MANUVIKASA

Hanns Seidel Foundation India

# APPROACH PAPER

# ON

# PERSPECTIVES ON INTEGRATED WATERSHED MANAGEMENT IN THE AGHANASHINI, THE VARADA, AND THE BEDTHI/GANGAVALI RIVER WATERSHEDS IN UTTARA KANNADA, KARNATAKA

Submitted to

**MANUVIKASA, KARJAGI**
&
**HANNS SEIDEL FOUNDATION INDIA**


Submitted by

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**UNIVERSITY OF AGRICULTURAL SCIENCES, DHARWAD**
**SIRSI 581 401**

**2021**

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## ABOUT HANNS SEIDEL FOUNDATION INDIA

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## ABOUT MANUVIKASA

Manuvikasa is a non-governmental, non-political, voluntary organization committed for the advancement of education, environment and rural folk. It was registered in the year 2003 and working in Uttara Kannada, Dakshina Kannada, Shimoga, Haveri, Dharwad and Davanageri districts of Karnataka, India. The organization is addressing the issues such as alleviation of poverty, awareness activities on different social problems; water conservation, publicize human rights and child rights, employment creation, proper management of natural resource and various other issues for rural development. An assessment study has been conducted to evaluate the different water harvesting systems adopted for improving groundwater recharge and associated benefits for the farming community in Uttara Kannada, Shimoga, Haveri, and Dharwad where Manuvikasa has created rain water harvesting structures in different eco-regions.

## EXECUTIVE SUMMARY

The concept of watershed administration has existed since the Vedic period. Typically, watershed management is a resource management process with the watershed area as the fundamental organizational unit. This includes socio-economic, human-institutional, and biophysical inter-relationships among soil, water, and land as well as the association between upland and downstream regions. As predicted by the '2030 Water Resource Group', India may face up to 50 per cent water shortage for domestic use by the year 2030 which is termed as the 'Water Gap'. Further, eminent changes in pattern and intensity of rainfall and glacial melt due to the changing global climate can potentially alter river flows, groundwater recharge, and saltwater intrusion in coastal aquifers, leading to severe drought, intense floods, and several other water quality-related issues. Because of this, the country's agriculture, food security, livelihood and public health are at stake.

In this context, this Approach Paper focuses on the integrated water resource management of two west-flowing rivers *viz*. the Aghanashini and the Bedthi/Gangavali and one east-flowing tributary of Tungabhadra *i.e.,* the Varada, all of them originating in the Central Western Ghats of Karnataka. While the paper draws substantially on secondary data, it does rely on the primary data collected through a structured survey on the people's perception of water resources and its administration. The contrasting basin-level patterns of geo-morphology, the land use type, soil type, *etc*., of three river basins, is considered in the light of issues of local water resource management, common to all the three basins. It flags key issues at the basin level and the local level and attempts to provide science-based and perception-based solutions.

A total of 451 households were interviewed from different river watersheds. Each interview took around 60-80 minutes for collection of data. Hence a total of 451-600 hours of actual interview time has been invested apart from the group discussion. As per the current study, the average age of famers was 52.7 years in the Bedthi, 50.82 years in the Aghanashini, and 48.8 years in the Varada watershed areas. The household size was slightly higher in the Aghanashini watershed (3.97) and among household size, coastal zone was slightly higher (3.93) than the other two zones. The sex ratio-the proportion of males relative to females in a population-among the farming communities exhibited remarkable male bias (1.38), larger than the national average (1.08). Interestingly, about 25 per cent of the agricultural households were headed by women; while it was 12% and 11% across plains and hilly zone. In nearly one third of the agricultural households, the head of family was illiterate; and in about half of the households the education level did not go beyond primary education. Only about five per cent of them were educated up to college level.

Overall, the mean farm size was 1.86 acre per household, of which 1.78 acre was actually cultivated with only 0.19 acres under assured irrigation. In the Varada watershed area, only 20.66 per cent of farms possess more than one irrigation source. Nearly to half *i.e.,* 43.79 per cent of farms of the Aghanashini watershed have at least one more source of irrigation.

The majority of the farm households reported that vagaries of the weather (75.11%) and poor groundwater availability (20.73%) as the major constraints for crop production. Further, 90 percent of them disagreed to continue agriculture without any water conservation measures (of the 52% strongly disagreeing) suggesting a strong willingness among the farming community to adopt water conservation measures. Nearly two-thirds of the interviewed farmers held the view that lake/tank rejuvenation can greatly help improve the water resources and applying tank silt to farmlands can improve yields. Unfortunately, nearly two-thirds of the farmers opined that no lake rejuvenation was undertaken in the past decade. There is an urgent need for undertaking large-scale tank rejuvenation in these watersheds. To improve water resources, nearly 44 percent of farmers wanted a government scheme and about 16 percent wanted more loan facilities. About 10 to 11 percent of the farmers suggested improving technical knowledge through training, provision of better farm equipment and marketing channels for their produce.

The Aghanashini, the Varada and the Bedthi/Gangavali which runs through different agro-climatic zones, each characterized by several unique watershed features, edaphic factors and with thousands of discrete non-exclusive local water management bodies. Two pertinent issues, jointly related to the Aghanashini and the Bedthi-Varada watersheds that need to be addressed adopting the rational planning relate to water harvesting structures in *betta*-lands and another relate to the Bedthi-Varada River linking. These issues are larger and may have overarching influence on water resource management in these watersheds. Further, the effectiveness of such watershed level plans is greater if integrated with local water management efforts and activities. So far, there are no major impact assessments done by an independent agency on the Bedthi-Varada River linking. Altered flow patterns may also cause riparian zone degradation and create habitats for invasive species.

Renovation and modernization of tanks and other local water resources are to be considered as priority task since there are over 4000 lakes in these watershed areas combined. The programme needs to be planned and implemented on a watershed basis, taking into account the comparative techno-economic feasibility of renovating existing tanks *vis-à-vis* construction of supplementary tanks, upstream and downstream. Tank rejuvenation is highly relevant for improving livelihoods and alleviating poverty in drought-prone regions

**Key Action Points to be addressed:**

1. Each watershed area could be categorized into different zones to ease the process of planning and implementation. These include: ecological function zones (protection zone vs. production zone vs. aesthetic zone); zones based on bio-climate (into hilly, coastal and plains); land-use functional zoning (dry vs. irrigated lands; Black vs. Red soil zones).
2. Considering an ecological approach, care should be taken not to alter the ecological flow in the Aghanashini and the Bedthi/Gangavali watersheds since both systems are lifeline to the valuable biological diversity of the Western Ghats and there is a deep dependency of people for their livelihood.
3. Better hydrological, water quality and groundwater monitoring and data assurance to enable better planning and management. Improving and sharing data/knowledge about climate variability in watersheds.
4. Since the Aghanashini River is one of the most un-polluted/un-damned/free flowing river system, it should be recognized as a Sacred Waterscape of South India and be developed on par with River Ganga. Encouraging eco-tourism is advisable.
5. The urban population and industrial development are growing rapidly causing increasing water demands and degrading water quality in the the Bedthi. Measures to control pollution

of the Bedthi River from increasing industry/population of twin cities of Hubli/Dharwad should be implemented.

6. Addressing inequitable water availability and water security in the Varada watershed is very essential. Regulation of lift irrigation projects and sand mining in all the basins, especially in the Varada River watershed needs special attention.
7. Sharp decline in Bivalve's production in the brackish water of the Aghanashini and the Bedthi river has jeopardized the livelihood of thousands of fisherman community and endangered the nutrition security. There is an urgent need to completely regulate the harvest and bring-in a community-owned-sustainable-harvesting system on the lines of Ashtamudi model.
8. Tank rejuvenation is highly relevant for improving livelihoods and alleviating poverty in drought-prone regions. Tanks restore the ecological balance between surface and groundwater resources. Collective action is possible in resource management, provided there are incentives for cooperation.
9. Based on the successful results of this massive joint effort of Manuvikasa and other agency and also with the participatory approach of the local people in the measures of harnessing, recharging and maintaining the quality of water and water bodies could be taken up as pivotal project in other areas of the district on a wider scale.
10. Science-based identification of newer locations for establishment of lakes should be encouraged. Further, if establishing a new tank or lake is difficult and if the costs are too inhibitive, tank locations for augmenting ground water recharge could be considered.
11. Tank rejuvenation which has been started purely as a physical rehabilitation to increase agricultural productivity should in future focus on institutional strengthening and poverty alleviation.
12. In drier districts where chain series of tanks are dominant, the integral holistic unit is the sub-basin of a river system, Water Users' Association (WUAs) are to be formed for each tank and federated at the sub-basin level. (*Kere Abhivraddi* Federation).
13. The rehabilitation budget should be allocated in the ratio of 10%, 75%, and 15% to institutional development, physical works and maintenance, respectively. A one-time investment of 15% for maintenance and management activity will be allocated from the rehabilitation funds and this amount will be deposited in a bank.
14. Setting up an expert appraisal committee to advice on various issues arising from time to time could be a viable option for long term impact.

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"One should take proper managerial action to use and conserve water from mountains, wells, rivers and also rainwater for use in drinking, agriculture, industries"

*-The Atharva Veda verse 19, 2.1*
*(800 BC)*

"……The best of all things is WATER"

*-Greek Philosopher Pindar*

"We plan, GOD laughs."

*–Old Yiddish Proverb*

## INTRODUCTION

### Watershed

A watershed is the geographic area of the land that drains all the streams, rivers, wetland, or lakes to a common outlet or any point along the stream channel. Spatially, watersheds can vary from thousands of square kilometers in dimension to a tiny region drained by a rivulet. Apart from being a hydrological unit, it can be considered as an all-encompassing environment in terms of the resources, materials, and energy that stream through it. They play a crucial role in determining food, social and economic security and provide life support services to people who inhabit its geographic area. Specialists consider a watershed as a basic building block for land and water planning as well as a socio-economic-political unit for management planning and execution. The phrase 'Catchment' is generally used synonymously with 'Watershed'.

### Watershed Management

Watershed management can broadly be defined as ''the study of the relevant characteristics of a watershed aimed at the sustainable distribution of its resources and the process of creating and implementing plans, programs, and projects to sustain and enhance watershed function that affects the plant, animal, and human communities within a watershed boundary'' (California Department of Conservation, 2015).

Typically, watershed management is a resource management process with the watershed area as the fundamental organizational unit. This includes socio-economic, human-institutional, and biophysical inter-relationships among soil, water, and land as well as the association between upland and downstream regions (Folliott et al., 2002). It revolves around organizing and guiding land, water,

and other natural resources to supply goods and services, apart from focusing on moderating the effect on the soil and watershed resources. The extent and process of watershed management can vary greatly in its complexity, focus, execution, and controversy around it.

'Basin management' typically refers to macro-management at the level of the entire river watershed system, sometimes across state/country boundaries and with a major focus on geopolitical, institutional, and policy issues. From the implementation perspective, watershed management typically refers to management at the level of the "micro or sub-watershed.

**The historicity of Watershed Management**

The concept of watershed administration has existed for several centuries. Evidence dating to 800 BC, the Atharva Veda gives an account of the earliest composed reference to watershed administration. The Atharva Veda verse 19, 2.1 states that: ''one ought to take legitimate administrative activity to use and moderate water from mountains, wells, streams conjointly for utilizing in drinking, farming, industries'' (Chandra, 1990). Flood control planning and water supply activities initiated during the earliest civilizations such as the Indus valley in India and Yellow River valley of China, since 3000 to 5000 years ago, suggest that water resource management is an ancient problem. It is also believed that the Indus Civilization collapsed due to improper management of land and water resources. As early as the 15$^{th}$ century, the Vijayanagara dynasty in Karnataka, which existed on the river Tungabhadra, had extensive irrigation channels for rice fields.

**Integrated Water Resource Management (IWRM)**

During the 1990s, several water professionals/managers all over the world realized that the water problems had blown into multi-dimensional, multi-sectoral, and multi-regional issues. Further, it was increasingly felt that these social problems associated with water could be resolved only through appropriate multi-disciplinary, multi-institutional, and multi-stakeholder co-ordination. Through such advancement of water administration, integrated watershed management originated, and today it has attained more prominence in every country. Integrated water resource management has been built on foundational standards of watershed administration, to integrate different social, specialized, and institutional dimensions, as well as preservation, social, and economic objectives (German et al., 2007).

The United Nations Conference on Environment and Development (UNCED), in Rio de Janeiro, Brazil (1992), affirmed Agenda 21, which gives basic rules for sustainable development and practice ever since. Agenda 21's articulations on watershed administration issues, in Chapter 13 on

"Sustainable Mountain development", recommended integrated water resource development and strengthening the livelihood opportunities. Agenda 21 encourages the active participation of local stakeholders in natural resource management, economic growth, and social change. Following the World Summit on Sustainable Development (2002) - Rio Conference, increased participation of watershed management institutions in several global events such as International Years of Mountains (2002) and Freshwater Year (2003), *etc* was witnessed.

**The Water Gap**

As predicted by the '2030 Water Resource Group', India may face up to 50 per cent water shortage for domestic use by the year 2030 which is termed as the 'Water Gap' (Vijay Kumar and Bharat, 2014). Further, eminent changes in pattern and intensity of rainfall and glacial melt due to the changing global climate can potentially alter river flows, groundwater recharge, and saltwater intrusion in coastal aquifers, leading to severe drought, intense floods, and several other water quality-related issues. Because of this, the country's agriculture, food security, livelihood and public health are at stake.

In this context, this Approach Paper focuses on the integrated water resource management of two west-flowing rivers *viz*. the Aghanashini and the Bedthi and one east-flowing tributary of Tungabhadra *i.e.,* the Varada, all of them originating in the Central Western Ghats of Karnataka. While the paper draws substantially on secondary data, it does rely on the primary data collected through a structured survey on the people's perception of water resources and its administration. The contrasting basin-level patterns of geo-morphology, the land use type, soil type, *etc*., of three river basins, is considered in the light of issues of local water resource management, common to all the three basins. It flags key issues at the basin level and the local level and attempts to provide science-based and perception-based solutions.

## THE SETTING

Located between 11°30' North - 18°30' North latitudes and 74° East - 78°30' East longitudes, the state of Karnataka is the eighth biggest in terms of geographic area, the ninth-largest by population (https://en.wikipedia.org/wiki/ Geography_of_Karnataka). With a total geographic area of 1,91,976 km², it occupies about 5.83% of country's geographical area. Officially, it is partitioned into four divisions and 30 districts. The state is situated on the Deccan plateau bordered by the Western and Eastern Ghats ranges. Four physiographic features namely (i) the

Northern Karnataka Plateau, (ii) the Central Karnataka Plateau, (iii) the Southern Karnataka Plateau, and (iv) the Coastal Karnataka Region are recognized in the state.

There are twenty-six east-flowing rivers and ten west-flowing rivers joining Arabian Sea in Karnataka. The west-flowing rivers of Karnataka provide 60% of the state's inland water assets with only 24 per cent of drainage area amounting to almost 2000 TMC of water (http://www.karnataka.com/rivers/) primarily used for drinking, irrigation, and electricity generation, apart from ecological flow. Most of the rivers that originate in the Western Ghats generally flow and meets the Arabian Sea after a short run varying from 50 km to 300 km where they have relatively flat gradients and a mild flood plain (http://waterresources.kar.nic.in/river_systems.htm#map). While the westward rivers pass through steep hilly portion, most east-flowing rivers gradually meander towards east before meeting Bay of Bengal after passing through several states.

**The Aghanashini River Watershed**

The word 'Aghanashini' means 'Destroyer of Sins'. River Aghanashini draws its name from the village Aghanashini / also known as Tadadi situated on the river mouth on the north bank in the Kumta taluka of Uttar Kannada district, in the state of Karnataka.

