



MASSCOTE in Hemavathi June 2007

Modernization Strategy for Irrigation Management

KARNATAKA - INDIA

HEMAVATHI PROJECT -CNNL

WORKING DOCUMENT [10/07/07].



CURRENCY EQUIVALENTS

Currency Unit = Indian Rupee (Rs)
US\$1.0 = Rs 41

MEASURES AND EQUIVALENTS

1 meter	=	3.28 feet
1 ha	=	2.47 acres
1 km	=	0.620 miles
1 cubic meter (m ³)	=	35.310 cubic feet
1 million acre foot (MAF)	=	1.234 Billion cubic meter (Bm ³)
1 cubic feet per second (cusec) (m ³ /s)	=	28.5 litre per second (l/s) = 0.0285 cubic meter per second
TMC	=	Thousand Million Cubic Feet = 28.3 Million Cubic Meters
MCM	=	Million Cubic Meter

ABBREVIATIONS AND ACRONYMS

AGLW	Agriculture Water Resources Development and Management Service of the Land and Water Development Division of FAO
CA	Command Area
CCA	Culturable Command Area
CR	Cross regulator
DO	Direct outlet
FAO	Food and Agriculture Organization
FO	Farmer Organization
GCA	Gross Command Area
ITRC	Irrigation Training and Research Centre (California Polytechnic University)
CNNL	
LMA	Local Management Agency
MAF	Million Acre Feet
MASSCOTE	
M&E	Monitoring and Evaluation
NCA	Net Command Area (irrigable)
O&M	Operations and Maintenance
OFWM	On-Farm Water Management
RAP	Rapid Appraisal Procedure
WUA	Water Users Association

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Introduction and Background

A FAO mission¹ visited Karnataka State from 17 to 29 June 2007 as part of a collaborative program between the Government of Karnataka and FAO, and more specifically a joint program targeting the re-engineering/modernization of irrigation management under the control of the Irrigation Corporates.

This mission follows a set of previous missions carried out with KNNL one of the main corporate of irrigation in Karnataka.

The mission organized for Cauvery Neeravari Nigam Limited (CNNL) a training workshop on modernization of irrigation management for 40 participants with a focus on Hemavathi project, lecturing field visits and working group sessions have been carried out from 17 to 29 June.

This mission is the fourth of a set of 4 planned as part of the collaborative program between Government of Karnataka and FAO aiming at developing a modernization strategy for Karnataka irrigation sector.

The application presented here has been developed through a training workshop in Karnataka with engineers and managers from the CNNL. The contributions of the working group sessions at this workshop (RAP–MASSCOTE) have been largely included in this report. The MASSCOTE exercise has been further carried out to its completion by a team of CNNL, comprising officers from CNNL HQ as well as some officers from the project itself. The conclusions and proposals have been further reviewed and refined by the local CNNL team together with FAO resource persons it is fair to say that they are reflecting the outcomes of the workshops.

This working document (draft report) has several purposes:

- produce food for thought for decision-makers in Karnataka before engaging in investment plans, particularly on how to ensure that diagnosis and solutions are investigated properly in modernization projects;
- suggest some specific strategies to managers of the Hemavathi system and CNNL on how they should conceptualise the modernization of irrigation management;
- introduce the MASSCOTE and RAP exercises to a large audience through real-case application.

¹ The FAO mission consisted of D. Renault, (Senior Irrigation Management Officer, AGLW FAO HQ Rome), T. Facon (Senior Water Management, FAO Bangkok), and P.S. Rao (Senior Officer of India FAO Bureau Delhi).

1. THE MASSCOTE APPROACH

The methodology used in the study is called Mapping System and Services for Canal Operation Techniques (MASSCOTE). It has been developed by the Land and Water Division (AGLW) of FAO on the basis of its experience in modernizing irrigation management in Asia. MASSCOTE integrates/complements tools such as the rapid appraisal procedure (RAP) and Benchmarking to enable a complete sequence of diagnosis of external and internal performance indicators and the design of practical solutions for improved management and operation of the system.

MASSCOTE is a methodology aiming at the evaluation of current processes and performance of irrigation systems and the development of a project for modernization of Canal Operation.

