Land Use and Water Resources Research

Watershed development: A solution to water shortages in semi-arid India or part of the problem?

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Abstract

There have been dramatic changes in the hydrology of many of the dry areas of South India in recent years as a result of increased groundwater-based irrigation, watershed development and land use change. Although intensive development of water resources has brought about huge benefits, its very success has thrown up new challenges. Demand and competition for water has increased to the extent that — in some areas — current levels of annual water use are so high that, in all but the wettest years, annual water use approximates towards annual replenishment of surface and ground water resources. In these areas, it is clear that the emphasis should switch from development to the management of water resources to ensure that water is allocated to activities with the highest economic and social value. Although current watershed development programmes bring a range of benefits, they may also change the temporal and spatial pattern of water availability and use. This can result in significant negative trade-offs such as more unreliable domestic water supplies in 'downstream' areas, particularly during low rainfall or drought years. As part of the Karnataka Watershed Development Project (KAWAD), a water resource audit assessed the status of water resources in the project watersheds and identified resource management practices that should be promoted by the project. This paper summarises the audit's findings and recommendations, the main lessons learned and progress to date in implementing recommendations. For comparison, findings and recommendations from a water audit in southern Andhra Pradesh are also summarised.

Introduction

The Karnataka Watershed Development Project (KAWAD) is located in the northern districts of Karnataka State, India. This is an area that is characterised by limited water resources for which there is increasing competition. In addition to piloting different institutional approaches to watershed development, KAWAD aims to improve the livelihoods of the inhabitants of three selected watersheds (total area of around 45 000 ha). As is typical with most watershed development programmes, the main focus of KAWAD's physical interventions is on soil and water conservation (e.g. field bunding, construction of check dams).

It was realised soon after the implementation of KAWAD in the first half of 1999 that some water-related aspects of the design were inconsistent with conditions in the project's watersheds. For example, a major part of the budget was earmarked for the construction of check dams and other water-harvesting structures, despite indications that runoff from the watersheds was already very low. In fact, river basins in the project area were clearly approaching a 'closed' classification (Molden, 1997) as, in all but the wettest years, utilisable outflows were fully committed. The original KAWAD design also took little account of the dramatic increase in groundwater extraction in the project area during the 1990s and the fact that demand for groundwater was starting to outstrip supply. This was indicated by falling groundwater levels, failing wells and, in some areas, reduced availability of domestic water supplies during peak summer demand and during droughts. These and other observations based on discussions with villagers and local specialists, and limited analysis of readily-available data, prompted a more detailed assessment of the status of water resources and the water-related aspects of KAWAD's design. This short paper summarises the methods used in the audit, the main findings and the progress in implementing recommendations. Findings from the water audit carried out as part of the Andhra Pradesh Rural Livelihood Programme (APRLP) are also summarised to support and complement the findings of the KAWAD water audit. The APRLP water audit was carried out in Kalyandurg and Dhone mandals in the Anantapur and Kurnool districts, located in southern Andhra Pradesh and geographically very close to two of the KAWAD project areas.

With the exception of the Doddahalla watershed, the areas studied in Karnataka and Andhra Pradesh are predominantly red soil (alfisol) areas that are underlain by granites and gneisses. Doddahalla is located in a black soil (vertisol) area underlain by Deccan basalts. The climate throughout the region is semi-arid with potential evaporation exceeding rainfall in all but a few months in any year. Mean annual rainfall is 400–600 mm; however, there is considerable inter- and intra-annual rainfall variability and both droughts and years of relatively high rainfall are not