Originating at Gadihalli, near Sirsi, the river has 117 km run path and joins the Arabian Sea near Kumta (Bhat, 2003). The streams, which join the Aghanashini River, are Kanasur *hole*, Soma *Nadi*, Benne *hole*, and Chandrika *Nadi*. The river traverses through the forested, agricultural landscape and covers a total catchment area of about 1350 sq. km. The Aghanashini river delta provides substantial livelihood opportunities to fishers and non-fishers through fish, bivalve, rice, and salt production (https://sandrp.in/2017/06/28/the-state-of-the-aghanashini-river-estuary/). It is regarded as one of the cleanest rivers of the country with no major city or industrial pollution being discharged into the river.

Aghanashini River has a catchment area of 1449 sq. km and elevation ranges between < 0 m and 786 m from mean sea level, and the slope of the catchment varies up to 119% (http://wgbis.ces.iisc.ernet.in/energy/water/pa). A very high slope is observed in the Ghats (Devimane Ghat). Because of the variations in the terrain along the water course, several aesthetically appealing waterfalls such as the Burude falls, Dabbe falls, Waate *halla*, Benne hole falls, Unchalli falls are formed (Ramachandra et al., 2015, Balachandran et al., 2012). There are no diversions to this river. However, a proposal to divert water to Bangalore was recently initiated.

Major soil type is lateritic throughout the watershed. Red soil and black soil are occasionally found. Rock types include Granite to Schists, Shale, Quartzite, and Phyllites. Major ore mines include Manganese, bauxite, iron, limestone, and quartz. Sand is mined all along the river.

Rainfall in the catchment is orographic (the Western Ghats hill range acting as an Orographic barrier) with annual rainfall varying spatially between 2500 mm at the Plains of Sirsi, to over 6300 mm at the Ghats (http:// wgbis.ces.iisc.ernet.in /energy/water/pa). The wind-word Western slopes receive heaviest rainfall than lee-ward eastern slopes. Water yield in the catchment is about 28-41 TMC. There is a declining trend with the changes in the land uses in the catchment (http://wgbis.ces.iisc.ernet.in/energy/water/pa).

As per the census of India data, the population in the watershed has increased from 2.21 lakhs in 2001 to 2.41 lakhs in 2011 with a density of 175 persons per square kilometer and a growth rate of 9.2% per decade (Census of India). Mostly the population is concentrated in towns such as Sirsi, Kumta, Yellapura and Siddapur. Major tribal and indigenous communities include Kumari Marati, Goudas, Konkanis, Havyaka Brahmin, Namadhari Naik, Goud Saraswat Brahmin, Nadavas, Kurubas, Siddis, Daivajna, Muslims, *etc.* (Chandran and Hughes, 2000, Wikipedia, Gazetteer of India-Uttara Kannada district). Between the 1970s to 2016, the forest cover has drastically reduced due to expansion of agriculture, developmental projects, increase in built-up area, *etc.,* The crops include varieties of Rice, Sugarcane, Banana, Arecanut, Coconut, Mango especially the wild aromatic pickled mango, spices, *etc*.

The Aghanashini River is the one free flowing, least-polluted rivers of the country with no diversion/dams resulting in highly productive estuary system with the rich diversity of fishes and bivalves. It is estimated that livelihood support offered by fishing and bivalves exceed over several crore rupees (Mahima et al., 2012; Boominathan et al., 2008) (http://wgbis.ces.iisc.ernet.in /biodiversity/database_new/).

**The Varada River Watershed**

The Varada River is a tributary of the river Tungabhadra in Karnataka. The Varada River originates from Varadamoola in the Western Ghats region of Shimoga district, Karnataka. The river flows eastward through the Uttar Kannada, Haveri, and Shimoga districts of Karnataka, covering an area of 5635.47 km$^2$ in Northern Karnataka. (14°6′ 25″ N to 15°7′ 10" N latitude and 74°52′ 6″ E to 75°43 10″ E longitude). It is not a perennial river, fed by small streams like the Dandavati, Dharma, Nallur, and the Dodda *halla*, and subsequently, the Varada joins the Tungabhadra River at Galaganath further north (https://doi.org/10.1007/s40899-018-0244-6). The Varada River positioned

at an altitudinal range between 507 m and 836 m above mean sea level, has a watershed area of 5135 sq. km.

The river meanders over a gentle slope flowing in the northeast direction encompassing over 4000 tanks, check dams, lift irrigation (slope of the catchment varies up to 119%). These tanks and check dams are an important part of watershed management that supports drinking water, ground water recharge, agriculture and inland pisciculture. Water yield in the catchment is 40 - 80 TMC.

The major soil type is either red or black throughout the watershed. Lateritic soil is occasionally found. Sand is mined all along the river. Annually, the rainfall varies from 660 mm (towards eastward region of Haveri) to over 3000 mm (towards hilly region of Shimoga).

As per the All-India Census data, about 1.2 million people live in this watershed with a density of 245 persons per square kilometer. Towns like Sagara, Haveri, Sorab, Shiggaon, Savanur, Hangal, Agasanahalli, Byadgi, *etc.* have major population concentration. Indigenous communities include Kumri Marati, Goudas, Konkanis, Havyaka Brahmin, Nadavas, Kurubas, Siddis, Daivajna, Muslims, Lingayaths, *etc.* (Chandran and Hughes 2000, Wikipedia, Gazetteer of India-Uttara Kannada district, Mysore Gazetteer).

Nearly 70 per cent of the watershed area is under agriculture (with Jowar, Cotton, Corn as major crops); about 15.4 per cent is covered by forests towards hilly zone. The Varada River watershed is known as Cradle of Rice Diversity (with over 500 indegenous varieties) which is also a hot spot for Pineapple, Mango and Ginger cultivation today. Serious reduction in forest area from 45.3 % to 34.5 % within 40 years (1973 to 2013) has resulted steep decline in ground water and creation of drought like situations.

**The Bedthi / Gangavali River Watershed**

This river system is known as Bedthi in the Upper Ghats/Plains and as Gangavalli in the coastal region. The watershed is spread across Uttara Kannada, Dharwad, Haveri districts of Karnataka. In terms of contrasting watershed features, water yield, perenniality, and the levels of pollution, they could very well be considered as two separate rivers. The total course of the river is 161 km long. The Bedthi is formed by the confluence of two streams, Bedthi and Shamala. Bedthi originates in Hubli tank and Shamala has its origin near Someshwara temple, south of Dharwad. Two joins near Kalghatgi and then, it is named Bedthi and it flows 25 km westwards and enters the Uttara Kannada district (Gazetteer of India).

The Bedthi after joining Shamala passes along the border Uttara Kannada - Dharwad for about eight km before flowing 96 km in the district. Small streams, which join Bedthi River, are

Mogadde *halla*, Sonda River, Bill *halla*, and Kulagi *halla*. But none of them are notable feeders. Vibuthi *hole*, Yenne *hole*, Shalmala nadi, Sonda *hole* feed Gangavali. The watershed area of Bedthi/Gangavali occurs in Dharwad, Haveri and Uttara Kannada district with a spread of 3935 sq. km and a range of elevation up to 834 m above mean sea level. As said earlier, the Eastern plain watershed area is much smooth while after Yellapura taluk the river coarse passes through several steep regions (up to 536.8% slope variation) forming waterfalls of Magod, Vibuthi, *etc*. Flat terrains in the plain land have led to the creation of a large number of lakes, check dams and bunds.

Red soil, lateritic soils, and black soil are found in substantial areas. Iron and Manganese ores are extracted apart from the sand. Eastern plains of the watershed receive an annual rainfall of about 900 mm in Dharwad while it may go up to 4400 mm in the Western Ghats resulting in 40 to 65 TMC water yield. Clearly, much of water yield comes from Ghats, while of the urban pollution is contributed from the eastern part. The census data indicates a population of 1.1 million with growth rate of 15.3% per decade (density of 277.5 persons/square kilometer). Cities and towns of the watershed with high population density include Hubli, Dharwad, Kalghatagi, Yellapura and Ankola. Major indigenous communities include Ambiga, Arer, Bandi, Bedar, Bandaris, Brahmins, Devadiga, Devalis, Gabit, Ganiga, Gouli, Gudikar, Harikanta, Hulsvara, Kahrvi, Vaishyas, Maratha, Kumri Maratha, Lingayath,, Maratha Kubri, Nadava, Namdharis, Pandits, Gidbudukis, Siddis, *etc.* (Chandran and Hughes 2000, Wikipedia, Gazetteer of India-Uttara Kannada district).

In the Eastern plains, sugarcane, corn, jowar, rice, groundnut, cotton and mango are grown. Arecanut based agriculture with Coconut and Banana is common in the hilly region. The Coast is predominantly rice grown. The forest cover in this region is about 32.16% (about 18.17% covered with evergreen species). The catchment is dominated by agriculture in the plains (34.89% of the total area).

## RESULTS OF THE SURVEY

### Sample size

To assess the socio-economic scenario and peoples' perspecptives about water resources, administration and climate change, a household survey was conducted adopting a well-structured questionnaire. A total of 451 households were interviewed from different river watersheds. Each interview took around 60-80 minutes for collection of data. Hence a total of 451-600 hours of actual interview time has been invested apart from the group discussion. All the households surveyed in the Aghanashini river (n=155) watershed belonged to "Hill agro-climatic zone"; while those from the

Varada River watershed were in "Plains agro-climatic zone". The watershed of the Bedthi / Gangavali included 50 households from Plains, 36 from Hilly zone and 87 households from the coastal zone. Hence, for the purpose of comparison of patterns among agro-climatic zones, only Bedthi/Gangavali watershed is considered (Fig. 1).

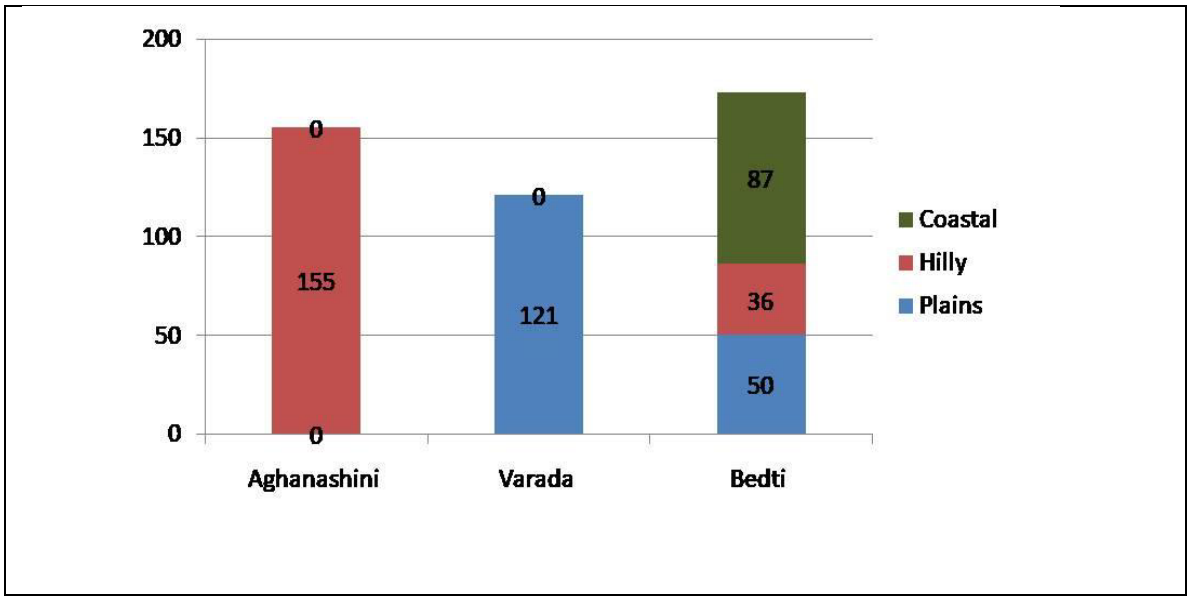


**Fig.1** Sample size (farming households) sampled across three bioclimatic zones of three river watershed areas in Northern Karnataka.

All HH of Aghanashini belonged to Hilly Zone, all HH in Varada were in Plains and Bedthi river watershed consisted of Plain, Hilly and Coastal zones

**Some Demographic and Social Profile of the Agricultural Household**

While much of the Indian population is young, the farmers are ageing. The mean age of an Indian farmer was estimated to be 50.1 years for the year 2011. As per the current study, the average age of famers was 52.7 years in the Bedthi, 50.82 years in the Aghanashini, and 48.8 years in the Varada watershed areas. Similarly, the farmers of the hilly zone are much older (56.65 years) than those in coastal or in plains (52.38 years and 50.46, respectively). Today, both middle-aged and young people are weaning away from agriculture, more so in the hilly zone. There might not be the next generation of farmers left in these watershed areas (Fig. 2). However, because of recent COVID conditions, young city dwelling entrepreneurs have started to return to agriculture as absentee land lords. It is estimated that in the last three years (2019-2021), at least 5000 acres of areca nut plantations have been established in and around Sirsi. This trend may translate into real reverse-

migration from city to villages. However, this trend appears to be fueled by increased demand and returns from areca nut cultivation.

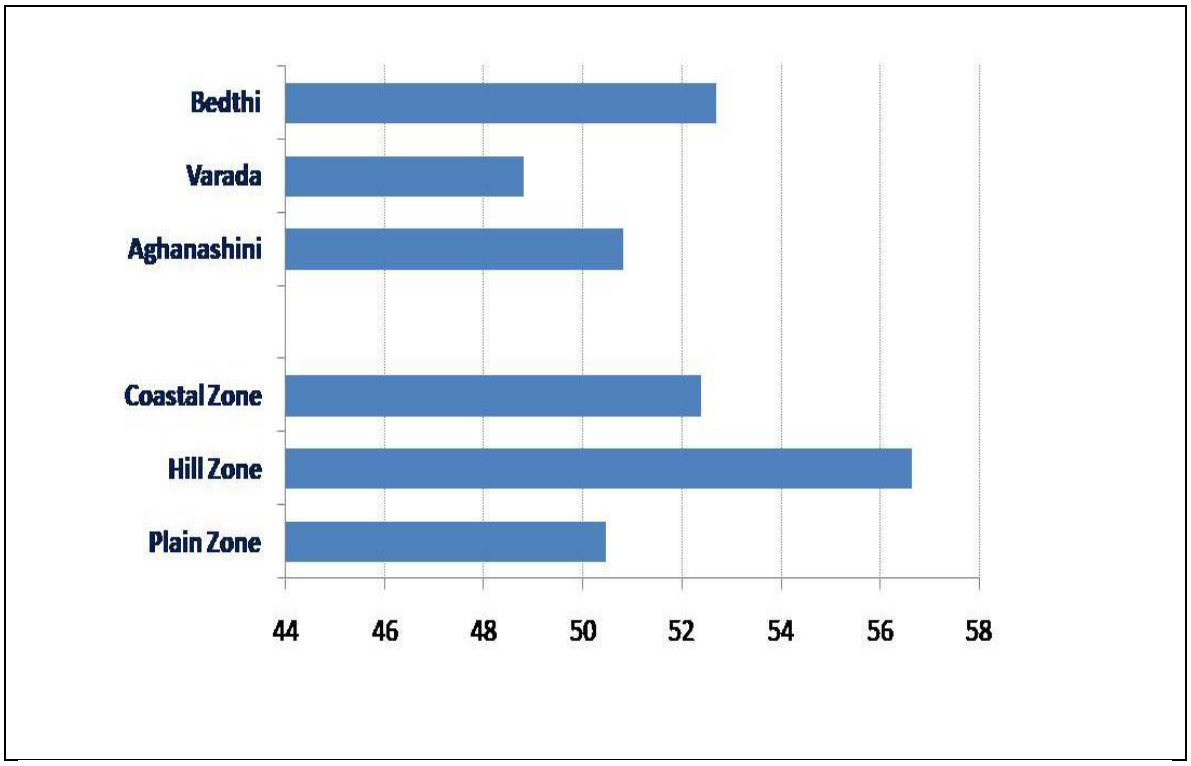


**Fig. 2.** Average age (years) of respondent farmers in three river watershed areas in Northern Karnataka and in three bioclimatic zones of Bedthi river watershed

The overall average agricultural household size is 3.91 members (Fig. 3). There was no much variation for the household size across three river basins and across three bioclimatic zones. However, household size was slightly higher in the Aghanashini watershed (3.97) and among household size, coastal zone was slightly higher (3.93) than the other two zones. The sex ratio-the proportion of males relative to females in a population-among the farming communities exhibited remarkable male bias (1.38), larger than the national average (1.08). While agrarian families of the Aghanashini watershed showed lower sex ratio (1.27), than those of the Bedthi watershed which had much higher male biased sex ratio (1.49). Similarly, in hilly zone of the Bedthi watershed, the sex ratio was strongly male biased (1.64) than from the coastal (1.44) or from Plains (1.48). The highest proportions of (17.3%) farm households were headed by women in the Bedthi watershed, followed by the Varada watershed area (15.7%) and the Aghanashini watershed area (4.6%). Interestingly, about 25 per cent of the agricultural households were headed by women; while it was 12% and 11% across plains and hilly zone (Fig. 4 and Fig. 5). This pattern of ownership may have deep cultural influence and larger social relevance in terms of decision making.