Operation is a complex task involving key activities of irrigation management which implies numerous aspects which have to be combined in a consistent manner. These aspects are:

- service to users
- cost of producing the services
- performance M& E
- Constraints and opportunities on Water resources
- Constraints and opportunities of the physical systems

MASSCOTE aims to organize project development into a stepwise revolving frame including:

- mapping the system characteristics, the water context and all factors affecting management;
- delimiting manageable subunits;
- defining the strategy for service and operation for each unit;
- aggregating and consolidating the canal operation strategy at the main system level.

MASSCOTE is an iterative process based on ten successive steps, but more than one round is required in order to determine a consistent plan. Some steps need to be rediscussed and refined several times before achieving a satisfactory level of consistency.

Presentation of the methodology

The first steps of MASSCOTE (Table 1) are conducted for the entire command area with the goal of identifying homogeneous managerial units for which specific options for canal operation are further sought by running the various steps of MASSCOTE for each unit taken separately. Then, aggregation and consolidation is carried out at the main system level. Thus, the methodology uses a back-and-forth or up-and-down approach for the different nested levels of management.

10 STEPS of MASSCOTE

Mapping	Phase A – baseline information
1. The performance (RAP)	Initial rapid system diagnosis and performance assessment through the RAP. The primary objective of the RAP is to allow qualified personnel to determine systematically and quickly key indicators of the system in order to identify and prioritize modernization improvements. The second objective is to start mobilizing the energy of the actors (managers and users) for modernization. The third objective is to generate a baseline assessment, against which progress can be measured.
2. The capacity & sensitivity of the system	The assessment of the physical capacity of irrigation structures to perform their function of conveyance, control, measurement, etc. The assessment of the sensitivity of irrigation structures (offtakes and cross-regulators), identification of singular points. Mapping the sensitivity of the system.
3. The perturbations	Perturbations analysis: causes, magnitudes, frequency and options for coping.
4. The networks & water balances	This step consists of assessing the hierarchical structure and the main features of the irrigation and drainage networks, on the basis of which water balances at system and subsystem levels can be determined. Surface water and groundwater mapping of the opportunities and constraints.
5. The cost of O&M	Mapping the costs associated with current operational techniques and resulting services, disaggregating the different cost elements; cost analysis of options for various levels of services with current techniques and with improved techniques.
Mapping	Phase B – Vision of SOM & modernization of canal operation
6. The service to users	Mapping and economic analysis of the potential range of services to be provided to users.
7. The management units	The irrigation system and the service area should be divided into subunits (subsystems and/or unit areas for service) that are uniform and/or separate from one another with well-defined boundaries.
8. The demand for operation	Assessing the resources, opportunities and demand for improved canal operation. A spatial analysis of the entire service area, with preliminary identification of subsystem units (management, service, O&M, etc.).
9. The options for canal operation improvements / units	Identifying improvement options (service and economic feasibility) for each management unit for: (i) water management, (ii) water control, and (iii) canal operation.
10. The integration of SOM options	Integration of the preferred options at the system level, and functional cohesiveness check. Consolidation and design of an overall information management system for supporting operation.
11. A vision & a plan for modernization and M&E	Consolidating a vision for the Irrigation scheme. Finalizing a modernization strategy and progressive capacity development. Selecting/choosing/deciding/phasing the options for improvements. A plan for M&E of the project inputs and outcomes.