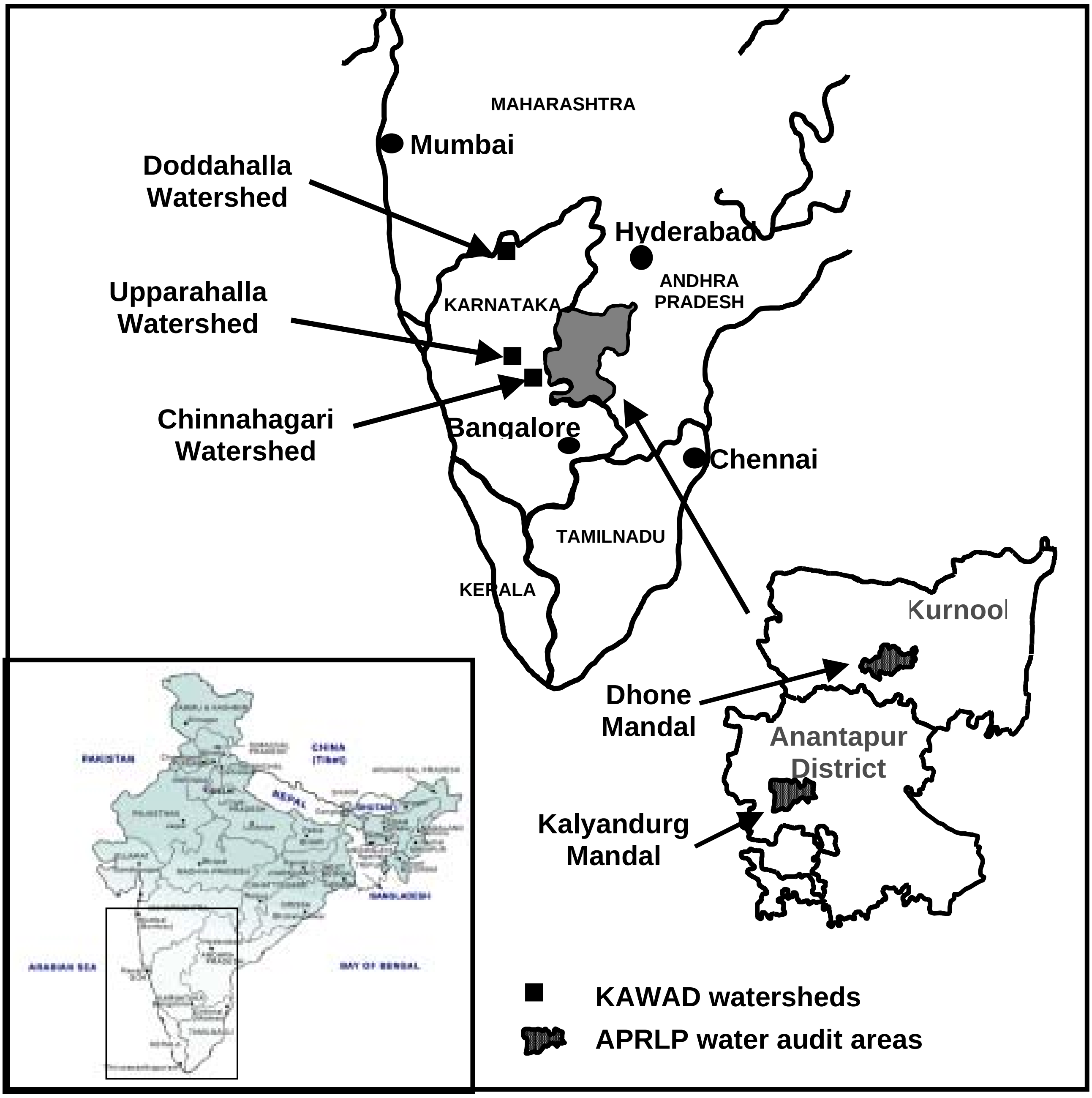

Figure 1. Location of study areas

uncommon. Most rainfall occurs during the monsoon period (June to December). The main land use is rainfed arable cropping with groundnut being by far the most common crop.

Additional information on the KAWAD and APRLP water audits can be found in Batchelor *et al.* (2000), Anon (2001), Rama Mohan Rao *et al*, (2003), James and Snehalatha (2002) and James (2002).

Water auditing methodology

Background and objectives

Water audits, under various different names, are being promoted increasingly as a key step towards sustainable and effective integrated water resource management. For example, the International Water Management Institute (IWMI) has taken a lead in advancing the case for water accounting and in developing relevant definitions and procedures (Molden, 1997; Molden *et al.*, 2001; IWMI, 2002). Similarly, the Global Water Partnership (GWP) has stressed the importance of water resource assessments as part of integrated water resource management (GWP, 2000). Although there are some subtle differences between the methodologies that are being promoted by different organisations (including KAWAD and APRLP), the overall objectives of the different approaches are similar.

The concept of water auditing is based on the argument that a knowledge of the current status of water resources and trends in demand and use is a precondition for successful water management. Equally important, an understanding of factors affecting patterns of access and entitlement to water resources is fundamental in any projects that seek to improve and protect the livelihoods of poorer social groups. Effective water auditing implies a holistic view of the water resources situation and its interaction with societal use. This includes:

(1) addressing the occurrence of surface and ground water, in space and time, and, in particular, assessing levels of sustainable use and the frequency of extreme events such as droughts and floods;
(2) providing a tentative assessment of the demand trends for different uses;
(3) identifying the main driving forces influencing demand and use (e.g. government policy, societal behaviour);
(4) assessing the functionality and effectiveness of institutions charged with developing and managing water resources; and,
(5) understanding factors that affect access and entitlements to water for both domestic and productive uses.