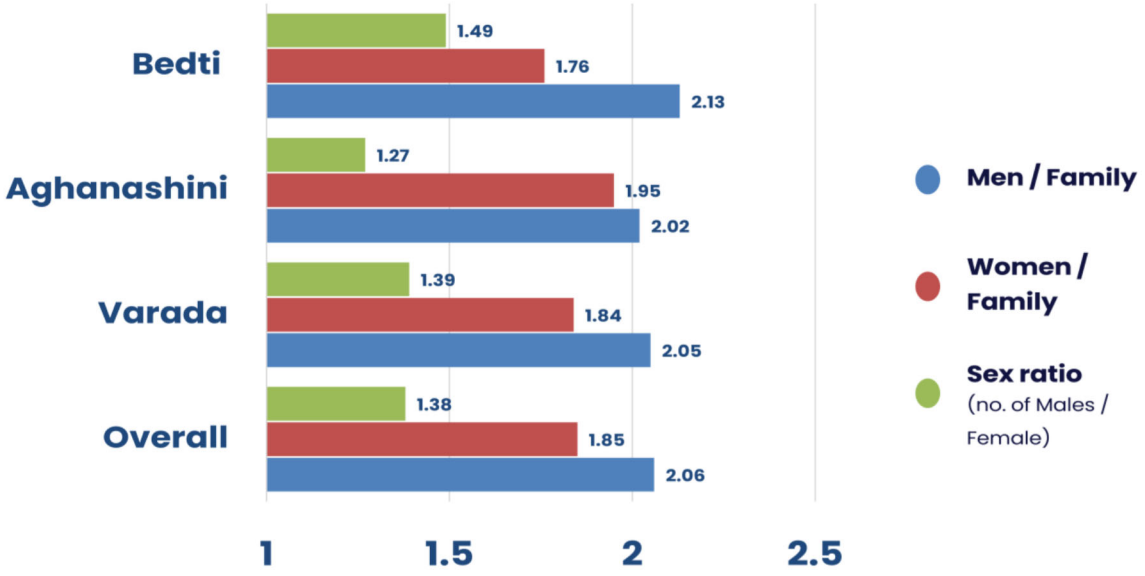


**Fig. 3.** Mean number of Men, Women and Mean Sex ratio in agrarian families across different river watershed areas in Northern Karnataka.

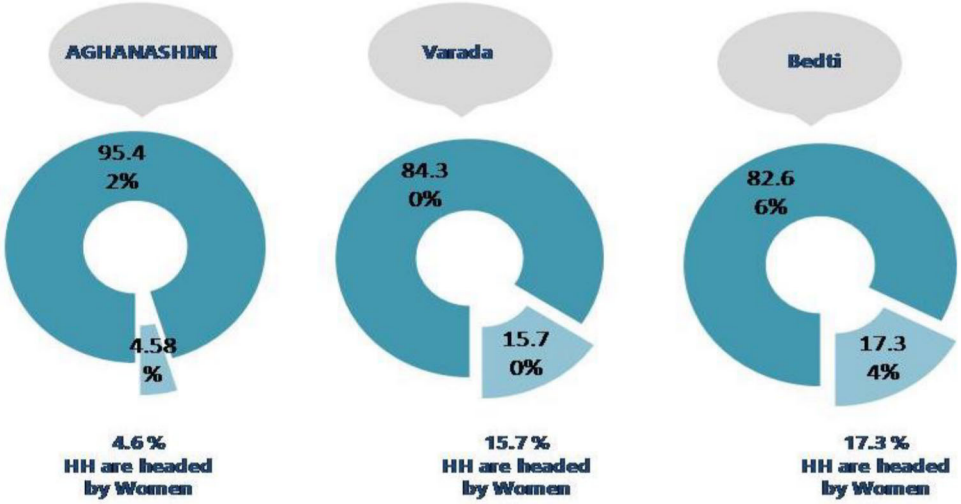


**Fig. 4.** Per cent Farmer households headed by Women in three river watershed areas of Northern Karnataka.

*Computed based on actual number of family members in agrarian families (HH= 450) of Varada, Aghanashini and Bedthi river watersheds clubbed over three bioclimatic zones*

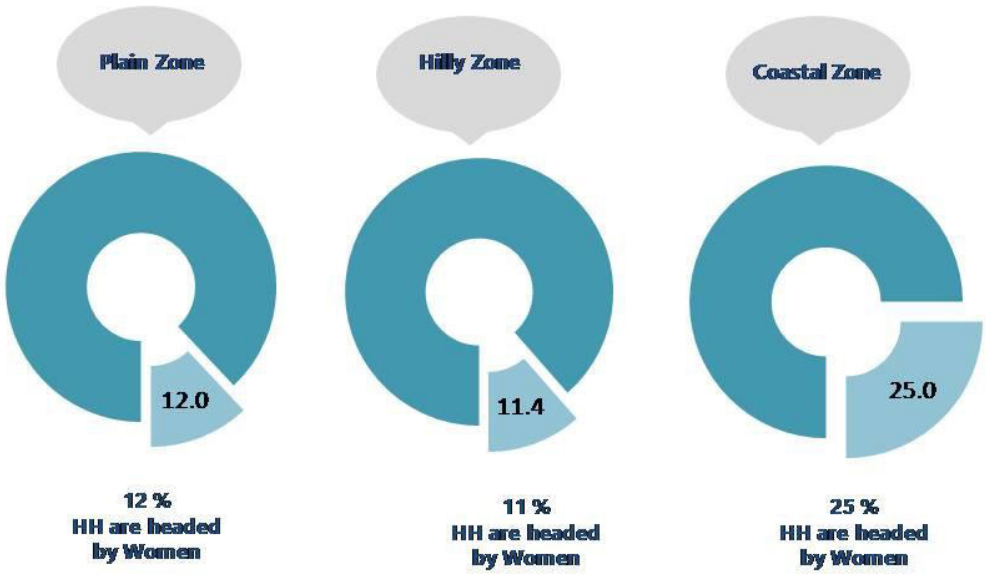


**Fig. 5.** Per cent Farmer households headed by Women in three bioclimatic zones of the Bedthi river watershed Northern Karnataka

In nearly one third of the agricultural households, the head of family was illiterate; and in about half of the households the education level did not go beyond primary education (Fig. 6). Only about five per cent of them were educated up to college level. Interestingly, there was a dichotomy in the level of education in the Bedthi River watershed (Fig. 7), which recorded both the highest per cent of illiteracy as well as highest percent of college educated head of the families (largely from coastal zone). Among Varada River watersheds, the literacy levels were highest (only 18.03% were illiterate).

**Land, Irrigation and Crops**

Overall, the mean farm size was 1.86 acre per household, of which 1.78 acre was actually cultivated with only 0.19 acres under assured irrigation (Fig. 8 and 9). Largest mean farm size was in the Varada River watershed (2.82 acre) with a mean cultivated area of 2.68 acre per household; however, the assured irrigation was lowest in this watershed (0.003 acres). The lowest mean farm size (1.31 acre) and cultivated area (1.29 acre) was found in the Aghanashini River watershed with 0.014 acres under assured irrigation. While highest mean area under assured irrigation (0.476 acre) was reported in the Bedthi with a mean farm of 1.68 acre and net cultivated area of 1.59 acre (largely in coastal region).

Coastal zone reported almost entire area under mean assured irrigation (0.91) with a mean farm size of 0.99 acre and mean cultivated area of 0.98 acre. All farms were rain fed in the hilly zone

with a sufficient rainfall. Plains comprised average farm size of 2.65 acres and mean cultivated area of 2.47 acre. The mean area under assured irrigation was reported to be 0.06 acre in Plain zone.

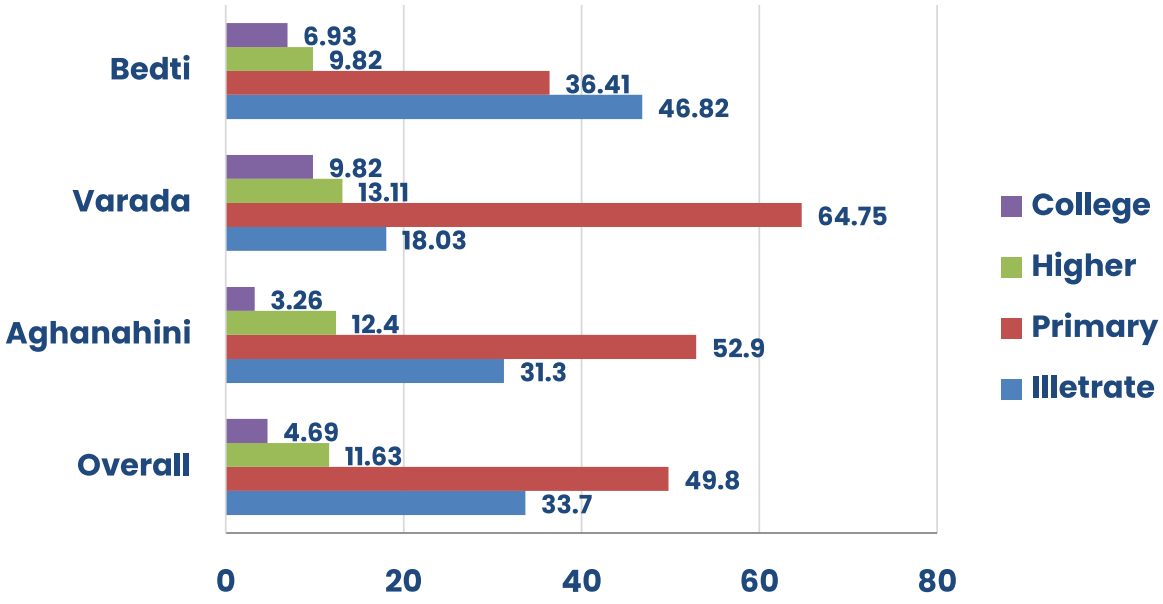


**Fig 6.**_Literacy Levels (Per cent)of Farmers across different river watershed areas in Northern Karnataka

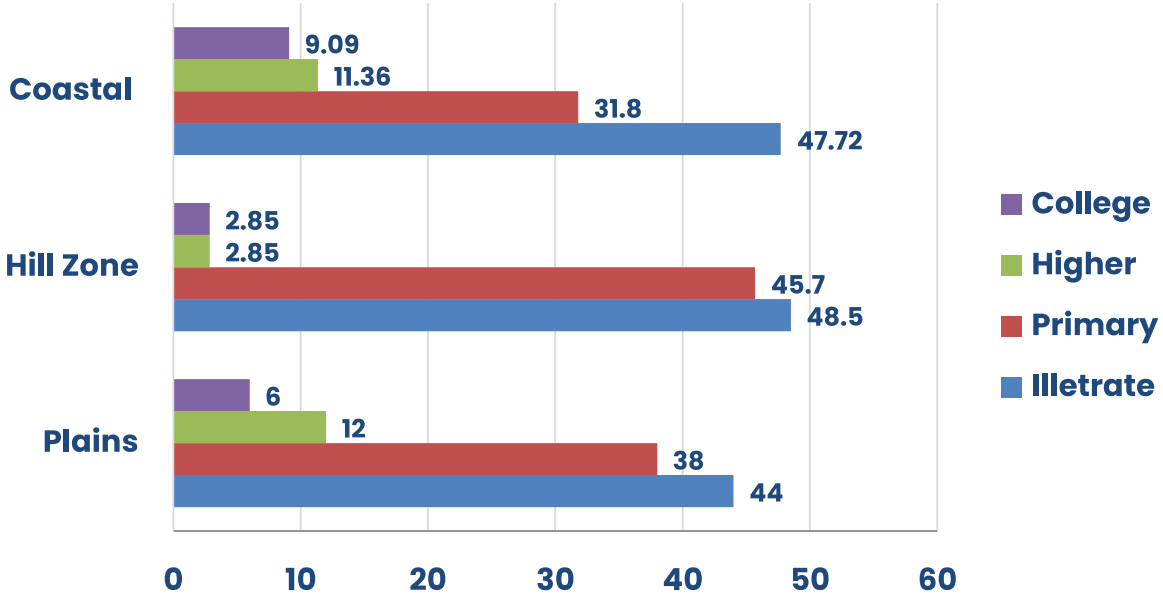


**Fig. 7** Literacy Levels (Per cent) of Farmers across different bioclimatic zones of the Bedthi river watershed

A little more than one third of watershed area of the Varada, the Aghanashini and the Bedthi practice dry land agriculture (43%, 37% and 31%, respectively). Horticulture crops were grown predominantly by the farmers of the Aghanashini (23% as pure garden crops plus 39% along with rainfed crops). In the Varada River watershed too, about 40% of area was under important garden crops (Fig. 10 and Fig. 11). About 51 per cent of land is under wetland land use type in the Bedthi river watershed area (contributed from the coastal region).

Of the total farmland surveyed, surprisingly, nearly to half *i.e.,* 43.79 per cent of farms of the Aghanashini watershed have at least one more source of irrigation (mostly tube well) apart from rain-fed conditions, despite receiving sufficient rainfall (Fig. 12). In the Varada watershed area, only 20.66 per cent of farms possess more than one irrigation source despite (mostly tube well) receiving lower rainfall and while lowest percent households (13.24%) possess more than one irrigation source in the Bedthi river watershed area. However, the Gangavali part of the Bedthi (*i.e.* Coastal region) was amazingly different with 98% of the farmlands possessing additional source of irrigation (mostly open well). In contrast, only 13% the farmlands in the Plain zone (Bedthi part) had additional source of irrigation (Fig. 13 and Fig. 14).

