iv. *Operational Management Framework.* An improved operational framework for planning watershed interventions needs to be developed. It is recommended that this framework is based on a process of stakeholder dialogue that incorporates tools and methodologies that assess the water resource and societal impacts of watershed interventions. The JSYS and KWDP projects in Karnataka already provide a platform for participatory planning but this, as in other watershed development projects, needs to be focused more towards water resource management.

3. **Improved assessment methodologies to determine societal impacts of watershed interventions:**
   Allocation Equity. It is recommended that any planned intervention which provides water retention in a closed catchment should be considered in the wider biophysical and socio-economic context. The decision is inevitably as much a political, in the sense that it must address state and national poverty alleviation strategies, as it is an engineering decision. It involves questions as to whether the future effective reallocation of water meets basic human needs and is equitable. For example, provision of greater water retention in headwater areas may be to the advantage of local people (perhaps often previously disadvantaged scheduled castes who are living on the poorer lands in headwater areas) but this gain in water availability would be at the expense of often the richer farmers, lower down the catchment, who would have been benefiting previously from this water.

4. **New 'green water' approaches need to be developed and piloted within watershed development projects**
   The effective closure of many Indian catchments requires a major shift in watershed development policy, away from the provision of further supply side measures and towards greater 'green water' demand management. New management systems will need to be developed and piloted that are more integrated and multi-scalar; these should take account of downstream externalities4, involve a process of stakeholder dialogue and are evidence-based. To raise awareness of these issues and to change attitudes will be a major task which will also require the provision of dissemination tools and mechanisms directed at all levels of management – from project management to the village level. Management systems need to encourage both sustainable green water use and improved conjunctive use of surface and groundwaters. Systems where green water use is sustainable (i.e. less than the rainfall and still allowing some agreed minimum blue water flow from the catchment) and where surface water is the predominant form of irrigation for average to high rainfall years, with groundwater use reserved for supplementary irrigation within the dry season and in low rainfall years, should not only mitigate many of the societal harms associated with present watershed developments, including the competitive 'chasing down' of water tables, but also avoid the high electricity costs of deep groundwater pumping.

Water-related timeline analysis (based on focus-group discussions in five villages) at Mustoor within the KWDP and JSYS study area.

Intervention	Before 1975	1975	Around 1985	Around 1995	1999-2005
Open wells	10-20 ft	10-50 ft	Some wells dry up in summer	Falling groundwater levels caused many openwells to fail or become defunct	Nearly all openwells defunct (except wells downstream of tanks)
Borewells	No borewells	No borewells	First borewells to a depth of around 250-300 ft	20-50 borewells to a depth of 500 ft	Around 350 borewells (depth 800 ft). More than 70% are defunct
Tanks	Full every other year, spill every 2-3 years	Full every other year, spill every 2-3 years	Full every other year, spill every 2-3 years	Full 1-2 years. Spill every 2-3 years. Last observed Bairekur tank spill in 1995	Spill from all tanks but Bairekur tank spill in 1999 and 2005. Almost no tank inflow in 2003 and 2004
Forest	Some forestry	Limited forestry	Limited forestry	Minimal forestry. Small amount of new horticulture	Minimal forestry. Small amount of new horticulture
Livestock	Large number of livestock	Reduced livestock numbers	Reduced livestock numbers	Reduced livestock numbers	Some increase in livestock numbers for dairying. Problem with fodder availability
Crops	Ragi, groundnut, paddy (Byruvadlu)	Ragi, groundnut, paddy	Ragi, groundnut, paddy (Byruvadlu)	Ragi, silk, tomato	Ragi, tomato, groundnut and very little silk
Health	Healthier than 2005	Healthier than 2005	Average	Average	Lot of diseases but treatments are available. Unlike in previous years

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forests & water

Recommendations for Improved Watershed Development

Forest and Water Policy – Improving outcomes

FAWPIO-INDIA Policy Brief

FRP FORESTRY RESEARCH PROGRAMME

FAWPIO

Based on research conducted on the World Bank and DFID supported JSYS, KWDP and KAWAD watershed development projects.