Ideally, a water audit produces practical recommendations in the form of options that, where relevant, identify the trade-offs associated with a different course of action. In the case of KAWAD and APRLP, the water audits considered the wider policy environments and the extent that these and other external factors would influence the potential success (or otherwise) of different courses of action. Consideration was also given to important factors such as levels of awareness of water-related issues and ownership of findings.

Both KAWAD and APRLP relied primarily on secondary data (e.g. water-related data collected routinely by government line departments) and the inputs of local specialists, NGO staff and people living in the study areas. The advantages of this approach are:

(1) It produces data sets that can be used for time series analysis.
(2) It provides a cross-check on official water-related statistics that, in many cases, are being used to underpin policy formulation and decision-making.
(3) It is relatively quick and cheap.

In both audits, more than 30 organisations were involved to some extent in data acquisition, quality control and interpretation. In terms of expenditure, the audits represented approximately 1% and 0.5% of the overall budgets of KAWAD and APRLP respectively.

Data collection, quality control and analysis

In India, large amounts of physical, institutional and socio-economic data have been and continue to be collected in rural areas. Unfortunately, this information is not always easily accessible to potential users and the quality is usually quite variable. A major feature of the KAWAD and APRLP audits was the consolidation of spatial and non-spatial data from a wide range of sources onto geographical information system (GIS) databases. Some ground-truthing and gap-filling was carried out during the collection process with further quality control checks made once the database was established. A major part of the quality control process was the comparison of data and statistics from different sources and analysis and discussions aimed at understanding the reasons for disparities when they occurred. This is arguably the key step in a water audit as it also involves assessing whether the data support accepted wisdom relating to the development and management of water resources.

Water balance calculations were used to assess the status of water resource availability, with particular attention on assessing the impacts of land use change, groundwater extraction and water harvesting structures on temporal and spatial patterns of water resource availability and use. An initial step in performing a water balance is to identify the domain of interest by specifying spatial and temporal boundaries. For example, a domain could be a tank bounded by its catchment and command area and bounded in time by a particular growing season[1]. Conservation of mass requires that, over the time period of interest, inflows to the domain are equal to outflows, plus any change of storage within. Conceptually, the water balance approach is straightforward and easy to use. Often though, many components of the water balance (e.g. groundwater recession) are difficult to estimate using data that are readily available. This said, the key to successful water balance approaches is to make maximum use of quality-controlled secondary information and to cross-check estimates with the often qualitative observations and experiences of specialists and local people working and living in the area of interest. Cross-checks are also possible by comparing results from any given water balance with results from research studies in areas with similar characteristics. Checks can also be made to ensure that upper physical limits were not exceeded (e.g. that actual crop water use does not exceed potential crop water

[1] A *tank* is a water reservoir and the *command area* is the irrigated area downstream of the tank that receives irrigation water from the tank.