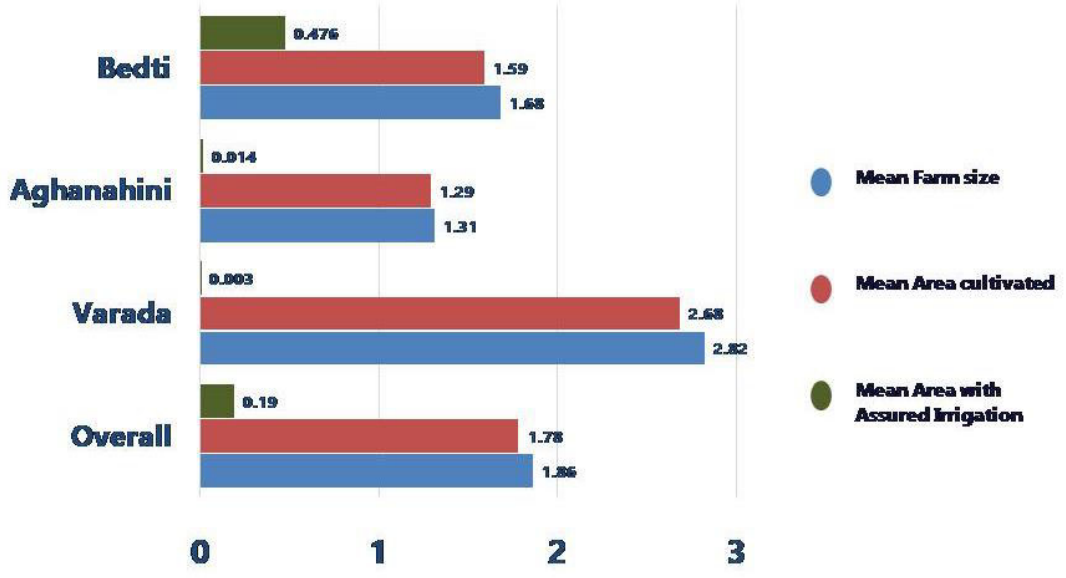


**Fig. 8** Mean farm size (acres), actual area cultivated (acres) and area under assured irrigation (acres) across different river watershed areas in Northern Karnataka

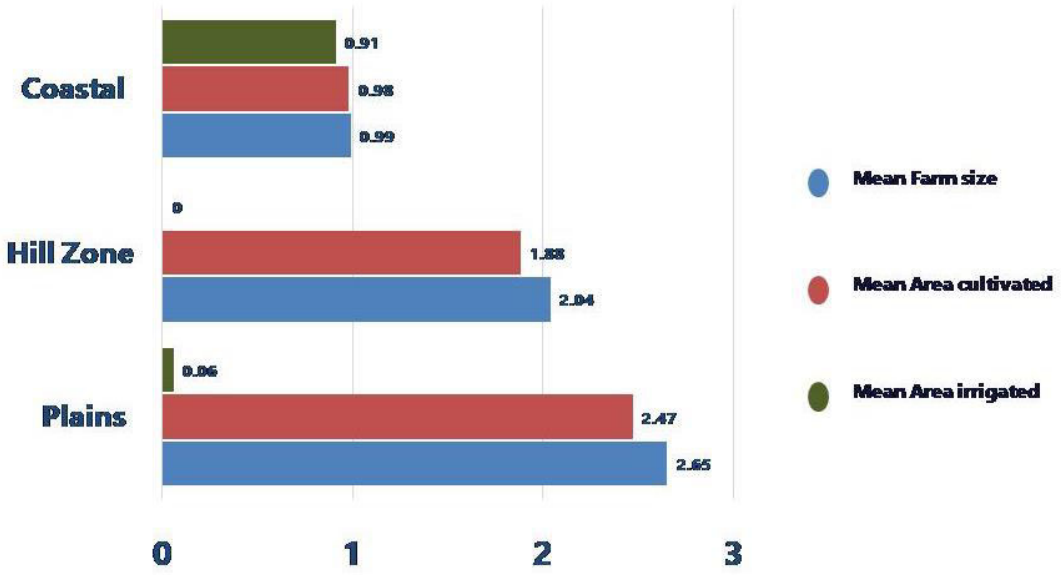


**Fig.9** Mean farm size (acres), actual area cultivated (acres) and area under assured irrigation (acres) across different bioclimatic zones of Bedthi river watershed areas in Northern Karnataka

*Computed based on agrarian families (HH=173) of three bioclimatic zones in Bedthi river watersheds*

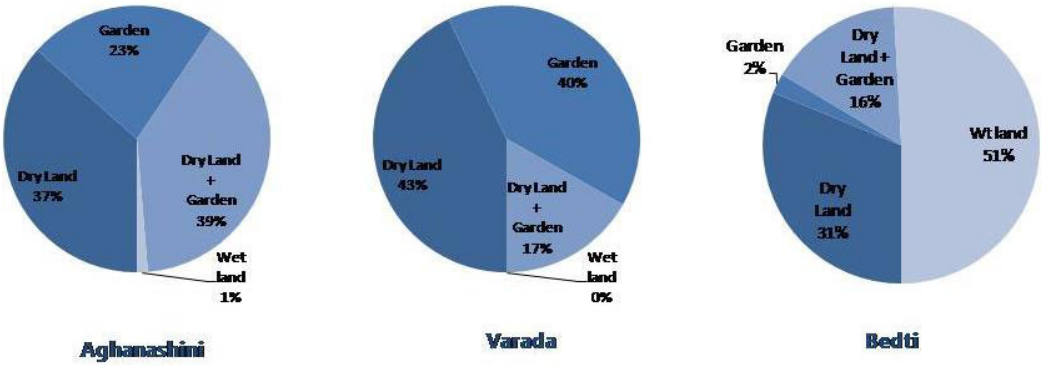


**Fig. 10** Land use type (Jameen) in three river watershed areas of Northern Karnataka

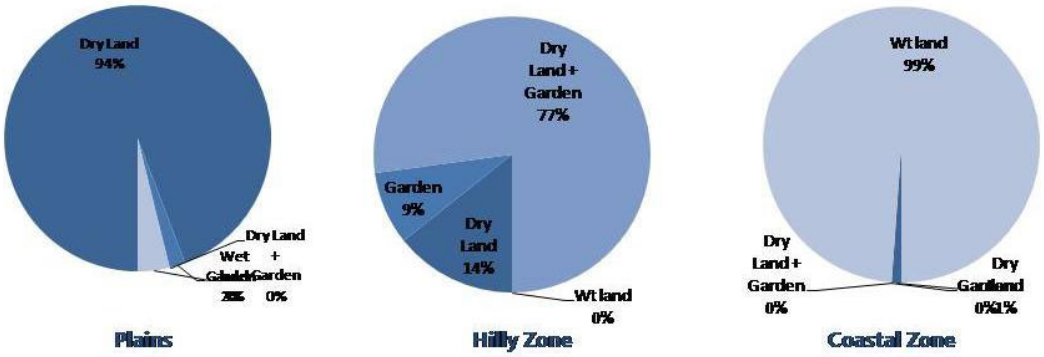


**Fig. 11.** Land use type (Jameen) in three bioclimatic zones of Bedthi river watershed of Northern Karnataka

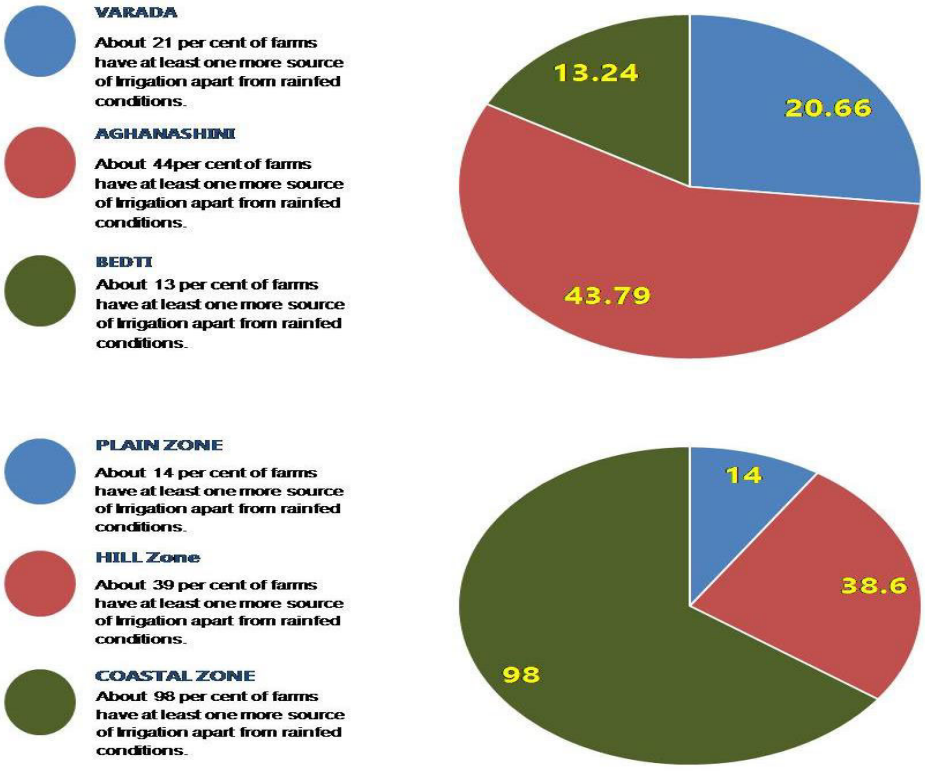


**Fig. 12.** Per cent farms with two sources of irrigation a) of three river watershed areas and b) across three bioclimatic zones of Bedthi watershed in Northern Karnataka

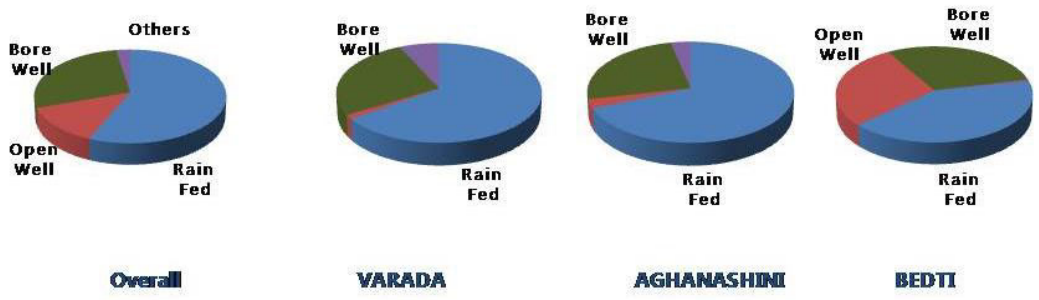


**Fig. 13.** Comparison of sources of irrigation in three river watershed areas pooled over three bioclimatic zones in Northern Karnataka


**Fig. 14.** Comparison of sources of irrigation in three bioclimatic zones of Bedthi river watershed areas in Northern Karnataka

**Water Conservation and Farmers' perception on Watershed Management**

The data with respect to the farmers' perception on water resources, watershed administration and climate change are summarized from Fig. 15 to Fig. 21. The majority of the farm households reported that vagaries of the weather (75.11%) and poor groundwater availability (20.73%) as the major constraints for crop production. Further, 90 percent of them disagreed to continue agriculture without any water conservation measures (of the 52% strongly disagreeing) suggesting a strong willingness among the farming community to adopt water conservation measures. While over 80 percent of the farmers were aware of the positive influences of water conservation measures in terms of improving irrigation, recharging well for drinking purposes, only 50 percent of them were appreciative of the ecosystem services. Only 60 percent of the farming households had extra land for the conservation of water harvesting structures such as farm ponds and check dams. This issue also points to the fact that community-level water harvesting needs to be undertaken without the need for extra land from existing farmlands.

*Question asked: I do not want to take up any kind of water conservation measures, I want to continue as it is .*

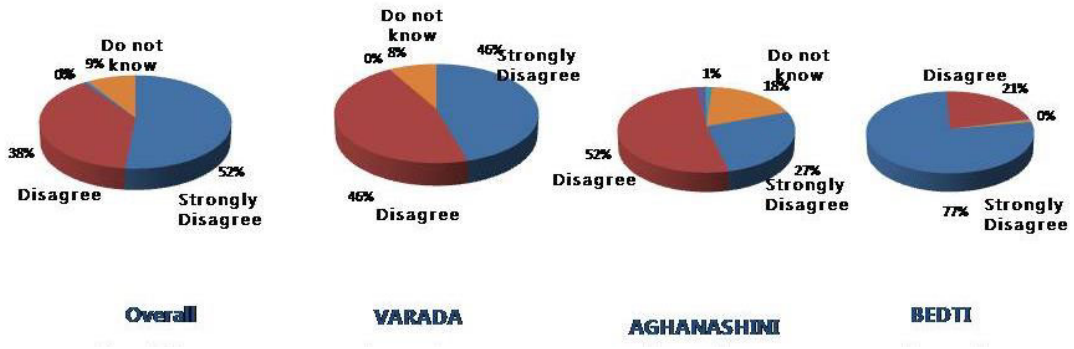


**Fig.15** People's perception about the Water conservation measures in three river watershed areas in Northern Karnataka

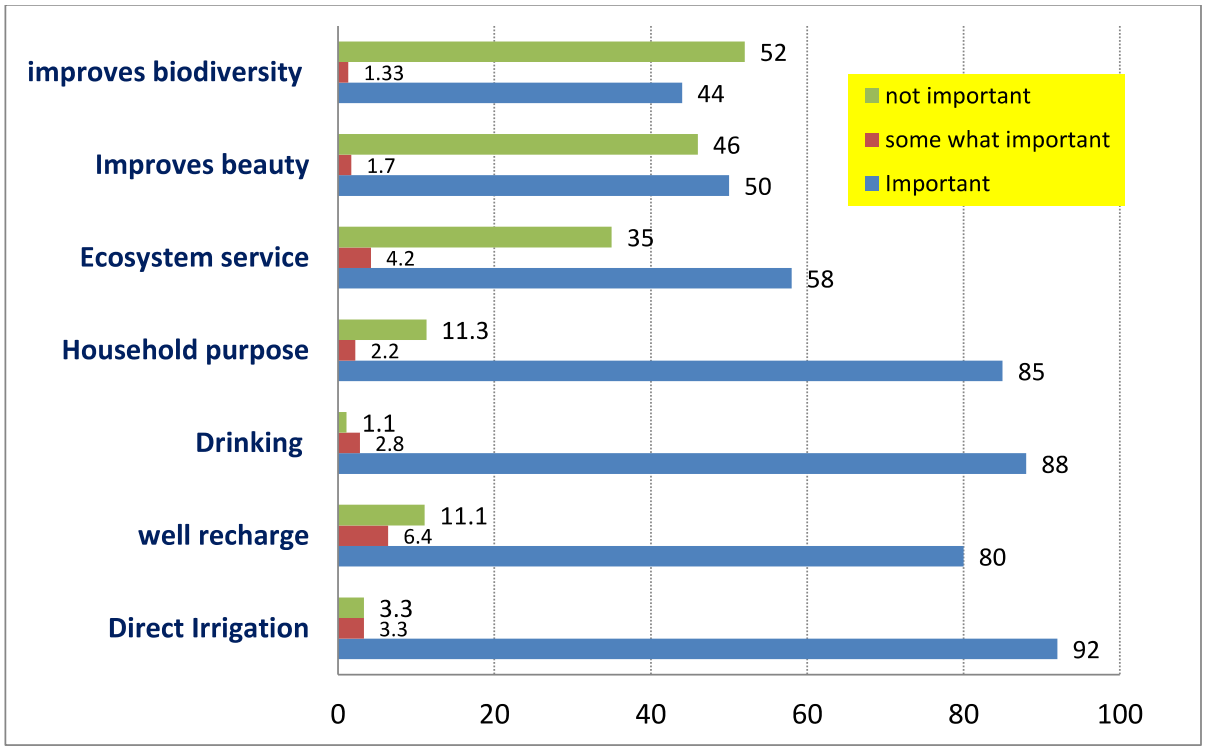


**Fig. 16.** Per cent respondent farmers (n= 450) approving various positive influences of water conservation structures in three river watershed areas in Northern Karnataka

Surprisingly, the majority of the farming community followed farm-level good practices of water conservation such as the adoption of micro-irrigation (95.29%), following practice of contour bund (92.60%), weeding (99.55%), and mulching (97.75%). However, only about 60 percent of the households followed farmer to farmer helping and community work as a good practice for water conservation.