2. The Hemavathi Irrigation Project

This section to be checked for accuracy/consistency of data

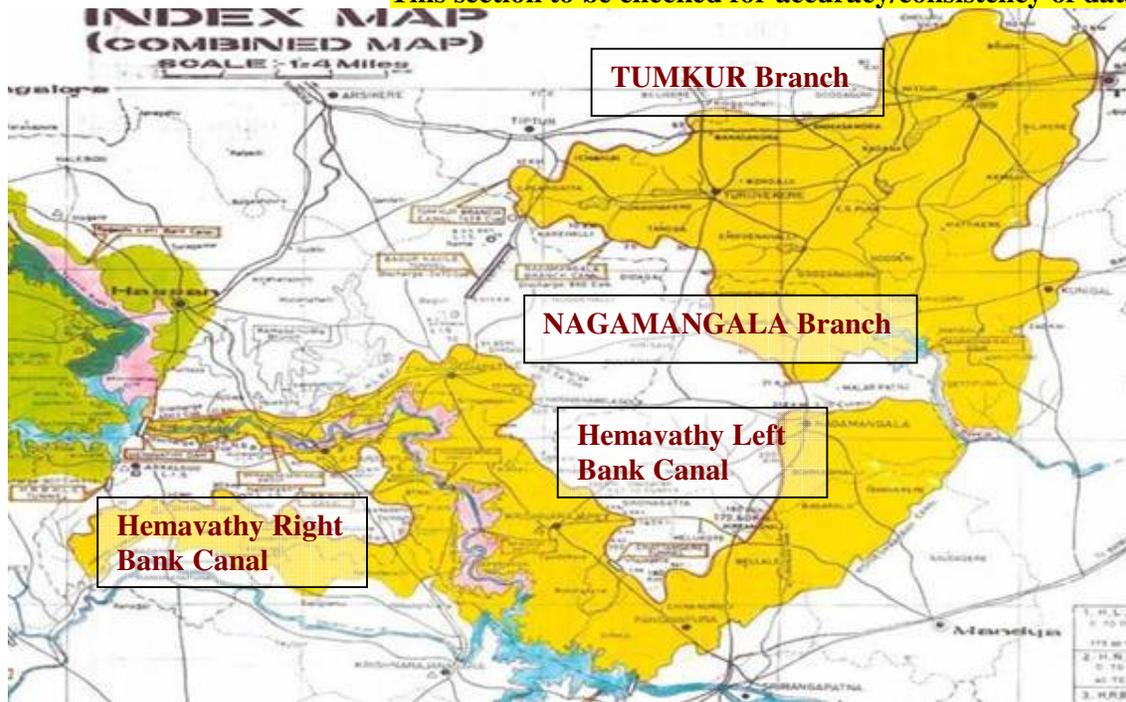


Figure 1. Location and lay-out of the Hemavathi Irrigation Project

BRIEF DESCRIPTION

Hemavathy Project envisaged construction of Hemavathy Dam near Gorur to store 37.10 TMC of water to irrigate 2,65,079 Ha. of land in Hassan, Tumkur, Mysore and Mandya Districts. There are 14 Lift Irrigation Scheme also to irrigate 18517 Ha. of lands. The Government has accorded approval to the project report costing Rs 588.00 crores during 1985-86.

THERE ARE TWO ZONES NAMELY:

1. Hemavathy Project Zone, Gorur
2. Hemavathy Canal Zone, Tumkur under Hemavathy Project.

HEMAVATHY PROJECT: GORUR.

The jurisdiction of Hemavathy Project Zone is as shown below.

Sl.No.	Name of canal	Length in Km	Atchkat in Ha.
1.	Hemavathy Left Bank Canal	212	78916
2.	Hemavathy Right Bank Canal	91	8093
3.	Hemavathy Right Bank High Level Canal	97	22662
	TOTAL		109671
4.	19 Lift Irrigation Schemes		16,666

The present cost of the project at SR of 1999-2000 is Rs 3710.00 Crores.

STAGE OF WORK:

Hemavathy LBC length is 212 Km, in this earth excavation, C.D., Work is completed. All distributor canal work is completed. But the lining work is in progress.

Hemavathy RBC 91 Km length, excavation & CD work is completed. Lining work is in progress.

HRBC in 96 Km length, the CD work and distributory canal work is also completed. Balance work 60 Km bed and 50Km side lining work is completed. 36 Km bed, 46 Km side lining work is pending.

Out of 14 LIS 4 Projects are in completing stage other 10 projects are in different stages.

Since inception to the end of March 2007, the expenditure incurred is Rs.1138.28 crores. Potential created is 120882 Ha.

HEMAVATHY CANAL ZONE: TUMKUR.**BRIEF DESCRIPTION:**

The Hemavathy Canal Zone, Tumkur was formed as per Govt. Order No.PWD/11/PCO/87, Bangalore dated 14-1-1987 for execution of canal works in Tumkur and Mandya Districts.

Hemavathy Canal Zone, Tumkur has a jurisdiction with area proposed for Irrigation as under:

Sl.No.	Name of canal	Length in Km	Atchkat in Ha.
1.	'Y' Alignment	5.50	-
2.	Tumkur Branch Canal	240.00	95909
3.	Nagamangala Branch Canal	78.325	59488
4.	Lift Irrigation Scheme at the exit of Bagur-Navile Tunnel	-	2358
	TOTAL		157755

STAGE OF WORK:

Total length of 'Y' alignment is 5.50 Kms. Earthwork and C.D works completed. Lining works has been taken up and are being executed. Till now 2.80 Kms lining is completed and balance work is under progress.