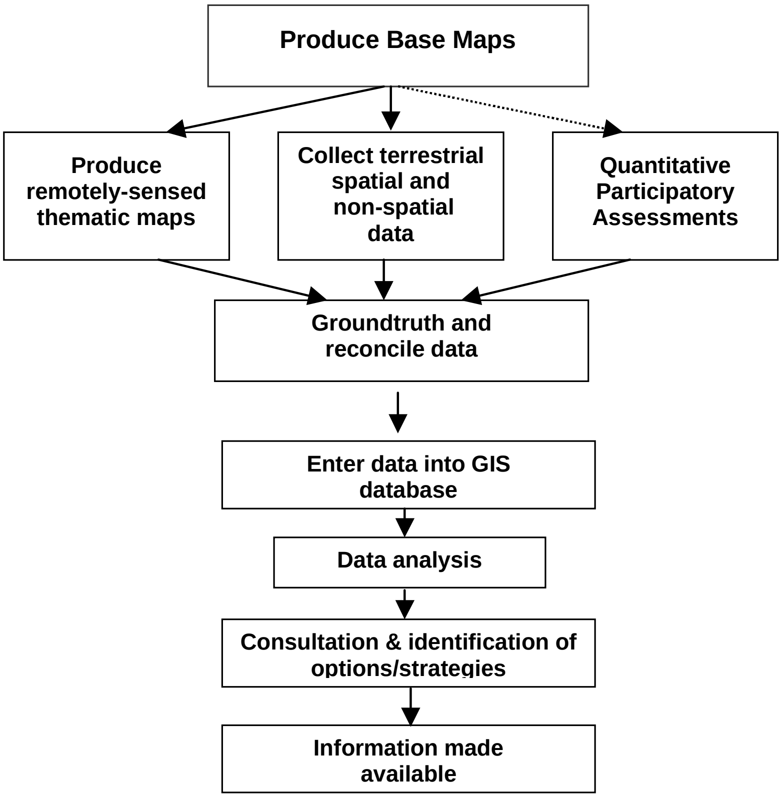

Figure 2. General procedure for collecting, quality controlling and processing information

use).

During the KAWAD and APRLP audits, rainfall and river gauging data were analysed using standard statistical methods. Run-off was estimated by a version of the US Soil Conservation Service method that has been adapted for Indian conditions (Samra *et al.*, 1996). Data on the profitability of different cropping systems were collected from relevant line departments and research organisations and analysed using standard procedures.

Provisional outputs were combined into computer-based slide shows used to promote discussion and comment at all levels. In many cases, this led to further quality control and analysis. A key principle adopted by the study was that quality control and ground-truthing was best carried out with the involvement of local people, NGOs and specialists from research organisations and government departments based near to the project watersheds or were responsible for the relevant districts.

Compared with the KAWAD audit, the APRLP audit made greater use of remotely-sensed data and participatory assessment of information on access and entitlements to water, the functionality of village-level institutions and the status of domestic water supplies. Information on the participatory assessment technique used, which was called quantitative participatory assessment (QPA), can be found in James (2000). Where relevant, QPA data were cross-checked against the more technical spatial and non-spatial data.

Data analysis was carried out primarily by exporting data files to spreadsheet software. Results were then re-imported into the GIS database and displayed using the GIS software.

Main KAWAD and APRL water audit findings and recommendations

Project design

The main findings and recommendations of the KAWAD and APRLP water audits are summarised in Tables 1 and 2. In the case of KAWAD, the water audit revealed a number of fundamental weaknesses in the project design. Reasons for these invalid assumptions included:

(1) Annual runoff was believed to be 30-40% of annual rainfall whereas secondary data showed it to be in the range 2-5% of annual rainfall at the large watershed scale;
(2) No account was taken of the large numbers of water harvesting structures that existed in the watersheds prior to commencement of the project; and
(3) No account was taken of the combined impacts at different scales of water harvesting and increased groundwater exploitation on patterns of availability and access to water resources.

Main 'project design' lesson. In areas with high levels of competition for limited water resources, water auditing should be carried out before finalising designs of watershed development projects and before budgets are fixed.

Groundwater depletion and poverty

Although it would be wrong to argue that watershed

Table 1. Summary of findings from KAWAD and APRLP water audits

Findings	KAWAD	APRLP
Climate change. No indication of systematic change in annual rainfall, however, there may be some change in seasonal distribution and variability.	✓	✓
Groundwater. Dramatic increase in extraction for irrigation during the last 15 years. Demand outstripping supply and, consequently groundwater levels are falling and competitive well deepening is taking place.	✓	✓
Surface water. Scope for developing additional surface water resources quite limited. Large watershed/river basin mean annual runoff generally in range 1%-8%.	✓	✓
Domestic water supplies. Increased agricultural water use and intensive water harvesting in some locations is impacting negatively on domestic water supplies.	✓	✓
Livelihood gains. Groundwater development and watershed development have improved the access of many landowners to water for irrigation.	✓	✓
Tradeoffs. In general, the potential negative tradeoffs associated with watershed development are being ignored in planning processes.	✓	✓
Pattern of access. Groundwater development and watershed development have radically altered spatial and temporal patterns of access to water.	✓	✓
Groundwater depletion and poverty. Overexploitation of groundwater and failed investments in borewell construction have become important causes of poverty.	✓	✓
Privatisation of water. The shift from tank irrigation to groundwater-based irrigation represents a privatisation of water ownership and management.	✓	✓
Water quality. Increased unreliability of domestic water supplies is forcing people to drink poor quality water during dry seasons and droughts.	NS	✓
Social discrimination. In some villages, social discrimination leads to inadequate access of some social groups to domestic water during periods of shortage.	NS	✓
Profitability. The profitability of irrigated cropping is in general twice that of rainfed cropping. This is a major reason for the high demand for water resources.	✓	✓
Power consumption. There has been a dramatic increase in power consumption in rural areas for pumping groundwater.	✓	✓
Groundwater drought. Levels of groundwater extraction are such that, in many areas, groundwater resources are insufficient to meet demand during droughts.	✓	✓
Tank inflows. Intensive water harvesting is having a negative impact on the inflow into many tanks and, thereby is adversely affecting their overall utility. This impact is greatest during years with low rainfall.	✓	✓
Water-related myths. Decision-making is often based on intuition and erroneous wisdom (e.g. myths relating to forestry, water harvesting) rather than on specialist knowledge.	✓	✓
Official statistics. Many important statistics are either out of date or under-reported (e.g. irrigated land use, well numbers, fluoride in drinking water etc.)	NS	✓
Water-related policies. Many important policy decisions are based on estimates that may be inaccurate (e.g. groundwater draft, mean annual runoff, rural water supply and sanitation coverage)	NS	✓
Institutional functionality. Large variability exists in the functionality of village-level institutions with regard to tackling water-related issues	NS	✓
Women and decision-making. In general, women rarely attend or participate in village meetings or influence water-related decision making	NS	✓
Water management. Institutions set up as part of watershed development rarely take an interest in water resource management	✓	✓