Nearly two-thirds of the interviewed farmers held the view that lake/tank rejuvenation can greatly help improve the water resources and applying tank silt to farmlands can improve yields. Unfortunately, nearly two-thirds of the farmers opined that no lake rejuvenation was undertaken in the past decade. There is an urgent need for undertaking large-scale tank rejuvenation in these watersheds.

To improve water resources, nearly 44 percent of farmers wanted a government scheme and about 16 percent wanted more loan facilities. About 10 to 11 percent of the farmers suggested improving technical knowledge through training, provision of better farm equipment and marketing channels for their produce.

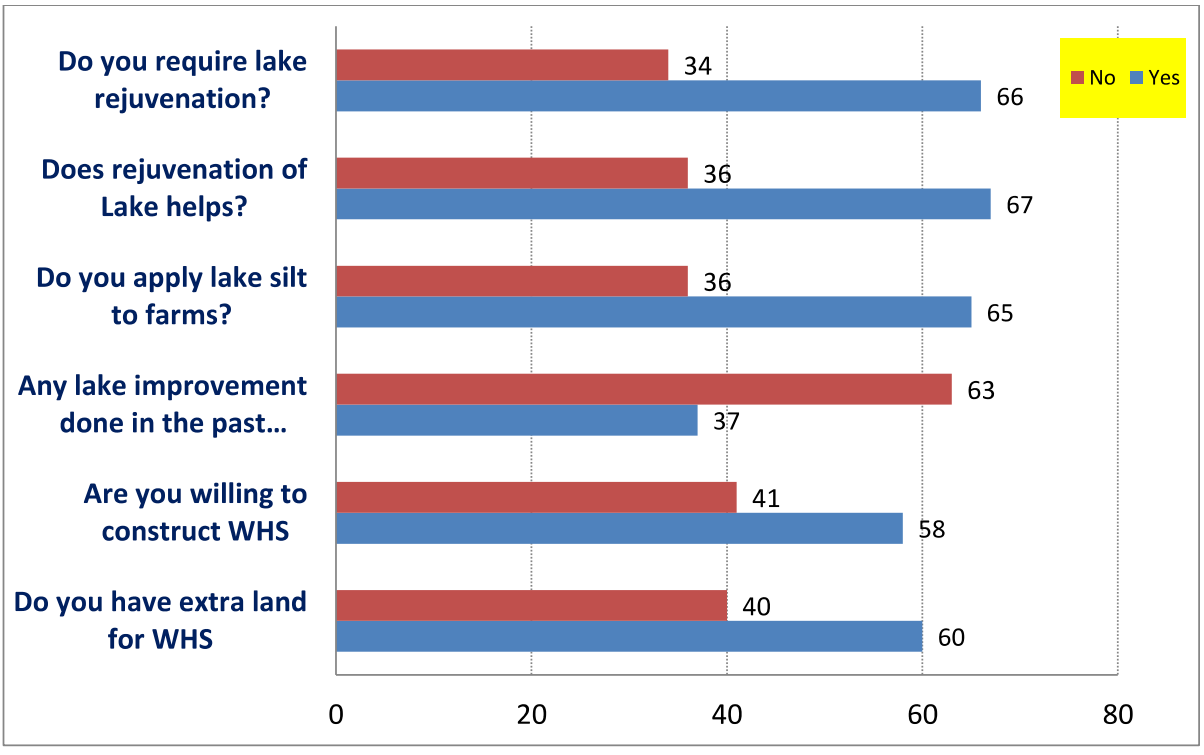


**Fig. 17.** Per cent respondent farmers' (n= 450) opinion on lake rejuvenation / Silt application in three river watershed areas in Northern Karnataka

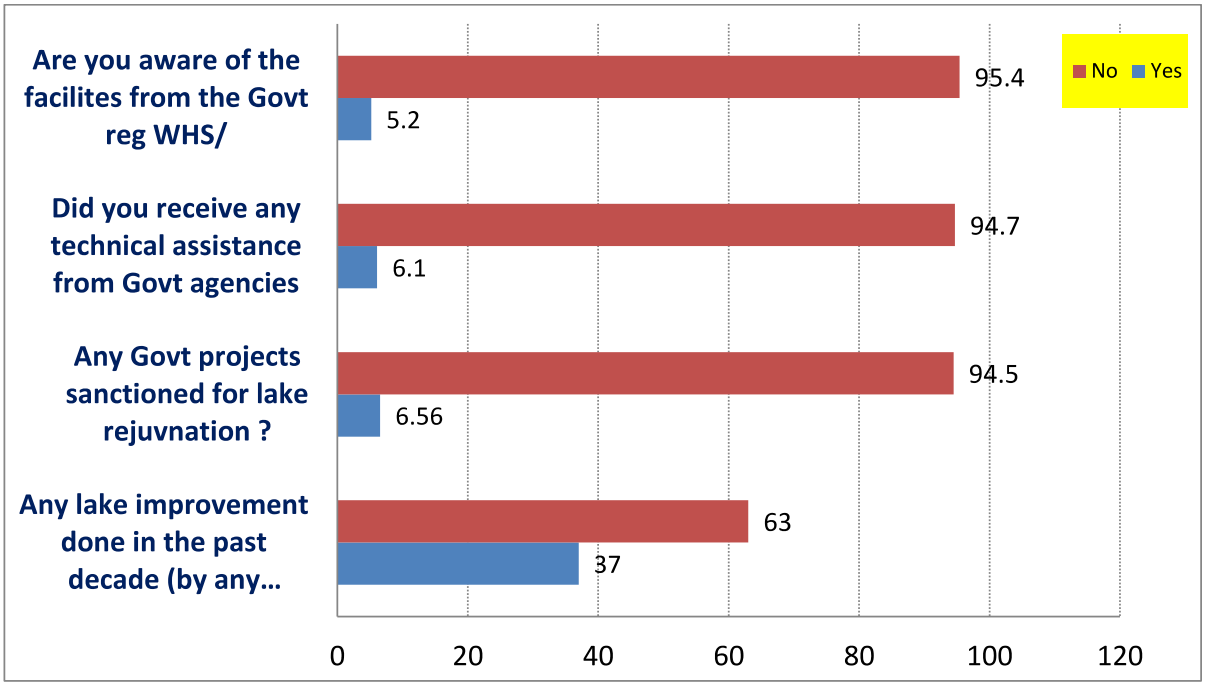


**Fig. 18.** Per cent respondent farmers' (n= 450) awareness regarding Government agencies in three river watershed areas in Northern Karnataka

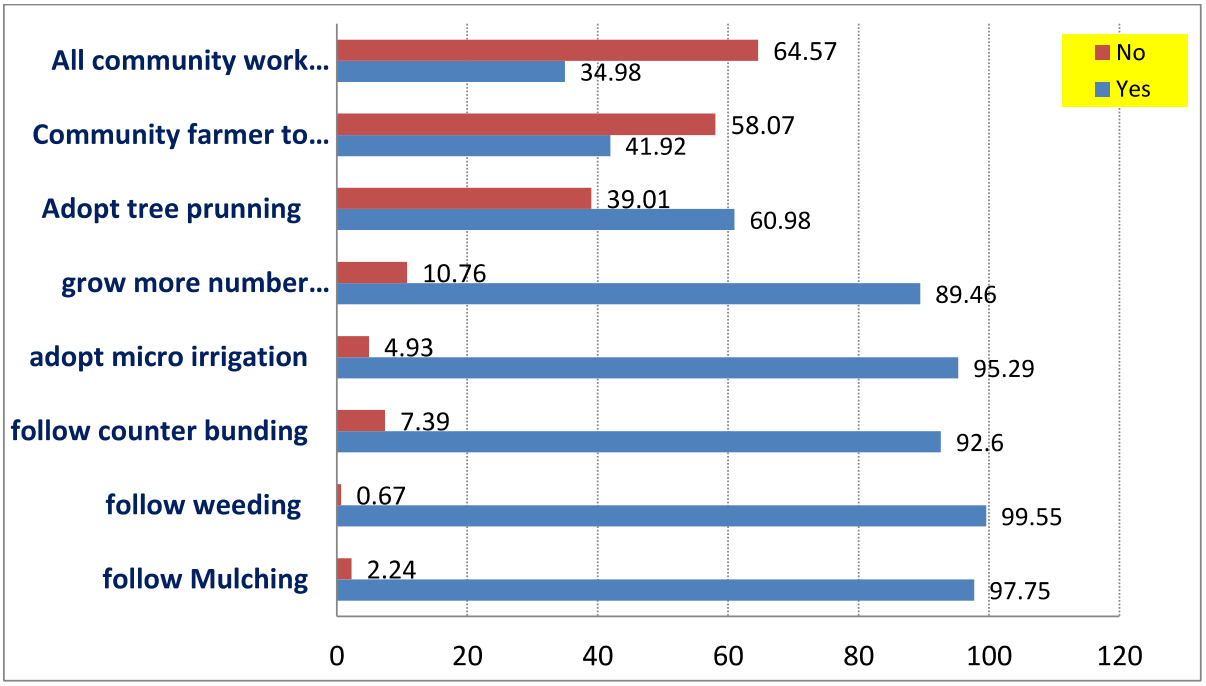


**Fig. 19.** Good Practices of Water conservation followed by farmers in three river watershed areas in Northern Karnataka

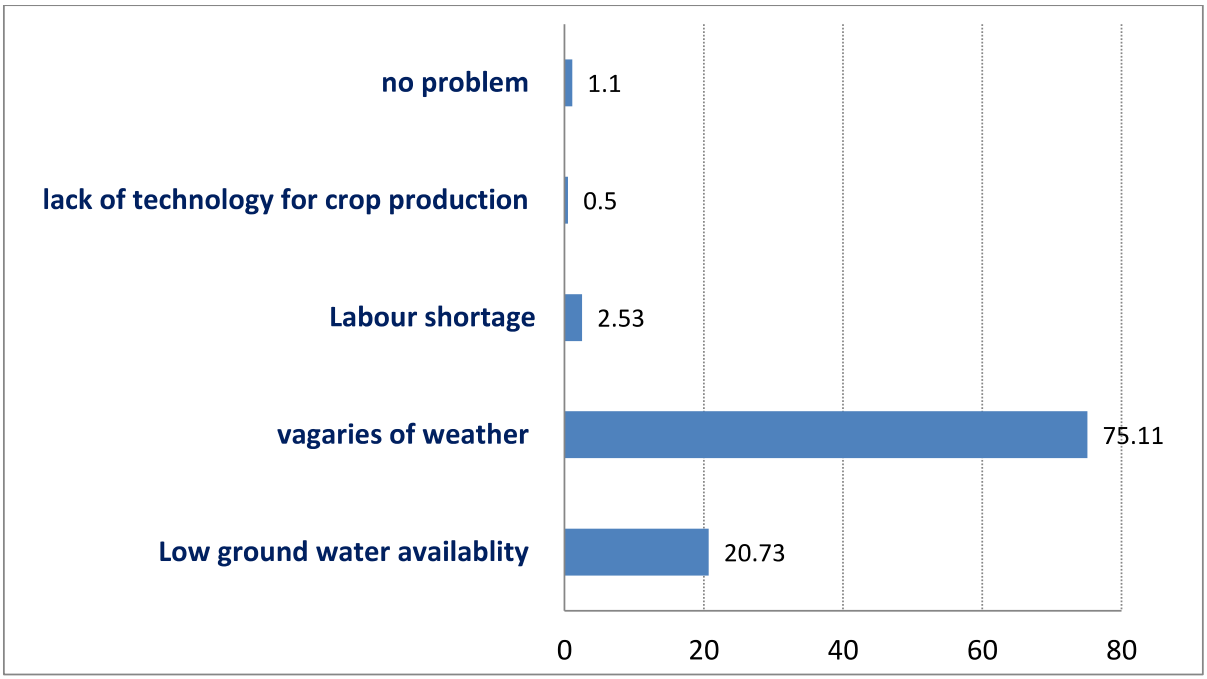


**Fig. 20.** Opinion by the farming communities (per cent respondents, n=451) regarding major production constraints in three river watershed areas in Northern Karnataka

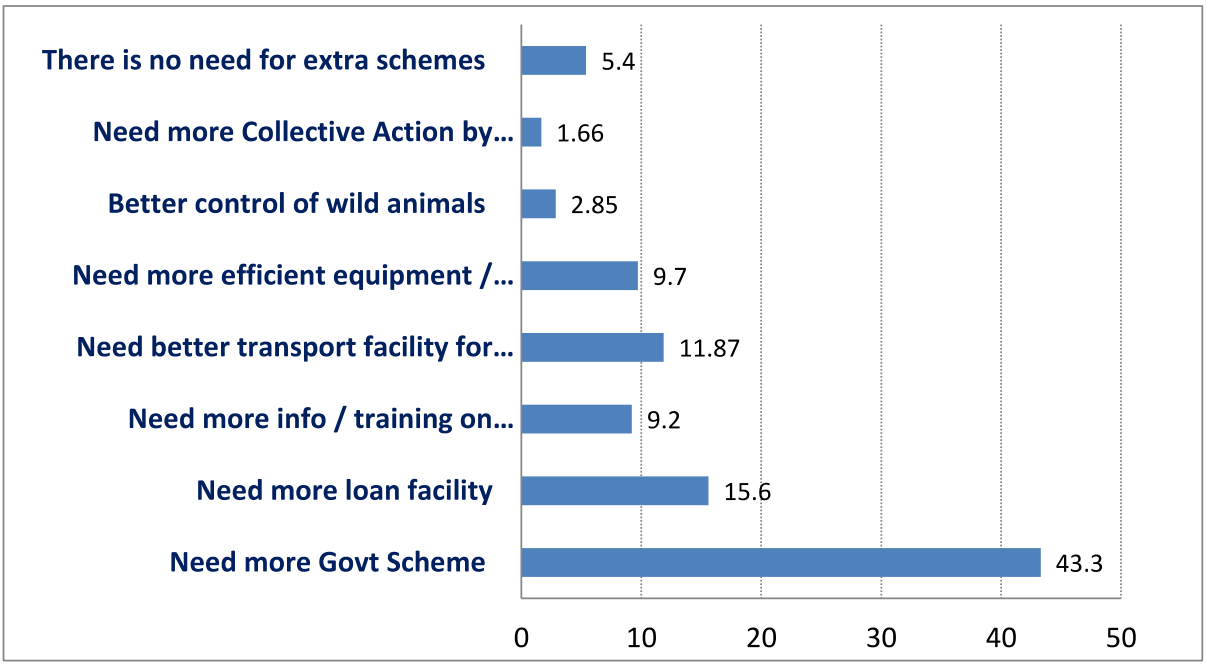


**Fig. 21.** Opinion by the farming communities (per cent respondents, n=451) regarding improving the water scarcity in three river watershed areas in Northern Karnataka

## THE APPROACH

Water resource problems are eternal and ever-changing both at watershed and at local levels. Planning is a good opportunity to focus on long-term issues such as increasing water use efficiency, addressing changing climate as well as to engage the discussions to arrive at a more meaningful course of action. Watershed plans and local plans must provide relatively comprehensive view/perspectives of the water management activities. A good consideration of implications arising out of uncertainties of climate and political influences is very essential.