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Problem

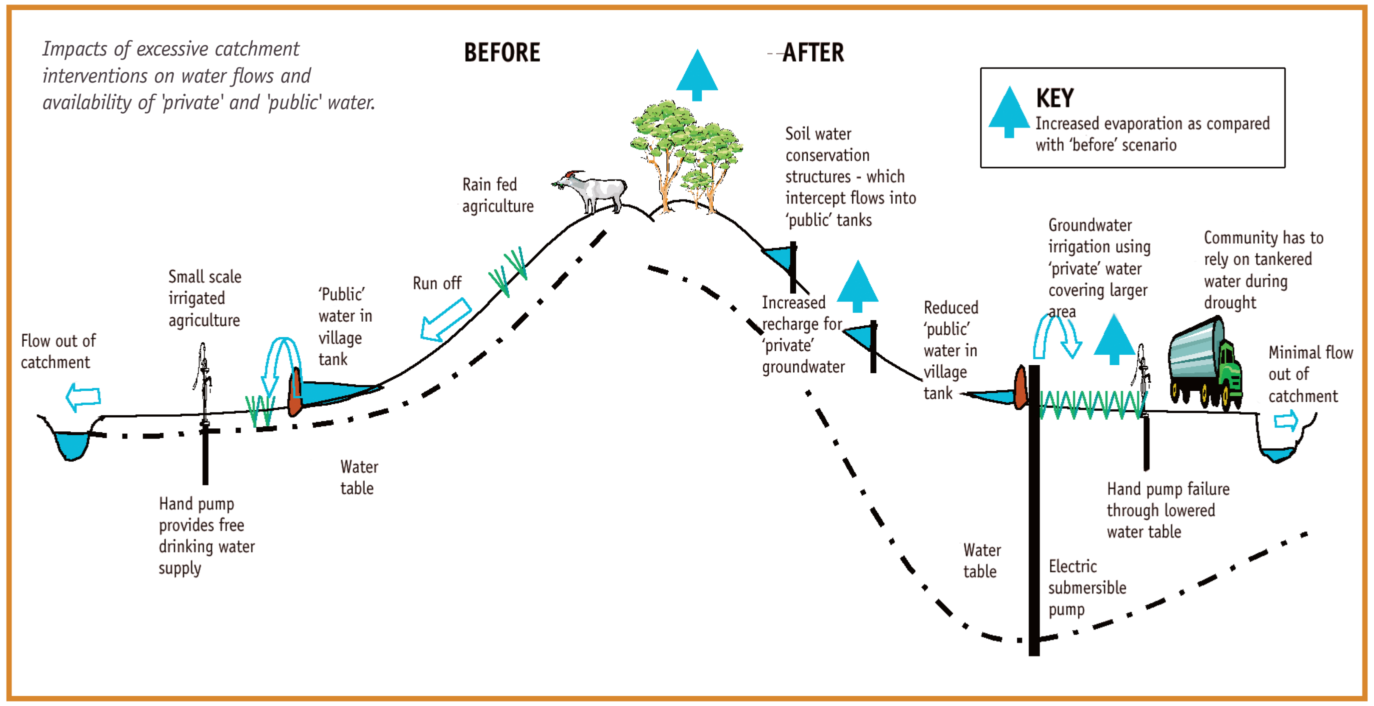
The cluster of projects dealing with land and water issues funded under DFID's Forestry Research Programme suggest[1,2] that erroneous views about land and water management may be leading to ineffective or counterproductive outcomes from watershed development projects.

In particular, excessive promotion of forestry, irrigation and soil-water conservation measures, without due regard to water resource constraints, can lead to many perverse and inequitable outcomes:

- Catchment closure, when no water is released from a catchment except in high rainfall years, causes damage to the environment and downstream users (many river basins in southern India including the Krishna and Cauvery are now approaching closure);
- Reduced availability of 'public' water in communal village reservoirs (known as tanks) but increased availability of 'private' water for farmers with access to deep groundwater through boreholes;
- Excessive lowering of water tables which threaten traditional village water supplies, both through reduced availability and reduced water quality (increased levels of arsenic and fluoride contamination are associated with deep groundwater extraction)[3];
- Boom-and-bust cycles in agricultural production, which cause extreme hardship and have been attributed as the cause of many farmer suicides when farmers become indebted in 'chasing down' the water table;
- Huge costs; due to electric power generation for pumping groundwater from ever greater depths (some estimates are that some two-thirds of all electricity generated in some southern Indian states is used for pumping groundwater).