NS – Not Studied

Table 2. Summary of recommendations from the KAWAD and APRLP water audits

Recommendations	KAWAD	APRLP
Wider range of options. Watershed development should promote a much wider range of interventions and practices than is currently the case.	✓	✓
Targeting of options. Instead of a “one size fits all” approach, watershed development should aim to match interventions to specific settings.	✓	✓
Sequencing of options. Interventions and activities, in any given location, should be carefully sequenced to minimise risks of benefit capture by elites.	✓	✓
Institutional development. Village-level institutions should be linked to the panchayats and have an emphasis on long-term watershed management.	✓	✓
Demand management. Given the limited scope for developing additional water resources, a shift towards demand management is needed at all levels.	✓	✓
Rural water supplies As villages are an integral parts of any watershed, the highest priority should be given to long-term protection of domestic water supplies.	✓	✓
District level planning. Village-level participatory planning should take place within a district-planning framework that takes account of the wider equity and sustainability issues that are not considered in village-level participatory planning.	✓	✓
Environment. Biodiversity and protection of rare habitats should be given more attention and explicit financial support.		
Specialist knowledge. Decision-making at all levels should be based on specialist knowledge and make use of decision-making tools (e.g. decision trees).	✓	✓
Accessibility of information. Steps should be taken to make reliable information more accessible to the implementors of watershed development programmes.	✓	✓
Quality of information. Statistics that underpin development programmes should be updated regularly and subject to strict quality control procedures.	✓	✓
Awareness. Much watershed development publicity is misleading. Better awareness of the major challenges facing semi-arid areas is needed urgently.	✓	✓
Involve women. Token involvement of women in watershed development is commonplace. Active involvement of women should be promoted.	✓	✓
Water resource audits. Interdisciplinary resource audits should be carried out routinely as part of watershed development programmes.	✓	✓
Extreme events. A higher priority should be given to planning for extreme events (e.g. droughts and floods).	✓	✓
Urban and peri-urban areas. Watershed development activities should be promoted in urban and peri-urban areas.	✓	✓
Water-related policy. Water related policies should be geared towards long-term management of water resources rather than to supply-side quick fixes.	✓	✓
Integrated water resources management (IWRM). Water-related policies, planning and management should take place within an IWRM framework.	✓	✓
Building on success. Finally, watershed development has widespread public and political support. It is important that any modifications to the current approach to watershed development gain similar levels of support.	✓	✓

development is the main cause of groundwater depletion, under some circumstances, it is an important contributory factor. This said, it is clear that watershed development, as currently practised, does little to tackle the root causes of unsustainable surface and groundwater use. Watershed development activities are directed at augmenting water supply as opposed to managing demand and, in many semi-arid areas, demand is fast outstripping supply.

Overexploitation and competition for groundwater resources has become an important cause of indebtedness and poverty in the KAWAD and APRLP project areas (see Box 1). Growing inequity in access to groundwater is also fuelling a process of social differentiation which impacts directly on the livelihoods of some groups and contributes

Box 1. Mechanisms that link poverty to overexploitation and competition for groundwater resources in crystalline basement areas

Failed borewell investments. Investment in well construction is a gamble with high risks, particularly in ridge areas and other areas with low recharge potential. Farmers who take loans to construct borewells but are unable to find groundwater, will not be able to make repayments and, in many cases, will quickly spiral into debt.