However, in practice, real water management systems usually have thousands of possible decision options and plethora of alternatives. It is often possible to develop only a limited number of alternatives while planning. Developing and implementing each alternative requires considerable effort and educating stakeholders to follow it. The latter part would be hard if there is a cloud of controversy or political influence on local communities based of state / language *etc*.

Formulating a generalized water resource management plan would be a Herculean task, considering contrasting watersheds such as the Aghanashini, the Varada and the Bedthi/Gangavali which runs through different agro-climatic zones, each characterized by several unique watershed features, edaphic factors and with thousands of discrete non-exclusive local water management bodies. Since the water resource management plans have to be ultimately executed by a large number of local people, usually the precision and comprehensiveness take a back seat.

A clearly structured approach to plan for water resources problems is very valuable. The following discussion may lead to an approach towards better planning process to mitigate water resource problems at the basin and sub-basin level as well as at the local level.

***Basin Level Water Resource Planning***

Largely, today internationally accepted management unit for water resources is the river basin. Integrated basin-wide management always adopts an ecosystems approach and decision-makers take into account all uses and resources of the watershed and are always bound by political and legal considerations in vogue.

Generally three basic principles are considered at this level of management:

- Firstly, the river ecosystem notion: Any action undertaken within this system will cause complex ecological reactions and interactions among users and nature.
- Secondly, since human societies are part of system, sustainable development without conflicts should be the focus, either between humans or between human societies and nature.

- Finally, users' participation must be ensured in order to achieve a sustainable use of natural resources, notably water and Non-Timber Forest Produce.

Further, at this level, two aspects are important:

- Firstly, since large volumes of water are to be considered and included in planning, the data component becomes huge and hence has to be handled with recent technology.
- Secondly, conflict among uses and users of water *viz*., agricultural and urban water supply, environmental uses, flood control, hydropower, recreation, and other uses all compete in economic, legal, and political forums over the management of water at watershed and local levels.

Considering the above, rational planning approach is suggested to arrive at water resources problems faced in the three river watersheds.

***Rational planning approach for basin-level water resource problems***

One of the popular planning approaches for basin-level water resources problem is the Rational Planning Approach. Any rational planning follows a rough stepwise process as per the outline of which is given in the box.

Statement of objectives, followed by identification of solution/alternatives and evaluation of alternatives on stated objectives are the core of rational planning (Von Neumann and Morgenstern 1944; Tribus 1969; Hillier and Lieberman 1995). Based on the partner criticism/feedback, new data, or changing settings they may be frequently re-visited.

**An Outline of Rational Planning (* = most fundamental steps)**

**Step 1. Statement of Problem:** John Dewey said, "A problem well stated is a problem half solved." Early in rational planning, the problem should be firmly defined, stating people's concerns and plan motivation.

**Step 2. Inventory/Background:** What is known about the problem and the problem-setting? What has been learned already? How have earlier attempts to solve similar problems fared?

**Step 3. Forecasting:** The lifetime of most water problems and solutions is very long, far longer than the careers of individual policy-makers, engineers, and planners. Forecasts of

demands and related conditions estimate how the problem and problem setting are likely to change over the life of proposed solutions. Uncertainty and inaccuracy in forecasts is unavoidable.

***Step 4. Statement of Performance Objectives:** What makes a proposed solution "good" or desirable? Performance objectives can be economic, financial, environmental, social, or the reliability of achieving technical standards. Planners and stakeholder representatives typically define performance objectives.

***Step 5. Identification of Alternative Solutions:** What actions are available to solve the problem (including doing nothing)? Alternatives should be mostly reasonable, represent a wide range of activities for solving the problem, and come from a variety of sources. Past experience with similar problems is helpful, as is more academic and creative thinking. Public participation and preliminary modeling often aid in identifying promising or politically important alternatives.

**Step 6. Development of Alternatives:** Time and resources prohibit examining "all possible alternatives." A limited number of promising alternatives are developed in sufficient detail for evaluation on performance objectives (the next step). Discussions with stakeholders and preliminary modeling often help screen, narrow, and refine alternatives.

***Step 7. Evaluation of Alternatives on Stated Objectives:** Each developed alternative is evaluated in terms of expected performance on each stated objective (*e.g.*, economic, financial, environmental, social, risk, technical standards, *etc.*). This is typically the most analytical step and can include consideration of reliability and uncertainties. Interpretation and sensitivity analysis are desirable parts of the evaluation.

**Step 8. Selection of a "Best" Alternative(s)**: The "best" alternative is selected based on evaluations from Step 7 and relevant stakeholder, policy, and public consultations or processes. "The plan" consists of the write-up of steps 1-8, with particular emphasis on presenting the selected alternative(s). Selection often involves multiple objectives and decision-makers, and can occur adaptively in stages over time.

**Step 9. Implementation and Pragmatic Revisions of the Selected Alternative(s)**: Implementation often requires substantial modification and adaptation of a selected alternative. Practical considerations arise regarding political and institutional support, financial support, construction, operation, and ultimately closure or replacement over an alternative's lifespan.

**Step 10. Periodic Re-Examination:** For the next problem, did we learn anything from this experience? How could we have improved our work?

**Adopted from Lund and Asce ( 2021)**

Two pertinent issues, jointly related to the Aghanashini and the Bedthi-Varada watersheds that need to be addressed adopting the rational planning relate to water harvesting structures in *betta*-lands and another relate to Bedthi-Varada River linking. These issues are larger and may have overarching influence on water resource management in these watersheds. Further, the effectiveness of such watershed level plans is greater if integrated with local water management efforts and activities.

**Rational Planning for Soil and Moisture conservation in *Betta*-lands in Aghanashini and Bedthi/Gangavali basin**

*Statement of Problem*

How to improve Soil and Moisture Conservation in the *Betta*-Lands of the Aghanashini and the Bedthi/Gangavali Basin

*Inventory/Background*

*Betta*-lands are montane fields owned by the government where local communities have century old customary rights to harvest the fruits and collect firewood, grasses and leafy biomass for non-commercial use. These privileges were sanctioned by the British and have long, already since Independence, been disputed. Despite requirements for farmers to maintain the lands, the *betta*-lands have become over-used and degraded. Some farmers ignore or lack the knowledge on how to

best maintain the lands and have been clearing the natural vegetation at will. While governmental regulations are meant to protect these lands, local leaders claim that they have the opposite results.

Physically, it has referred to the strips or patches of tree land on the hill slopes adjoining the Areca orchards that were traditionally lopped by the Areca cultivators for mulch, animal bedding, manure and fuel wood. Legally, it refers to the specific piece of forest land attached or assigned to a specific orchard plots, conferring exclusive privileges to the owner of that orchard plot.

These two River watersheds encompass little over 50,000 ha of *betta*-land (which is collectively equivalent to a medium sized wildlife sanctuary!!). It is estimated that about 50% of these *betta*-lands are in various stages of degradation. It has been undergoing degradation over the years. This gradual change is almost unnoticed. Today having such a vast expanse of degraded *betta*-land system in a watershed is highly risky both in terms of ground water recharge and risks of un-intended land slide. Hence conservation of soil, moisture and species diversity of *betta*-lands should be taken up on priority with at most care and good scientific basis. There is a need to educate farming community about the deleterious effects of degradation of *betta*-lands.

*Forecasting*

The Arecanut plantations are a major source of income to the farmers of Uttara Kannada district. Hence, the area under Arecanut is increasing at a rapid pace. In the last two years alone (2020 and 2021), about 20,000 ha of agricultural land were converted into Areca cultivation around Sirsi. Although this may not automatically increase the *betta*-land, but the pressure on the *betta*-land may increase tremendously hitting soil and water conservation.

*Statement of Objectives*

- To standardize suitable soil and moisture conservation structure for *betta*-lands
- To prepare a knowledge based information system for the design of these structure
- To evaluate the developed system for a *betta*-lands
- Implementing water harvesting structures in at least 10,000 ha of *betta*-land in five years.

**Rational Planning for Implications of Bedthi-Varada River Linking**

*Statement of Problem*

Inter-basin transfer of water resource may cause severe flow changes in smaller streams and sustainably influence the endemic biological diversity which may have cascading influence. The proposed dam sites submerge over 1000 ha and take away a large junk of land for tunneling and powerhouse's *etc* leading to changes in the livelihood of people.

*Inventory/Background*

The project to utilize excess water in the rivers of the Western Ghats was conceived by the National Water Development Agency (NWDA). In 1995, the NWDA came up with a pre-feasibility report for diverting about 8.5 tmcft water from two streams of Bedthi River.

Bedthi-Varada Link proposal envisages diversion of 242 Mcum of surplus waters of Bedthi basin to water short Tungabhadra sub-basin, to be utilized under Tungabhadra Project Command. The irrigation that proposed under the link canal is 60,200 hectares in the drought prone Raichur district of Karnataka. Two powerhouses with an installed capacity 1.8 MW each are also proposed. The requirement of power for lifting the water has been estimated to be 61.10 MW for a total lift of 123.70 m. in three stages.

The head works of this project consists of two dams *viz.* Pattanadahalla dam on Pattanadahalla stream and Shalamalahalla dam on Shalamalahalla stream and interlinking systems between these two reservoirs. The proposed FRL of the Pattanadahalla dam is at 512.75 m and that of Shalamalahalla dam at 480.4 m. The live storage and dead storage capacities of these two dams are fixed at 13.00 Mcum and 5 Mcum and 72.50 Mcum and 7.5 Mcum respectively. The conveyance system of the link canal has been sub-divided into two main components *viz.* interlinking of Pattanadahalla and Shalamalahalla reservoirs and interlinking of the canal/tunnel from Shalamalahalla reservoir to a tributary of Varada river. The interlinking of the first component is about 8.5 km long including 2.2 km long tunnel. The second component is about 14.83 km long including 6.8 km long tunnel. The canal takes off from the Shalamalahalla reservoir at FSL 520.3 m after an initial lift of 57.8 m and outfalls into a stream leading to Varada river at FSL 565.0 m with additional lift of 65.90 m in two stages of 25.78 m and 40.12 m.

In this link, about 1,005 ha of area in Uttara Kannada district would come under submergence of which 787 ha is forest land, 130 ha cultivable land and 88 ha under non-

> agricultural use. Provision for compensatory afforestation on account of submergence of forest land has been made. No important historical monuments and archaeological structures will be coming under submergence. Due to construction of the two proposed dams, one village with a population of 967 will come under submergence.
>
> -Sourced *verbatim* from https://indiawris.gov.in/wiki/doku.php?id=bedthi-varada_link

*Forecasting*

The watershed encompasses tropical forests which host over 2000 species of valuable forest resources and over 500 other wildlife. This is an amazing concentration of biological diversity. Since the tributaries involved in this project are smaller in size, changes in flow due the link may have large impact on biological diversity. So far, there are no major impact assessments done by an independent agency. The flow will be discharged into the Varada without a receiving reservoir, which may increase channel erosion in the localized parts of the river. Altered flow patterns may also cause riparian zone degradation and create habitats for invasive species. The proposed project is expected to generate 3.6 MW of power, but it may take over 61 MW to lift the water to the Varada!!.

*Statement of Objectives*

Stabilizing flow changes in streams due to dam construction and to conserve the endemic biological diversity of the watershed.

Developing promising alternatives and selection of best alternative for both the above cases in sufficient detail for evaluation on performance objectives is beyond the scope of this approach paper as in involves detailed discussions with stakeholders as well as preliminary modeling. However the points mentioned in the next section may show a broad approach.

**Inventory of all Biological Resources of River Basins**

Apart from traditional starting point of basin-level water resources management plan, *viz*., water resource inventory, all biological resources (from important sectors such as agriculture, domestic uses and industry, *etc*.) of the basin need to be inventoried.

The following are the broad stages identified for resource documentation

1. Document all the biological resources and their usage in a watershed (water, agriculture, forestry, fishery, beekeeping, tourism, energy etc.)
2. Document changes in the use of these resources (trend identification)
3. Identify the human activities (such as land use changes) and natural phenomenon (Climate Change) that are influencing these changes
4. Integrate the information and diagnosis of the problem and issues
5. Identify the issues and conflicts in each of the usage/change
6. Develop action plan for mitigation at legal, scientific, community action *etc*
7. Develop and submit project proposals for the funding
8. Monitoring of the activities

However, these steps are easier said than done.

***Local level Water Resource Planning***

Although considerable public and professional debate exist on how water planning should be done at a basin level or at a sub-basin level, planning for local level water resource such as village lake water utilization plan is often ignored and/or usually copy pasted. While planning at the level of a watershed, hundreds of local water utility planners have to be considered. Every local water planner has to listen to thousands of agricultural, residential, commercial, and industrial water users. Ultimately it is these partners making long and short-term water management decisions. Integrating these local and user decisions with regional and state water management decisions is both difficult and but essential for effective regional management. More often local water planning must consider policies, plans, and regulations that already exist at regional, state, and central levels.

Lake management needs to be decentralized and must employ local knowledge, maintain local accountability and performance objectives widen the range of options considered, and ensure widespread review and comment on intermediate and final policy and planning products. Effective decentralized management requires informal or formal coordinating mechanisms, such as coordinating committees (*Kere Abhuvruddhi Samitis*), agreements and contracts with local NGO such as Manuvikasa, a regional federation of lakes (agency of local agency members). A regional water plan with decentralized water management is likely to be more educational and define a framework or direction for common activity, and less likely to define a detailed plan of action. Hence a federation of lake management committees at a taluk level may be necessary.

**Lakes are the MEANS towards a True Integrated Water Resource Management at local level**

Renovation and modernization of tanks and other local water resources are to be considered as priority task since there are over 4000 lakes in these watershed areas combined. The programme needs to be planned and implemented on a watershed basis, taking into account the comparative techno-economic feasibility of renovating existing tanks *vis-à-vis* construction of supplementary tanks, upstream and downstream. Tank rejuvenation is highly relevant for improving livelihoods and alleviating poverty in drought-prone regions (Delvalatha *et al*., 2014). Tanks restore the ecological balance between surface and groundwater resources. Collective action is possible in resource management, provided there are incentives for co-operation. It has been shown in many studies that the lake rejuvenation has brought in socio-economic changes among the villagers.

If a local level management bodies such as *Kere Abhivrudhdhi Samitis* have better financial resources, they can implement the plan independently and timely. However, at a higher level both the vigour and timely implementation of plan specifics may diminish. A constant evaluation of sustainability of local tank institutions is necessary. An Example of Indicators for Performance Evaluation to Assess the Sustainability Level of a Tank Institution is given in the box.

**Indicators for Performance Evaluation of a Tank Institution**

A subjective score in the four point scale (0 to 3) given by the field researcher is used for valuation of the indicator. Based on the six indicators, an overall performance indicator was also developed. The following six indicators are scored for each tank.

**(1) Institutional performance**: Measured by the structure and composition of the tank user's group; their decision-making process; effectiveness in augmenting tank storage; rules and tools for operation and maintenance; conflict resolution procedure; the institution's ability to make plans according to water availability so as to provide social safeguards against water scarcity; avenues of resource mobilisation, and interventions undertaken for improving the tank performance.

**(2) Tank contribution to livelihood**: Livelihood performance is assessed by people's dependency on the tank not only for irrigation, but also for other uses like fish rearing, cattle use, and domestic use. The use of the tank bed and adjoining wasteland for vegetable cultivation, tree cultivation, fuel wood cultivation, cattle grazing and employment generation; women's representation in the institution; non-farm activities relating to tank use, and tank water scarcity forcing migration were considered.