The lining works were taken up from 2000-01 in stage by stage. So for 2.80 Km length of lining is completed. Lining works for balance length is under progress.

Tumkur Branch Canal (0-204 KM)

Total length of this canal is 240Km. An atchkat of 95909 Ha. can be irrigated after the completion of this canal works. The Earth Work, formation of embankment, constructions of CD works are completed in the reach from 0 to 124 Kms during 1997-98. The lining works are taken up and a progress of 105 Km is achieved. The lining works in the balance 19 Kms are under various stages of progress. In the second stage, the Earth Work excavation and construction of CD works from Ch: 125 to 187 Km are taken up and are almost in completion stage.

Since 1996 water is being allowed in the canal upto 183 Km for Khariff seasons for land development activities.

The water is being allowed since 1996-97 to Eachanur Tank and Bugudanahally Tanks to provide drinking water supply to Tiptur and Tumkur towns. Action is also being taken as per the decision of irrigation consultative committee.

The Earth work and construction of CD works of 19 distributaries coming in the reach from 0 to 124 were completed during 1997-98 & 98-99. The alignment of canal from 125 Km to 187 Km and 185 Km to 200 Km is approved. The survey work of further reach is under progress.

Nagamangala Branch Canal (0 to 78.325 KM)

The total lengths of this land is 78.325 Km having an atchkat of 59488 Ha.

The Earth Work of canal from Ch: 0 to 78.325 Km is completed and water is allowed upto 59 Kms. The aqueduct in Km. 65.66 is under progress. After the completion of this work, water can be allowed upto tailend. About 17Km of lining work is completed and the lining works in balance reaches is under progress.

(Distributories): The works are under various stages of progress in 14 distributaries coming in the reach from 0 to 67.5 Kms. Water is allowed upto D-10 for land development activities.

The works of D-11 to D-18 are under various stages of progress.

Bagur-Navile Exit Lift Irrigation Scheme: It is proposed to provide irrigation facility to 2358 Ha of land by this scheme. Progress of 2148.45 Ha is achieved upto the end of Dec-2006. The works of Raising Main, Distribution Chamber, Jackwell cum pump house are completed and the scheme is commissioned. Canal works are under progress.

The total expenditure incurred so far upto the end of Dec-2006 in Hemavathy Canal Zone, Tumkur is Rs.995.69 crores and the total irrigation potential created so far is 96718 Ha.

FINANCIAL / PHYSICAL:

Since inception to the end of March 2007, the expenditure incurred is Rs.1049.37 crores. Potential created is 11963 Ha.

GROUND WATER POTENTIAL OF THE COMMAND AREA :

Groundwater aquifers are limited in the area. Shallow groundwater is recharged by percolation from rainfall and irrigation in the GCA and lateral flows from the nearby watersheds. The net potential contribution from groundwater is thus minimal but shallows aquifers are used as a local recycling storage, numerous pumping stations are benefiting from this storage.

RAINFALL IN THE COMMAND AREA

Annual rainfall in the Command Area (CA) is a quite variable from 700 up to 1500 mm. The general gradient East-West which has a significant effect in the watershed.

EXTERNAL SOURCES OF WATER

The external sources of water to the CA are mainly from surface streams (small) bordering the GCA. The areas of the adjacent watersheds draining into the CA have been assessed, it amounts to XXXXXXXX ha.

IRRIGATED AGRICULTURE

The notified irrigated area in 2007 amounts to 96,000 ha.

3. MASSCOTE in Hemavathi Irrigation Project

Step 1. RAPID DIAGNOSIS

A RAP (Rapid Appraisal Procedure) was carried out as part of the first step of the exercise during the June 2007 workshop. The following sections is the RAP executive summary.

RAP Methodology

The RAP is a quick and focused examination of irrigation systems and projects that can give a reasonably accurate and pragmatic description of the status of irrigation performance and provide a basis for making specific recommendations related to hardware and management practices. The first step in evaluating irrigation performance, whether at the farm level or an entire irrigation project, is to perform a rapid appraisal (RAP) of the system as it is being operated.