Higher borewell costs of latecomers. Latecomers to borewell construction often have to make larger investments than firstcomers. This is because groundwater levels have already fallen and siting a successful borewell involves drilling to greater depths. Also latecomers often have smaller land holdings and, as a result, the scope for siting a successful well is more limited. The net result is latecomers have to take larger loans and, consequently, are more likely to default.

Competitive well deepening. Wells owned by richer farmers tend to be more productive and/or generate more income. If groundwater overexploitation takes place and water levels decline, richer farmers are more able to finance competitive well deepening. Also, as wealthy farmers tend to have established their wells before competitive deepening starts, they are in a much better position to take new loans. As latecomers are often unable to finance competitive well deepening, their wells fail and they are unable to repay loans and often have to sell their land to moneylenders, who are in many cases the richer farmers.

Impacts on domestic water supplies. Overexploitation of groundwater for irrigation has lowered water tables in aquifers that are also sources of urban water supply. This has led to a reduction in supply, particularly, in peak summer and periods of drought. Collecting water takes more time and involves carrying water longer distances. In some extreme cases, competition between agricultural and urban users is leading to complete failure of the village water supply. In these cases, villagers sometimes have to use water sources that are not safe and suffer illness as a result. Illness usually represents both a loss of income and expenditure of medical treatment.

Crop failure or low market prices. If crops should fail for any reason (e.g. major interruption in electricity supply, wells running dry) or if there should be a steep fall in market prices of produce, farmers with large loans for borewell construction are extremely vulnerable. If they should fail to make repayments on loans, which typically have interest rates of 2% per month in the informal money market, they can easily spiral into indebtedness with little hope of recovery.

Falling groundwater levels. Falling groundwater levels in many areas have increased the risk of wells failing during periods of drought as there is no longer a groundwater reserve or buffer to maintain supply during dry seasons and droughts. It is often poor and marginal farmers that have borewells that are most likely to fail albeit temporarily during such periods.

Impact of intensive drainage line treatment. Intensive drainage line treatment as part of watershed development and other programmes can impact on the pattern of recharge. The net result is that, in semi-arid areas, some borewell owners can see the yields of their borewells increase but others (usually located downstream) see their borewells become less productive.

Reduction in informal water vending. Informal markets for groundwater have emerged in recent years in many parts of southern India, as farmers with access to surplus supplies sell water to adjacent farmers who either lacked the financial resources to dig their own wells or had insufficient supplies in the wells they did own. Now as well yields decline, water markets are becoming less common as well owners keep all available supplies for their own use.

to the consolidation of power relations within communities (Janakarajan and Moench, 2002). The water audits have helped identify a number of mechanisms or processes that link groundwater over-exploitation to poverty.

Main 'water resource' lesson. In semi-arid areas, the emphasis of watershed development programmes should shift from resource augmentation to resource management at all levels.

Impacts of watershed development on the poor

The water audits showed clearly that, even under conditions of sustainable water use, watershed development activities and increased groundwater extraction for irrigation are having major impacts on the pattern of water use and access. In many cases, this has resulted in distinct winners and losers. The impact of intensive treatment of drainage lines is of particular concern as this is contributing to a major reduction in the utility of traditional tank systems (Singh *et al.*, 2003). From the irrigation perspective, changed patterns of water use during the last 10–20 years have, in general, been positive, not least because increase in irrigated area and associated agricultural intensification have benefited many poor and marginal farmers as well as relatively richer farmers. However, if the non-irrigation uses of tanks are considered, it becomes obvious that the 'irrigation' benefits have come at a social and economic cost. During the last 10–20 years, the utility of many tanks has declined for activities such as washing, bathing, watering livestock and pisciculture. It is clear also that, in extreme cases, reduced tank inflows are having a negative impact on domestic water supplies, especially where tanks are an important source of recharge of aquifers used for urban supply. And domestic water shortages invariably have a greater impact on the poor and, in particular poor women and children.

Main 'poverty' lesson. Information from the audit should inform decision-making at all levels. This information can be used to assess the negative trade-offs associated with particular activities and to target and sequence interventions so as to maximise benefits and minimise potential for the capture of these benefits by elites.