**(3) Enabling conditions**: Factors such as the socio-economic condition of villagers,

favourable hydrology to ensure adequate water to the tank, eviction of tank bed and supply channel encroachment, co-operative ethos within the community, infrastructure development and access to the markets, employment generation and re-investment of net income in agriculture were collected and used for computing the enabling environment performance.

**(4) Agricultural performance:** The success of an irrigation institution depends on its capability to bring water, manage it effectively and distribute it equally to increase in agricultural production, increase in area irrigated, income generated and development of other associated non-farm activities were recorded.

**(5) Objective-based impacts:** The impact of the performance of an organization is measured by the fulfillment of its objectives. Successful tank institutions strive to conserve water to enable multiple uses. The productivity per unit of water must increase. Successful agricultural practices were identified together with employment generation and the re-investment of net income in agriculture by the tank users. All these factors were measured to assess the impact performance.

**(6) Institutional sustainability**: The sustainability performance of a tank institution is measured in terms of leadership; adequate water supply; rules and tools and powers to impose sanctions; support from other development agencies including the government; conflict resolution process; and role of traditional village council.

(adopted from R SAKTHIVADIVEL, P GOMATHINAYAGAM, TUSHAAR SHAH)

Application of tank silt to the dry land farms is an effective way to boost the water holding capacity of the soil thereby contributing to the agriculture productivity. It was shown by MANUVIKASA that a massive amount of silt, over 10,000 tractor loads, has been added to the nearby lands by undertaking de-silting of only 40 lakes. This in itself is a massive ecological benefit. It was estimated in a study by MANUVIKASA that the whole operation of silt lifting from 40 tanks has generated about 20,000 man hours of labor and an estimated transaction of over 498 lakh INR. This was crucial for the livelihood of the people during the period of COVID. Further the positive influence of tank rejuvenation can reach over an agricultural area spread up to few kilometers in the '*achcut* area'. Due to participatory approach, common understanding arrived among the community members because of the efforts of Manuvikasa, most farmers interviewed, has expressed great satisfaction about the initiative and the work of Manuvikasa in tank rejuvenation. Tank rejuvenation is not just a physical rehabilitation to increase water resources, it should evolve into an activity to boost agricultural productivity and poverty alleviation.

Agro-forestry should be popularized in every watershed area; tree farming has been widely recognized as an effective tool to mitigate the impact of global climate change, to earn cash income as well as to achieve nutritional security to farming community. Pisci-culture could be encouraged in the tanks to provide additional livelihood options. Tree park or garden could be established along with boating in the tanks in association with Forest Department/tourism department in the historic tank villages to attract tourists to promote eco-tourism. As a further suggestion, bund planting with Khus-grass, *Citronella* grass, and other hybrid fodder grass to check bund erosion is encouraged. Planting riparian species such as Appe midi mango along the banks on either side of the bunds to check erosion and also to facilitate bird population in the area is another option.

***Requirement for Datasets and Analysis***

For effective planning of water resources management, availability of robust and reliable dataset on water usage, water yield, ground water potential, long-term water demands, environmental regulations, and climate change is a must. Big data on watershed features, water utility, water yield, point pollution, edaphic factors and water usage psychology can be used to build models and test alternative management scenarios. This facilitates more accurate analyses that may lead to well-informed decision-making as well as help improve operational efficiency/reduce cost. However, poorly or unsystematically collected or estimated big data often contain less useful planning information than simple more transparent estimations.

Further, method of empirical data collection/interpretation and the scientific controversy existing over them, often pose a big problem for analysis and its subsequent use in planning. This is especially true whenever the scientific concept itself is debatable. For instance, level of base flow or ecological flow in a river is highly debated. There is significant variability in field data collection regarding computation of carrying capacity of a river.

Today, most water resource planning are becoming increasingly public nature and decentralized in implementation. In this context, education, leadership, and development of reference documents on processes can be very significant, even where their short-term impacts are small.

***Education***

Water planning and plans educate the public, political leadership, stakeholders, and water agency professional staff and leadership about water problems and options. The public education role of the plan is rarely direct; few people read plans. Even the best political leaders can devote little time to technical aspects of decisions.

***Robust Reference Document***

Central to good water resource management is the reference documents for local, regional, and statewide activities and decisions. A good reference document should consists of robust estimates of water storage, information on water demands, forecasts of demand for every type of use, information on water usage by crops, mitigation of pollution, *etc*. Periodically the data in these reference documents have to be visited, discussed at various levels and should be the point of focus for future planning. Such good plans should only act as a leadership for every local water management decisions. *Kere abhivruddhi samities* may maintain such data sets at the local level. While the federation of the *Kere abhivruddhi samities* may collate at taluka or sub-watershed levels for easy comprehension in local language.

**Key Action Points to be addressed for Basin-level planning:**

1. The each watershed area could be categorized into different zones to ease the process of planning and implementation. These include: ecological function zones (protection zone vs. production zone vs. aesthetic zone); zones based on bio-climate (into hilly, coastal and plains); land-use functional zoning (dry vs. irrigated lands; black vs. Red soil zones).

   Planning should consider different goals such as protection of terrestrial and aquatic biodiversity, food production and support resilient economies, meet aesthetic, recreational, and spiritual needs, site specific water conservation projects, *etc*.

   Considering an ecological approach, care should be taken not to alter the ecological flow in Aghanashini and Bedthi/Gangavali watersheds since both systems are lifeline to the valuable biological diversity of the Western Ghats and there is a deep dependency of people for their livelihood. Strengthening approaches for provision of water for the environment and monitoring of environmental conditions.
2. Better hydrological, water quality and groundwater monitoring and data assurance to enable better planning and management. Improving and sharing data/knowledge about climate variability in watersheds.

3. Since Aghanashini River is one of the most un-polluted/un-damned/free flowing river system, it should be recognized as a Sacred Waterscape of South India and be developed on par with River Ganga. Encouraging eco tourism is advisable.
4. The urban population and industrial development is growing rapidly causing increasing water demands and degrading water quality in the Bedthi. Measures to control pollution of the Bedthi River from increasing industry/population of twin cities of Hubli/Dharwad should be implemented.
5. River basin governance arrangements to co-ordinate water resource management institutions so that an integrated approach is taken to ensure sustainable use into the future with best use of the available resource.
6. Addressing inequitable water availability and water security in Varada watershed is very essential. Regulation of lift irrigation projects and sand mining in all the basins, especially in the Varada River watershed needs special attention.
7. Soil erosion and sedimentation in rivers, tanks, reservoirs and canals is a common issue throughout the basin
8. Sharp decline in Bivalves (clams, oysters, mussels, scallops belonging to a phylum *Mollusca),* production in the brackish water of the Aghanashini and the Bedthi river has jeopardized the livelihood of thousands of fisherman community and endangered the nutrition security. While the reason is still a matter of conjecture, there is an urgent need to completely regulate the harvest and bring-in a community-owned-sustainable-harvesting system on the lines of Ashtamudi model (An estuary in Kerala where 10,000 tons of bivalves are harvested annually).
9. Setting up an expert appraisal committee to advice on various issues arising from time to time could be a viable option for long term impact.

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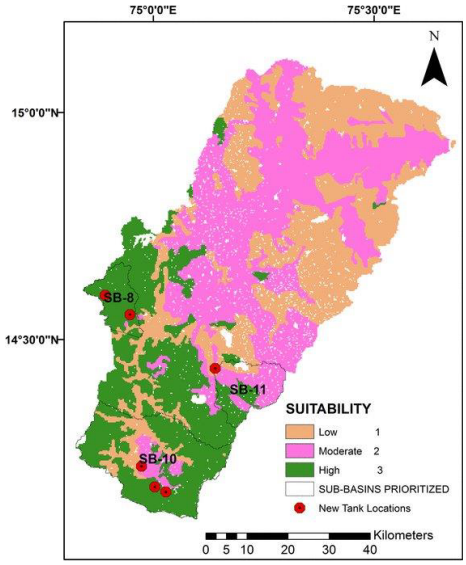
**Key Action Points to be addressed for Local-level planning:**

1. Tank rejuvenation is highly relevant for improving livelihoods and alleviating poverty in drought-prone regions. Tanks restore the ecological balance between surface and groundwater resources. Collective action is possible in resource management, provided there are incentives for cooperation.
2. The selection of tanks should be based on its hydrological endowment. Depending upon the hydrological endowment, rehabilitation components have to be decided. As far as possible, all tanks in a cascade need to be considered for rehabilitation.

3. A study in Varada watershed has identified locations for new tank construction based on ground water retention potential (as shown in the Map). Such studies may be encouraged. Such science-based identification of newer locations for establishment of lakes should be encouraged. Further, if establishing a new tank or lake is difficult and if the costs are too inhibitive, tank locations for augmenting ground water recharge could be considered. These may involve setting up percolation tube wells (usually of 50 feet and below) within the tank bed to siphon only the excess rain water directly to recharge ground water.




4. In drier districts of Karnataka where chain series of tanks are dominant, the integral holistic unit is the sub-basin of a river system, Water Users' Association (WUAs) are to be formed for each tank and federated at the sub-basin level. (*Kere Abhivraddi Sangha*).
5. The sub-basin needs to have a hydrological linkage with the main river basin utilization such that there is no clash of interests among the different units and other schemes in the river basin. The federal body at the basin level will then endeavor to apportion water of the basin to the tank systems equitably.
6. Market strategies such as beneficiary contribution are necessary for strengthening and sustaining the collective strategies. Considering the increased benefits and from point of equity, it is also important to improve the livelihood of the rural community through increasing the gross tank product in future tank rehabilitation and rejuvenation projects.
7. Tank rejuvenation which has been started purely as a physical rehabilitation to increase agricultural productivity should in future focus on institutional strengthening and poverty alleviation.

8. Based on the successful results of this massive joint effort of Manuvikasa and other agencies and also with the participatory approach of the local people in the measures of harnessing, recharging and maintaining the quality of water and water bodies could be taken up as pivotal project in other areas of the district on a wider scale.
9. Developing database on land use changes and cropping pattern and Water budgeting in each village to be developed.
10. The rehabilitation budget should be allocated in the ratio of 10%, 75%, and 15% to institutional development, physical works and maintenance, respectively. A one-time investment of 15% for maintenance and management activity will be allocated from the rehabilitation funds and this amount will be deposited in a bank.

**Key elements that contribute to the success of the integrated approach:**

1. **Political will for developing and conserving water resources**. Should result in legal framework, institutional arrangements, budgetary allocation which is not-influenced by the elected terms of politicians.
2. **Scientific Knowledge and organized information sharing**. Should result in Integration of information and development of management tool.
3. **Developing sustainable technologies for efficient water usage at grass-root level**. Should result in modern technology transfer till the last mile.
4. **Seamless Institutional arrangements from local to highest level**. Should result in working groups or task forces to bring people and institutions together.
5. **Expertise Recognition and building upon.** Should result in database of expertise, and further capacity development.
6. **Community Involvement and Prosperity.** This is the key for any natural resources management project. Lakes could be the level at which integration start. More than just direct project funding, a whole range of government incentives are necessary.

**The Future of Watershed Management**

The prime objective of the integrated watershed management should be to broadly balance the economic development of the watershed as well as protection of natural resources considering the social and political narratives in vogue. The long-term watershed administration will have to primarily consider the local impacts of global climate change. A cross-disciplinary approach in cutting-edge science such as RS/GIS, big data analysis, and multi-level systems analysis is necessary to guarantee the functioning of watersheds both from ecological and economic perspectives. RS in

combination with geographic information systems (GIS) can provide a) spatial input data for watershed management simulation models that are highly useful in achieving optimal management, b) assist policymakers to produce watershed management plans efficiently through the development of alternative management scenarios. Further, GIS empowers the watershed to be subdivided into more discrete units to undertake discrete management plans. Multi-level socio-ecological system analyses involve line Departments engaged in watershed development, NGOs, all village level institutions and all other stakeholders.

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## APPENDIX I

**Agenda 21, Objectives on Quality in Water Management:**

**Agenda 21, Chapter 18, adopted at the Rio Earth Summit of 1992, deals in detail with the water issue; three objectives were defined and they include some elements on quality in water management:**

- **Maintenance of ecosystem integrity by protecting aquatic ecosystems from degradation on a drainage basin level;**
- **Public health protection, including safe drinking water and disease vector control;**
- **Human resources development.**

## APPENDIX II

**Key principles in IWRM – The Dublin Principles**

- **Ecological - Freshwater is a finite and vulnerable resource, essential to sustain life, development and the environment.**
- **Institutional - Water development and management should be based on a participatory approach involving users, planners and policy makers at all levels.**
- **Gender - Women play a central part in the provision, management and safeguarding of water.**
- **Economic - Water has an economic value in all its competing uses and should be recognized as an economic good.**

**-The International Conference on Water and the Environment, January 1992, Dublin**

## APPENDIX III

**The lake rejuvenation contributes to Lake / Wetland protection India by various Acts and Rules and Global Sustainable Developmental Agenda:**

- The Indian Fisheries Act - 1897;
- The Indian Forest Act - 1927;
- Wildlife (Protection) Act - 1972;
- Water (Prevention and Control of Pollution) Act - 1974;
- Water (Prevention and Control of Pollution) Cess Act - 1977;
- Forest (Conservation) Act - 1980;
- The Environment (Protection) Act - 1986;
- Wildlife (Protection) Amendment Act - 1991;
- National Conservation Strategy and Policy Statement on Environment and Development - 1992;
- The Biological Diversity Act - 2002;
- National Water Policy - 2002;
- National Environment Policy - 2006;
- Environment Impact Assessment Notification - 2006;
- Wetlands (Conservation and Management) Rules - 2010,
- Government of India; National Water Policy - 2012;
- Wetlands (Conservation and Management) Rules - 2017,
- Government of India; Karnataka Lake / Tank Conservation and Development Authority Act, 2014.


Schematic representation of the ecosystem services generated by the tank rejuvenation and their relevance to the Global conservation Goals.

# APPENDIX IV

## Guidelines of the Ministry of Water Resources for Tank Rejuvenation

1. Background

1.1 Water is the lifeline of civilization. The biggest crisis that the world will face in the 21st century will be the crisis of water. Water is indeed a renewable resource but, in any given year, it is not inexhaustible. The crisis of water has affected the lives of millions of our fellow citizens. In some cities, whole households keep awake to receive one or two buckets of water well past midnight. In rural areas, the girl child is often pulled out of school in order to fetch water.

1.2 Through the ages, Indian agriculture has been sustained by natural and man-made water bodies such as lakes, tanks, ponds and similar structures. It has been estimated that there are about five lakh water bodies/tanks used for irrigation. Many of them have fallen into disuse and are in urgent need of repairs These water bodies have been a part and parcel of minor irrigation in the country under which even today two thirds of irrigated agriculture is covered in our country. Such minor irrigation schemes generally suffer from problem of loss of storage due to silting of the tanks, poor maintenance and management, encroachment, etc. Damage to various structures, inadequate surplussing arrangements, and silting are some reasons for deteriorating conditions in the irrigation system. It is necessary to restore the storage capacity of water bodies with the purpose of recovering their lost irrigation potential.

1.3 The Union Finance Minister, in his Budget Speech 2004–05, proposed a scheme to repair, renovate and restore all water bodies that are directly linked to agriculture. It was proposed that in the current year, pilot projects could be taken up in one or two districts to be selected in each of the five regions of the country.

1.4 The scheme "National Project for Repair, Renovation and Restoration of Water Bodies directly linked to Agriculture" has been prepared to take up pilot projects in states for implementation by the State Governments for which funds will be released to the states. Criteria and issues to be considered for preparing these guidelines were discussed in meeting with representatives of some states and concerned Central Ministries.