The RAP can be described as follows:

The Rapid Appraisal Process (RAP) for irrigation projects is a 1-2 week process of collection and analysis of data both in the office and in the field. The process examines external inputs such as water supplies, and outputs such as water destinations (ET, surface runoff, etc.). It provides a systematic examination of the hardware and processes used to convey and distribute water internally to all levels within the project (from the source to the fields). External indicators and internal indicators are developed to provide (i) a baseline of information for comparison against future performance after modernization, (ii) benchmarking for comparison against other irrigation projects, and (iii) a basis for making specific recommendations for modernization and improvement of water delivery service.

Use of a systematic RAP for irrigation projects was introduced in a joint FAO/IPTRID/World Bank publication entitled *Water Reports 19 (FAO) – Modern Water Control and Management Practices in Irrigation – Impact on Performance* (Burt and Styles 1999). That publication provides an explanation of the RAP approach and gives the results from RAPs the authors conducted at 16 international irrigation projects. Refer to Water Report 19 for further background to the RAP approach, available directly from FAO (<http://www.fao.org/icatalog/inter-e.htm>).

RAP is now fully integrated as the STEP 1 or the foundation of the new approach developed by FAO for modernization strategy and plans which is called MASSCOTE.

A key component of the successful application of the RAP and MASSCOTE approaches is the knowledge and experience of qualified technical experts that can make proper design and modernization decisions. It is critical that MASSCOTE-RAPs are conducted by irrigation professionals with an extensive understanding of the issues related to modern water control. This technical capacity building will be addressed initially through training workshops that are going to be held by the FAO. In addition to making proper recommendations for modernization, evaluators using the RAP approach must have the ability to synthesize the technical details of a project with the concepts of water delivery service into a functional design that is easy-to-use and efficient.

Key performance indicators from the RAP help to organize perceptions and facts, thereby facilitating the further development of a modernization plan through the different steps of MASSCOTE. From the RAP we have already some good indications on:

- Further investigations that should be carried out for the development of the modernization plan.
- Specific actions that can be taken to improve project performance
- Specific weakness in project operation, management, resources, and hardware
- The potential for water conservation within a project

Broad goals of modernization are to achieve improved irrigation efficiency, better crop yields, less canal damage from uncontrolled water levels, more efficient labor, improved social harmony, and an improved environment by reducing a project's diversions or increasing the quality of its return flows. In general, these goals can only be achieved by paying attention to internal details, or the internal indicators. The RAP addresses these specific internal details to evaluate how to improve water control throughout the project, and how to improve the water delivery service to the users.

Looking at different management levels

When one analyzes a project by “levels” (office, main canal, second level canal, third level canal, distributaries, field), a huge project can be understood in simple terms. The operators of the main canal only have one objective – everything they do should be done to provide good water delivery service to their customers, the distributary/minor canals (and perhaps a few direct outlets from the main canal). This “service concept” must be understood and accepted by everyone, from the chief engineer to the lowest gate operator. Once it is accepted, then the system management becomes very simple. Personnel on each level are only responsible for that level's performance.

An important step of MASSCOTE is precisely to start from this diagnosis and re-organize the management of the system into units which are functional, responsible and responsive and consistent with the main features diagnosed in the gross command areas. On large system the partitioning into management units is fundamental to allow an effective service oriented management from one level to the other down to the end-users.

Main canal operators do not need to understand the details of that day's flow rate requirements for all the individual fields. Of course, in order to subscribe to the service concept, operators generally need to know that their ultimate customer is the farmer. But the details of day-to-day flow rates do not need to be known at all levels. Rather, the main canal operators have one task to accomplish – to deliver flow rates at specific turnouts (offtakes) with a high degree of service.

External indicators

The external indicators compare input and output of an irrigation system to describe overall performance. These indicators are expressions of various forms of efficiency, for example water use efficiency, crop yield, and budget. But they do not provide any detail on what internal processes lead to these outputs and what should be done to improve the performance. They, however, could be used for comparing the performance of different irrigation projects, nationally or internationally. Once these external indicators are computed, they are used as a

benchmark for monitoring the impacts of modernization on improvements in overall performance.