Watershed development and rural water supplies

The KAWAD and APRLP water audits showed that, in the projects areas, competition for water resources between agricultural and urban water users is getting progressively worse as demand for both uses increases, and as surface and ground water resources become increasingly depleted. The water audits also showed that, as the competition for water increases, the reliability of domestic water supplies in terms of both quantity and quality declines. Almost invariably, the poorer social groups suffer most, as their access to safe water supplies is limited. As water-related social exclusion is commonplace, particularly in the areas where the APRLP is operating, poorer groups often have fewer options for alternative supply when their main source of domestic water fails.

Main "rural water supply" lesson. Better integration and planning of watershed development and rural water supply programmes is needed urgently. Identifying and managing water resources to meet basic human needs, especially during peak summer, should be given a higher priority than is currently the case. Ideally, such integration and convergence should take place within an integrated water resources management framework (GWP, 2000).

Evaluation of watershed development programmes

Many assessments of watershed development programmes rely on crude indicators and take little account of issues of variability, scale and the potential negative trade-offs associated with certain activities. As a consequence, certain approaches to water development have gained credibility and acceptability on the back of flawed assessments. For example, change in groundwater level in a single well is an extremely crude indicator as it provides no information on, say, the extent of a rise or fall in groundwater level or the balance between recharge and extraction. Information on changes in access and entitlements to water, changes in the time taken by women and children to fetch and carry water, changes in the number of villages requiring tankers or with water markets, changes in irrigated cropping intensity and so on, provides more compelling evidence as to whether or not a programme is successful. However, the groundwater level (as measured by single wells), numbers of structures and lengths of bunding are more commonly presented as indicators of success.

Main 'M&E' lesson. When considered in detail at a range of scales, many assessments of watershed development programmes produce findings and recommendations that are often incorrect. When negative trade-offs are taken into account, watershed development has either no significant water-related impact or has a negative water-related impact on the livelihoods of poorer social groups and, in particular, poor women and children.

Water-related myths

The KAWAD and APRLP audits have shown that water-related policy development and decision-making at all levels is often based on water-related statistics that are either wrong or out of date. The audits have also shown that there are a number of water-related myths that have an extremely high level of acceptance within the watershed

Box 2. Water-related myths

Water-related myths that were encountered frequently during the water audits included:

Water harvesting is a totally benign technology. Although water-harvesting technologies can produce huge benefits, intensive drainage line treatment can significantly reduce water resources availability to "downstream" communities particularly in years with low rainfall. In some cases, this negative trade-off may not matter, but in others severe hardship can result.

Planting trees increases local rainfall and runoff. The reality is that forests exert a small, almost insignificant influence on local rainfall and, notwithstanding a small number of exceptions, catchment experiments generally indicate reduced runoff from forested areas as compared to those under shorter vegetation (Calder, 1999).

Runoff in semi-arid areas is 30-40% of annual rainfall. Although localised runoff and runoff from individual storms can be high, annual runoff in semi-arid areas at the micro-watershed scale (or greater) tends to be less than 10% of annual rainfall.

Rainfall has decreased in recent years. With few exceptions, studies of long-term rainfall data (from a single set of rain gauges) have not shown significant decrease (or increase) in mean annual rainfall.

Aquifer are underground lakes. The reality is that check dams and other water-harvesting structures usually only have localised impacts on groundwater levels and aquifers rarely behave like underground lakes (i.e. localised recharge in semi-arid areas does not lead to an immediate rise in groundwater levels many kilometres away).

Water use of crops depends mainly on crop type. A common misconception is that the daily water use of crops is directly related to the crop type and that evaporation rates are many times higher from some crops as compared to others. The reality is that, assuming that a crop is well supplied by water and has a full canopy (i.e. the crop completely shades the ground), the daily rate of evaporation is driven primarily by the meteorological conditions (e.g. radiation, wind speed, dryness of the air).

Aquifers once depleted stay depleted. A pessimistic view of aquifer depletion is that it is an irreversible process. The reality is that, in most cases, aquifers can be re-established or replenished as long as the balance between recharge and extraction is swung towards recharge. This can occur as a result of increased recharge, decreased extraction or both.

development programmes (see Box 2). These myths appear frequently in political speeches, in the press and in watershed development publicity such as wall paintings and street plays.

'Water-related myths' lesson. Decision-making based on poor statistics and water-related myths can lead to a waste of human and financial resources, insignificant or even negative impacts on target groups and unsustainable development of natural resources.