Water-related myths

- Planting trees increases local rainfall and runoff
- Water harvesting is totally benign
- Runoff in semi-arid areas is 30–40% of annual rainfall
- Decreased rainfall, rather than catchment interventions, is the principal cause of reduced catchment flows
- Watershed development programmes drought-proof villages and protect village water supplies



Basis of recommendations

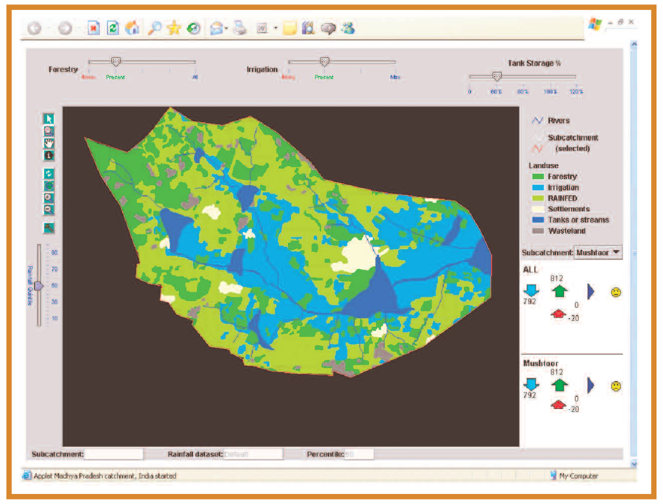
Studies conducted by the FAWPIO-India project in conjunction with World Bank and DFID watershed development projects in Karnataka indicate that a major revision of watershed management policy may be required by government – particularly in relation to the planning of structural interventions. This is because over the past 10 to 15 years agriculture intensification has reduced flows of water into water reservoirs (known as tanks in India). Field levelling, field bund construction, the increase in areas under horticulture and forestry and the increased abstraction and use of groundwater for irrigation are all contributing factors to reduced flows. Planning methods and approaches, which may have been appropriate 20 years ago, are not appropriate today.

New planning methods are required which take account of these reduced flows. These methods also need to ensure that basic human needs are given priority (e.g. domestic water supplies) and equitable allocation of water so that the poorest people are not disadvantaged and that environmental flows are maintained to support the river system.

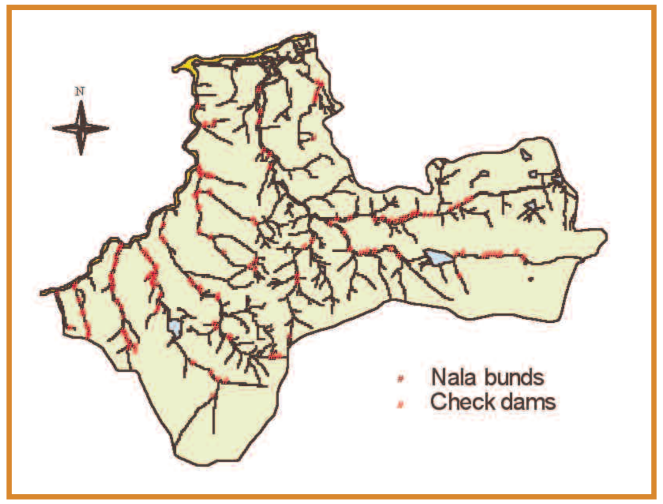
Recommendations

1. **Bridging Research and Policy.** A gap exists between the knowledge and understanding of specialists and policy makers. We need to bridge this gap and raise awareness of the technical issues and constraints involved in watershed management, including:
   i. Challenging the conventional wisdom that water scarcity can be solved simply by increased tank or soil water conservation interventions. Water retention interventions should be considered only within a broader, integrated approach to land and water management which takes account of downstream externalities[4].
   ii. Promoting awareness that major river basins such as the Krishna and Cauvery are approaching closure (essentially there are now no annual outflows except in high rainfall years).
   iii. Raising awareness that creating additional water storage capacity or promoting further agricultural intensification or tank rehabilitation and deepening wells in a closed basin will provide only local water benefits often to a small number of households at the expense of the wider community, downstream users and the environment.