2. Objective

2.1 This is a pilot scheme for repair, renovation and restoration of water bodies directly linked to agriculture, to be taken up during the remaining period of X Plan. The objectives of the scheme are: (a) to restore and augment storage capacities of water bodies, and (b) to recover and extend their lost irrigation potential. Once the pilot scheme is completed and validated, it will form the basis for launching of the "National Water Resources Development Project" at much larger scale and spread to be completed in 7–10 years.

3. Scheme Design

3.1 The scheme envisages the States to take up the activities for project formulation in the manner generally prescribed as follows:

3.1.1 Projects in one or two districts each in the states are to be taken up under the scheme. If some states do not come up with a viable project proposal, the funds may be utilized for taking up priority projects of other states.

3.1.2 The States shall take up restoration of water bodies having original irrigation-culturable command area of 40 ha up to 2,000 ha, to revive, augment, and utilize their storage and irrigation potential. Water bodies having original irrigation culturable command area of less than 40 ha are to be covered under other ongoing schemes/existing schemes.

3.1.3 For the above purpose, the States may also undertake repair of related structures like check dams, weirs, bunds, and water conveyance systems. The detailed project report (DPR) from the states shall ensure that not more 50% of a given project cost is earmarked for ancillary works for conveyance system.

3.1.4 The DPR shall not include works for incomplete minor irrigation schemes or schemes completed within the last 10 years.

3.1.5 DPRs should clearly indicate the targeted benefits, both in physical and financial terms, relative to proposed costs.

3.1.6 The pilot project should be based on sound techno economic considerations so that the viability of the project is established and value addition for the proposed investment is achieved.

3.1.7 The states shall accord priority to the areas which are arid, semi-arid, drought prone, backward, and tribal-dominated while selecting the districts. Prioritization of water bodies are to be done by the respective states.

3.1.8 No proposals for funding establishment costs will be made under the scheme.

3.1.9 The projects are to be completed within a period of 2 years.

4. Preparation of Detailed Project Reports

4.1 The DPRs to be prepared by states should address the following considerations:

4.2 Selection of project:

Project should be selected from consideration of priority, need for repair and restoration for providing benefits. The main thrust of the project should be for augmenting storage capacity of the tanks/water bodies for recovering the lost irrigation potential. The States shall take up restoration of water bodies having original irrigation culturable command area of 40 ha up to 2,000 ha, to revive, augment, and utilize their storage and irrigation potential.

Details shall be given in regard to the background, present status of the project with reasons for deteriorating conditions of the project and alternatives, if any, which have substituted/modified the original project objectives, social/economic considerations and future plan. Arid/drought prone areas, backward/weaker sections and particularly tribal dominated areas will be given due consideration while preparing the project proposal and this should be appropriately brought out in the DPR.

4.1.2 Type of project:

The type of project should be clearly brought out. Relevant information, e.g., general topographical details, and description of components of the project such as renovation of minor irrigation tanks, check dam, weir, surface flow/lift, renovation of field channels, etc. shall be brought out. Other considerations like recharging of groundwater, water utilization for other purposes are to be brought out appropriately. Measures for water utilization efficiency, e.g., lining of canals, etc. should be considered and adopted in the project proposal. Work on repair of related structures like check dams, weirs, bunds, and water conveyance systems should be clearly brought out.

4.1.3 Command Area:

The total command likely to be irrigated from the project vis-à-vis the original and lost storage, intensity of irrigation, etc. should be brought out. This chapter should contain details relating to status of the existing conveyance system giving *inter alia* details of existing deficiencies, which are hindering water use, status of maintenance, availability of funds for O&M, participation of water users' associations, etc. in the O&M activities, details of potential created and utilized and that targeted under the project.

4.1.4 Project planning and design:

In the project formulation the following points should be considered among other issues involved.

4.1.4.1 Data availability and hydrological studies

Data availability and hydrological studies: General water availability giving hydrological conditions of the area, physiography covering climate, the source of availability of water, rainfall data including hydrological studies for water availability, and quantum of water available vis-à-vis proposed storage capacity, should be considered. Sources of irrigation available in the command area vis-à-vis the requirement should be analyzed.

4.1.4.2 Design criteria and viability

Design criteria and viability:

Design criteria shall be elaborated and viability justified highlighting the basic requirements and importance related to the project. The targeted benefit from the project implementation bringing out quantitative assessment, incremental area brought under irrigation and other aspects will have to be clearly brought out.

4.1.4.3
Issues on convergence of the project with related activities under other schemes should be achieved and this aspect should be brought out clearly.

4.1.4.4 People's Participation, capacity building and survey for collection of baseline data and survey for collection of baseline data: A provision up to 10% of project cost will be kept for related capacity building and people's participation and surveys for collection of baseline data for impact assessment and evaluation. Detailed surveys are to be undertaken in each district to establish baseline data at the village level and also at the tank level for performance parameters considered appropriate.

Parameters like agricultural production and productivity, fisheries production and productivity, fodder production and productivity, livestock production and productivity, status of irrigation intensity, area irrigated, and volume of water stored in the tank will be taken up for the purpose as applicable for the particular water bodies under the project. Detailed surveys in the district will be taken up simultaneously with project implementation.

4.1.4.5 Catchment description

Catchment description:

A brief description of the catchments, i.e., plain, undulating, hilly including forests, etc. shall be given with the following information.

a. Catchment area map of the project showing all upstream works affecting the flow into the reservoirs
b. Full command area maps showing all details of canals, branches, distributaries, minors and outlets
1. Privately owned water bodies are not to be considered for funding

i. *Social/ecological consideration*: Socioeconomic status covering data on population, the type of population affected by the project and the likely social, environmental and ecological impact of the area is to be considered and commented upon.

ii.*Community involvement for project implementation and handing over of project to community on completion of project*: Active community participation is necessary to ensure optimum utilization of assets and facilities created under the proposed scheme and, to sustain the scheme on a long-term basis. DPRs from the states will, therefore, include plan for involvement of panchayati raj institutions (PRIs) and the community—especially water users associations (WUAs)—to build, operate, monitor, and maintain the assets and facilities. DPRs should specify the plan for handing over the revived facility for O&M, monitoring, and maintenance to community organizations such as WUAs or PRIs.

iii. *O&M of the facilities created under the Project*: The O&M responsibility is proposed to be of the beneficiary community. An appropriate institutional framework is required to ensure viability and sustainability. Appropriate institutional framework for the purpose should be evolved simultaneously during project implementation from intense deliberation of related issues at different levels.

iv.*Cost aspect*: The components of estimated cost of the project to be taken up as pilot project and phasing of cost, i.e., cost to be incurred during the current year and subsequent years, should be projected. All works proposed for execution should be classified, lead ing to total assessment of the works. The detailed estimate of the project needs to be given. Their phasing and plan for taking up these activities should be spelt out. The phasing should cover both physical and financial aspect.

2. For preparation of DPR, there will be a limit of approximately Rs 30,000/per ha of the culturable command area of the project. Individual components of a project have to adhere to command area development cost norms of Ministry of Water Resources (MoWR).

3. In terms of additional irrigation potential restored under the project, an upper limit of approximately Rs80,000/per ha will be followed.

4. The DPR should clearly indicate the targeted benefits, both in physical and financial terms, relative to proposed costs. Cost benefit ratio of the projects in DPRs will generally conform to planning commission norms. Analysis like the economic rate of return may also be included.

5. No proposals for funding establishment costs will be made under the scheme.

*Monitoring and evaluation*

1. Water bodies serve the interest of local communities. It is imperative that a graded and bottom-up approach is established for progressive monitoring and evaluation of the revived water bodies at thelocal district-state-central level. The DPRs will spell out this monitoring mechanism at these levels.

2. The states may also provide for such other periodic evaluation of the project as necessary, to be specified in DPRs, to draw suit able lessons to take the scheme forward with better efficiency.

3. Salient features: Salient features of the project proposal, e.g., specific project component details, cost, time of completion of project etc. should be provided in the DPR.

5. Clearance of DPR from State Authority

5.1 Projects need to be cleared from the State Technical Advisory Committee or an equivalent arrangement per procedure in vogue in a State, to select districts and, to approve the DPR for the project works for the selected districts under the Scheme. The environmental clearance and forest clearance from the State government departments have also to be obtained as per procedure in vogue. The project preparation should adhere to the guidelines of the Planning Commission also.

6. Manner of Approval of DPRs

6.1 Central Water Commission (CWC) will be responsible for examination of DPRs received from the States, and for recommending those for approval by the MoWR.

6.2 For that purpose, the States shall submit DPRs— duly approved by their TAC or equivalent arrangement—to the concerned regional office of the CWC.

6.3 The concerned regional office of CWC—in association with the concerned regional office of the Central Groundwater Board (CGWB) and their counterparts in the States where necessary—will examine DPRs and send their findings to CWC (headquarters).

6.4 CWC will forward DPRs with their considered views and recommendation to MoWR for approval.

6.5 To select DPRs for funding, a committee under the chairmanship of Additional Secretary, MoWR, will consider the DPRs recommended by CWC. This committee includes representatives of Ministry of Agriculture, Ministry of Rural Development and officers from Ministry of Water Resources.

6.6 Techno-economic appraisal by CWC:

6.6.1 The Techno-economic appraisal for the proposed projects by CWC will include, inter alia, the following aspects:

(a) Scrutiny of the cost-benefit aspects analyzed in the DPR submitted by the State.
(b) Scrutiny of water availability study vis-à-vis proposed storage capacity.
(c) Scrutiny of soundness/viability of basic planning and alternatives studied.
(d) Considerations on groundwater regime and management/development related to the project proposal.

7. Post project sustainability Post project sustainability is an important factor for minor irrigation projects.

7.1 Measures and consideration for ensuring post project sustainability need to be clearly brought out in the DPRs. This chapter would also high light the existing set up for operations and maintenance and delivery arrangements up to farmers. Holding and other on-farm development (OFD) works.
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7.2 Legal status of provisions of regulatory Acts, administrative measures, methodology of achieving farmers' participation and realizing of water charges, etc., are to be detailed out along with proposal for rationalization of water charges.

8. Implementation Arrangement

Implementing Agency: The project is planned for implementation on priority as per the present institutional arrangements, available in the respective state with strengthening of community participation. The projects are generally technical input based for extending irrigation facility. Implementation arrangements also have to cater for appropriate consideration on this aspect.

*District-level Implementation Committee*
There will be a district-level implementation committee (DLIC) to decide all issues on implementation management, supervision and effectiveness of the pilot project including post project sustainability. This committee will be chaired by the District Collector and the Vice Chairman of the DLIC will be from a reputed NGO to be nominated by MoWR, GoI. The Committee will include representatives from WUAs, NGOs, village panchayats, women, SCs/STs and the landless. The DLIC will also provide a platform for working out active community participation in implementation, supervision and monitoring of the projects. Executive engineer of the nodal department in the state in charge for project implementation will function as member secretary for the DLIC. Member secretary shall ensure utilization of the existing infrastructure with him for administrative support for day-to-day functioning.

The functions of the DLIC will be as follows:
(a) Finalizing actual implementation strategy and management for effective implementation.
(b) Selection of private sector agencies and/or NGOs, local community and deciding implementation issues such as extent of involvement of contractor for execution of work.
(c) Deciding mode of procurement of construction materials/goods and approve construction activity and works from time to time.
(d) Approving project plan for sensitizing the panchayati raj functionaries, WUAs, related government officials, local opinion makers and politicians and the community regarding the merits and modalities of the community-managed program of the project.
(e) Deciding on formation of local level implementation committee at WUA/panchayat level.
(f) Approving awareness campaign, participation and HRD training activities.
(g) To supervise quality in works and procurement.
(h) Monitoring, supervision and signing off on all completed works including all construction activity.

(i) Interaction with state and GoI as required.

The WUA will include all stakeholders associated with the tank system such as women, SCs/STs, landless and other vulnerable groups and not only command area farmers.

*Arrangement at State level*

This is a state sector scheme. The nodal department in the state government will have the overall responsibility for planning, implementation, super vision and monitoring of the project. The state would have an apex committee headed by Secretary/Principal Secretary in-charge of minor irrigation/water resource/irrigation department in the particular state. The apex committee will provide policy direction, approve the annual plan and also review and monitor implementation of the project. This committee will decide strategy at the state level and consider broad issues like convergence of the project with the other projects in the area and appropriate coordination between different departments. The committee will also address issues like long-term O&M arrangements through community organization like WUA/PRI, maintenance fund for the purpose and facilitate interaction at various levels. The concerned chief engineer will be the member secretary of the committee.

An executive committee shall be constituted by the apex committee and shall be headed by the chief engineer of the concerned department. This committee will consider and identify project related issues for handling the same and report to the apex committee for assisting the apex committee in the due discharge of its functions.

9. Financial Arrangement

The funding pattern of the scheme will be in the ratio of 75:25 (center:state). The central funding will be in form of grant to the states. A budget provision for the total amount of the project for both Central plus State share is to be kept in the state plan for the year. A pre-condition of sanctioning annual central funds to the states will be that they have made suitable provision of funds, including both central and states share, in the state budget.

The DLIC shall maintain a separate bank account for implementation of the project in the district. State will transfer the funds along with the State's share to the dedicated bank account for the project. The first two installments of central share shall be released on approval of DPR at half yearly interval.

The third central installment will be released on receipt of utilization certificate and the expenditure statement of the first installment (including the state's corresponding share). The subsequent installments would likewise be released after receipt of utilization certificates for the penultimate installment. State should send Utilization Certificate to GoI for release of installment in the prescribed performa.

The utilization certificate must be prepared strictly on the basis of the receipts and payment accounts. The audited account for project works from the state is to be substituted to the GoI as per usual procedure.

10. Monitoring and Mid-Term Review

10.1 Monitoring of minor irrigation projects is a state subject.

10.2 Monitoring of the scheme is to be done by the states with appropriate set up in the State in the concerned department. The monitoring agency has to be independent of the construction agency.

10.3 Project graded and bottom-up monitoring mechanism is to be established for progressive monitoring and evaluation of the revived water bodies at the local-district-State-Central level.

10.4 State level committee as mentioned in para 8.4.2 will be in-charge of monitoring and evaluation of the program at state Level and thereby bring about a qualitative improvement in the implementation of the program. The state monitoring committee may incorporate a CWC representative from their corresponding regional offices. Besides, the states may also provide such other periodic evaluation of the projects mentioned in para 4.1.9.2. 10.5 An appropriate system of monitoring of the projects will be taken up through CWC and CGWB in the states consisting of on-site examination of works and off-site analysis of states' monitoring reports. Such mid-course evaluations as necessary of the scheme during the plan period would also be taken up through CWC and CGWB.

11. Project Evaluation

11.1 MoWR and the respective state may appoint an independent institution to carry out evaluations of the project.

11.2 Services of the NABARD could be utilized for independent evaluation studies on the scheme toward validation of the pilot project with suit able inference.

12. Post-project Sustainability and Maintenance:

12.1 Resource for post-project maintenance will consist of water charges/user charges and beneficiary contribution apart from the government funds for major repairs in particular circumstances. The O&M resource requirement for the project on completion will have to be worked out by the concerned State during implementation period of the scheme.

13. Completion Report Containing Main Findings on Implementation of the Project:

Recommendations for Future Projects

13.1 On completion of the project, a project completion report is to be prepared by the nodal department and submitted to MoWR. The report should take into account the views of the DLIC. The report should contain important observations on design and implementation of the project as regards its effectiveness. It should also focus on critical aspects of the scheme such as community involvement, O&M, and development of tank management system for assessment purposes to enable suitable decision for the future scheme.


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