Uptake and implementation of water audit findings by KAWAD

Discussions involving many KAWAD stakeholders led to the preparation of a plan for the establishment of 11 demonstration/pilot villages and hamlets in the KAWAD project areas. The long-term objective of the demonstration/pilot villages is to demonstrate and assess some of the more innovative options listed in the KAWAD Water Resource Audit Report (Batchelor *et al*., 2000) and, in particular, options related to improving the **management** of water in and around village areas and safeguarding domestic water supplies during dry seasons and periods of drought. To date, the focus of the initiative has been on raising awareness, participatory planning and agreeing budgets. There have been delays, in part because KAWAD NGO staff have been extremely busy on more traditional watershed development activities. However, it is now expected that work on the ground will commence in all villages during the next six months.

Despite the active involvement in the water audit of key decision-makers of the project, implementation of the findings and recommendations has been slow. Reasons for this include:

(1) It is difficult for a project to change direction once budgets, schedules and contracts have been agreed.
(2) As some findings challenge accepted wisdom, making even small changes to procedures and practices requires a leap of faith.

Raising awareness and promoting ownership of findings and recommendations at the NGO level has also been a challenge, not least because traditional watershed development projects in semi-arid areas do bring benefits to many households (see Box 3). At the NGO level, the tendency is to believe that the positive aspects of watershed development greatly outweigh the less positive aspects. Arguably, traditional watershed development has become synonymous with the construction of check dams and other water harvesting structures. Soil and water conservation activities are seen as being benign, an initial step towards sustainable development and as a cost-effective means of disbursing substantial amounts of funding. Promoting better water management, conflict resolution and other water-related demand management activities, in contrast, are cheap and do not result in anything as tangible and obvious as construction of check dams and bunding.

Conclusions

The KAWAD and APRLP water audits have shown that, in the study areas, demand for water is outstripping supply and that scope for augmentation is limited. As important, the water audits have found no evidence to suggest that traditional watershed development activities have halted degradation of water resources or made villages less susceptible to the shock of drought. Intensive water harvesting has altered the spatial and temporal pattern of availability and access to surface and ground water resources. In many cases, this has brought about significant benefits but — in semi-arid areas in particular — these benefits often have significant negative trade-offs associated with them that are highest during years with low rainfall.

Although the water resource situation in the KAWAD project area is extremely serious, and arguably at crisis point for many villages, there is much that can be done. However, it cannot be stressed enough that there are no quick fixes to the complex challenges facing people in the project area. Policies and practices are needed that are based on accurate information, that seek long-term solutions

Box 3 Positive and less-positive aspects of "traditional" watershed development

Results from the water audits indicate that positive aspects of the ongoing watershed development programme include:

- Increases in net agricultural production on arable and non-arable lands;
- Development of village-level institutions;
- Substantial improvements in the livelihoods of some social groupings;
- Implementation of an approach that has widespread political and public support.

The less positive aspects of the programme in dryland areas include:

- Certain groups capture water resources often at the expense of the poor;
- New village-level institutions are usually outside government and, consequently, they often have a short lifespan and minimal political or legislative support for any actions or decisions that they might take;
- Protecting drinking water supplies is not seen as an integral part of watershed development;
- Emphasis is on development of water resources (i.e. on increasing water supplies by constructing check dams, rehabilitating tanks etc.) and not on management of water resources (i.e. on managing demand and on maximising the social and economic value of water).
- As planning takes place at the village-level, a whole range of wider issues are ignored (e.g. upstream-downstream equity, inter-village equity, flood protection, drought preparedness, pollution of water courses, biodiversity and protection of rare habitats).
- Watershed development publicity or propaganda (e.g. wall paintings, street plays etc.) is often misleading in that it suggests that there are quick fixes to water-related problems in semi-arid areas.

and that have a strong emphasis on promoting the management of water resources at all levels. It is quite clear that 'traditional' watershed development is not going to lead to sustainable or equitable development of natural resources in the KAWAD watersheds. Watershed development that is biased towards the management of water resources has long-term potential, if it is carried out in an appropriate policy environment and if a modified approach to watershed development receives widespread political and public support. Based on experiences to date, gaining the necessary level of support is not going to be easy. Not least because attitudes and behaviour are founded on a belief that the scope for augmenting water resources is unlimited, and on a range of state-level policies that have the unintended consequence of encouraging inefficient, unsustainable and inequitable use of water (e.g. grants for well construction, subsidised electricity for pumping irrigation water, support prices for paddy production).

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