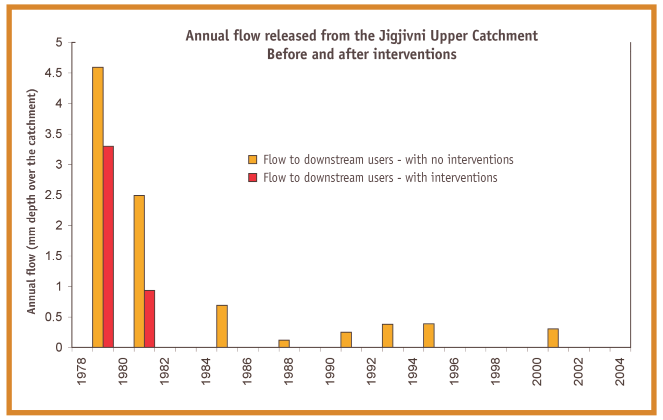
2. **Improved framework for watershed management including methodologies to determine water resource impacts of watershed interventions:**
   i. The connection between land use in the catchment and inflows into tanks indicates that traditional methods for estimating tank inflows may now need to be reviewed and revised. Where these empirical methods, which were calibrated at a time when no borehole-derived irrigation was present in the catchment and water tables were high, are applied under present conditions (when there is essentially no groundwater flow to tanks), the methods may overestimate tank inflows.
   ii. Assessing the changes in tank inflows that will occur as a result of decreased water tables will also require modifications to process-based methods such as the Soil Water Assessment Tool (SWAT) or Hydrological Land Use Change (HYLUC) model, so that they can then be used to recalibrate more empirical engineering methods.
   iii. *Minimum flow requirement.* Together with the political and socio-economic questions influencing the choice of which tanks should be prioritised for rehabilitation there remains the question of which catchments may already be 'over-engineered' in terms of tanks and soil water conservation measures. The modelling methodologies outlined above will enable users to calculate the number of interventions that could be allowed before any minimum flow requirement from the catchment is breached.



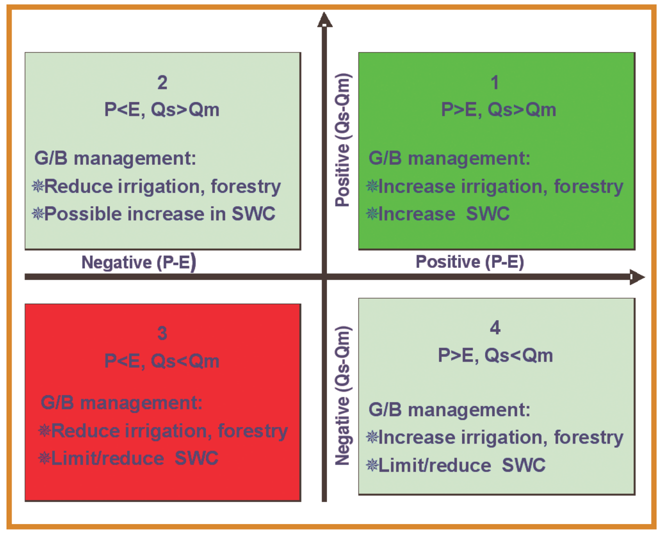
Example of the HYLUC-based EXCLAIM tool applied to the Mustoor Catchment, within the KWDP and JSYS project area, showing 'present case' scenarios of areas under tree crops, irrigation, and tank storage for a median rainfall scenario. In this scenario EXCLAIIM shows that net groundwater recharge is negative (red arrow) and surface flows out of the Bairekur tank (last tank in cascade) are zero. Total blue water flows (Surface plus groundwater) from the catchment are negative.



High density of soil water conservation structures located in one of the catchments of the KAWAD project.



The HYLUC-Cascade model shows that soil water conservation structures on the Inchigeri, KAWAD watershed will reduce flows severely to the Inchigeri tank and limit the availability of water to downstream users.



The 'Quadrant' approach can be used to identify green and blue water management options and whether benefits would be derived from further soil water conservation measures and water retention structures. Notes: E and P represent average annual evaporation and precipitation respectively. Qs and Qm represent actual and agreed minimum flows respectively. Quadrant 1 exhibits benefits from further soil water conservation (SWC) measures; quadrant 3 and 4 exhibit no benefits; quadrant 2 shows local benefits but at the expense of downstream users. Using Green and Blue water terminology, E represents green water flows from a catchment and Qs represents blue water flows.