is continuously taking place. What we see of endogenous practices today is the outcome of very long years (or centuries) of continuously adapting to weather variability. Therefore, exogenous adaptation and development measures do not enter in a vacuum. Considering this, external agencies need to first be aware of and then harmonise themselves with systems prevailing in the communities for enhanced effectiveness. This also means that adaptation is a process that takes place locally, informally and in congruence with the ethos, tradition and within the specific local geography. Any exogenous intervention that ignores or remains unaware of such adaptative measures loses the opportunity to blend benefits and strengths of the local informal systems with newer learnings of planned, exogenous intervention. However, for this to happen, the external agencies need to be humble and open to learning even from our rural counterparts.

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Watershed Organization Trust (WOTR)

The Watershed Organization Trust (WOTR) is a not-for-profit NGO founded in 1993. Its operations presently span five Indian states – Maharashtra, Andhra Pradesh, Madhya Pradesh, Rajasthan and Jharkhand.

WOTR's mandate is reflected in its vision *"communities, especially the poor within, are empowered and secure their livelihood and well being in sustainable ecosystem."*

Since its inception WOTR has been working in resource-fragile semi-arid rain-fed regions through participatory watershed development. Now, WOTR has moved from "regenerating the degraded lands through in-situ harvesting of rainwater" to a holistic integrated and systemic ecosystems based model of community development that aims to address climate variation and climate change.

WOTR mobilises the communities to tap into their capacities to help them move on the path of equitable sustainable development – and along the way – reduce poverty, through regenerating the eco-space and watersheds they live in. It helps the rural communities in resource fragile rain-fed and drought-prone regions, to organise themselves, to respond to, emerging climate variations while enhancing their adaptive capacities, to address the climate change.

Watershed Organisation Trust (WOTR)
'The Forum', 2nd Floor, S.No. 63/2B, Padmavati Corner,
Pune Satara Road, Parvati, Pune 411009, India.
Phone: +91-20-24226211 • Fax: +91-241-2451134
Email: info@wotr.org • Website: www.wotr.org

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