Key findings

- Hemavathi is a complex project in terms of water circulation, it integrates irrigated areas fed by canal water and by tanks or by recycled systems in the downstream part, plus additional water supply from shallow groundwater. As a consequence it is difficult to estimate the value specifically associated with irrigation water and in particular to calculate the productivity per m³.
- When compare to other systems, Hemavathi rank medium for the value generated per ha (1200 \$/ha). (Based on the figures of yield, price and area in the RAP sheets of the Water Balance. THESE FIGURES are to be checked again)

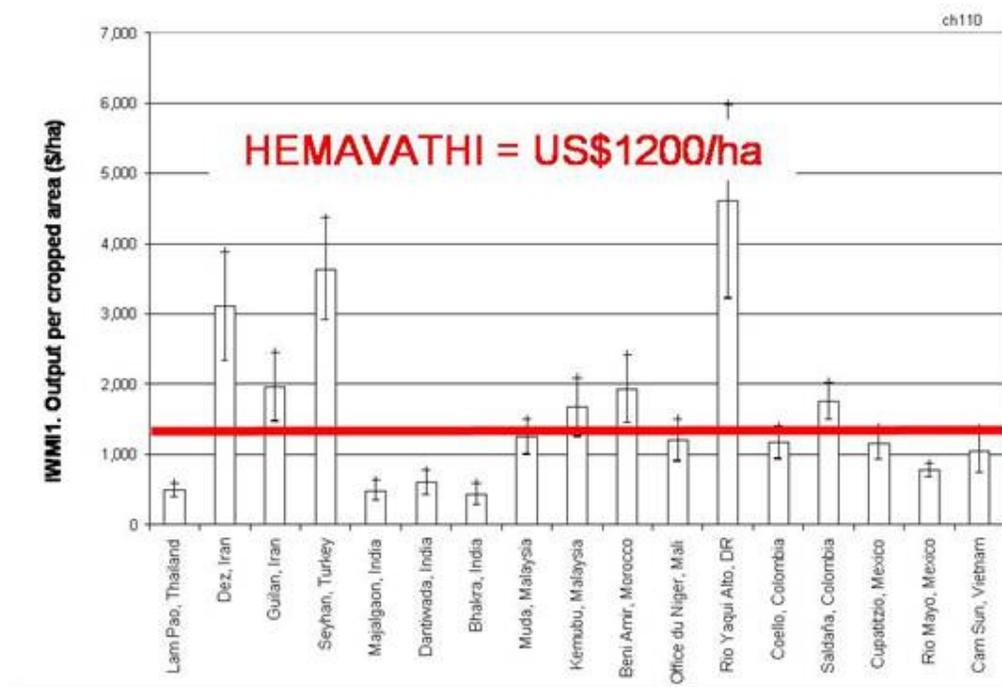


Figure 2. Economical Value of the agriculture production per ha

Internal Performance Indicators

The Rapid Appraisal carried out in the Hemavathi Project focused on internal project operations and canal system infrastructure. The objective was to identify the key factors related to water control, measurement and communications in the system as well as to the social organisations. The completed result of the RAP including those for the main canal, secondary and tertiary canals, and final deliveries are contained in **Appendix 1**.

The internal indicators quantitatively assess the internal processes (inputs - resources used and the outputs - services to downstream users) of an irrigation project. Internal indicators are related to operational procedures, management and institutional set-up, hardware of the

system, water delivery service etc. These indicators are necessary in order to have comprehensive understanding of the processes that influence water delivery service and overall performance of a system. Thus they provide insight into what could or must be done to improve water delivery service and overall performance (the external indicators).

Participants were divided into 5 groups:

- **Group 1: RBC Low High levels**
- **Group 2: UPSTREAM LB (km 0 to km 130)**
- **Group 3: DOWSTREAM LB (km 130 to km 212)**
- **Group 4: TUMKUR BRANCH**
- **Group 5: NAGAMGALA BRANCH**

They spent 2.5 days on the field and gave ratings to all internal indicators. During a plenary session rating were reviewed and finalized.

The values of the primary internal indicators reflect an evaluation of the key factors related to water control and service throughout the command area. The internal indicators and their sub-indicators at each level of the system are assigned values from 0 to 4 (0 indicating least desirable and 4 indicating most desirable).

A discussion of the internal indicators for the Hemawathi Project compared to other international irrigation projects is included in **Appendix 2**. In general, the internal indicators for the Hemawathi Project were much lower than the other international irrigation projects evaluated by FAO during last decade.

Key findings from the RAP/Field visits

1. Highly recycling cascade system. 2 major sources: Canal & Rainfall – and locally potential of 2 additional: tanks, groundwater.
2. High consuming & productive crops mainly (rice, sugarcane, garden) deviating from official cropping pattern.
3. Absence of water control (level or discharge) and proper measuring structures at all levels.
4. Downstream part of the canal runs below FSD: It increases outlets sensitivity and chaos
5. Severe inequity along MC and SC: pockets of water scarcity - over irrigation in initial reaches
6. Maintenance is not sufficient
7. Management is too fragmented and communication set up inappropriate.
8. On paper WUAs - involvement of farmers in water management is too low.
9. On farm water management skill is low.
10. In practice official “Kharif area” and “Rabi area” are not followed.
11. In practice rotation of water is not properly done in upstream reaches.

But:

- No major physical constraints
- Good assets, drainage
- Good communications and transportation



Figure 3. Canal not old yet degraded

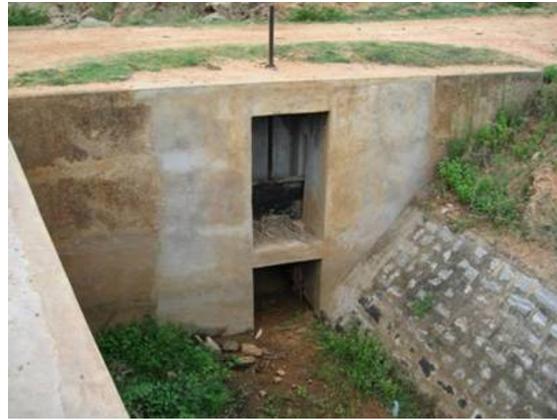


Figure 4. Rehabilitation of gates

Improper maintenance leads to rehabilitation

The infrastructure is at most 15 years old yet improper maintenance (figure 3) has already yield to rehabilitation works (Figure 4.).



Figure 5 Pockets of water scarcity on high lands along the canal (limited access to groundwater)

Main Canal of Hemawathi Project

Table 1 summarizes the internal performance indicators for the Main Canal of the Hemawathi Project. It shows the relatively low values suggesting widespread problems of poor levels of performance, particularly those that are associated with operations. Equity along the main canal is an issue as the tail-enders are receiving highly fluctuating and lower than expected supply.

No water level control

The main canal cross regulators are not used as water level control but associated with the near by offtake as a partition structure to split discharge between Main canal and offtaking secondary canals. Thanks to the generally low sensitivity of the offtakes the water deliveries to the secondary level remains to a certain extent under control. But there is obviously an amplification of the perturbations as we go downward.

The concept of “no water level control” which might work well with insensitive offtakes and a strictly constant discharge in the main canal is increasingly distorted/degraded as we go down along the canal. The result is that the tail-enders are hit by large fluctuations of discharge as shown in MASSCOTE Step 4 on Perturbation (Figures 12 & 13).

Communications among the canal operators is present and could be easily improved.

Certainly one of the main management problems is the fragmented partition of the main canal operation: too many divisions and subdivisions preventing from having an overall assessment of the flows.

Table 1. Internal Performance Indicators for the Main canal of Hemawathi Project
(Maximum possible value = 4.0, minimum possible value = 0.0)

Internal Performance Indicator	Value (0-4)
Cross regulator hardware	2.4
Headgates (distributaries/minors) from the Main Canal	2
Communications	2.3
General Conditions	1.2
Operations	1
Actual Water Delivery Service by the Main Canals to the Secondary Canals (overall index)	0.8

Secondary Canals in Hemawathi Project

The performance of the secondary canals (branch and main distributary) in the Hemawathi Project is summarized by the key internal indicators in Table 2. In general, the performance indicators for the second level canals were substantially worse than those for the main canal.

The secondary canals **are not equipped with water level control structures** whereas discharge changes a lot from one season to the other and probably during each season as well. During low flows in the canals the issue of water level is critical and operators are taking some temporary measures to raise the water level (blocks placed at bottom bed of the canal). This lack of water control structures increases the chaos downward.



Figure 6 Deficient water level control along a secondary canal leading farmers to tinker.



Figure 7. *Water flows does not go that far along ditributaries and tertiaries (often between 1/3 and 1/2 only of the canal length receives water).*

Table 2. Internal Performance Indicators for the Branch /Distributaries in the Hemawathi Project (Maximum possible value = 4.0, minimum possible value = 0.0)

Internal Performance Indicator	Value (0-4)
Cross regulator hardware	1.4
Turnouts (watercourses) from the Distributaries/Minors	3
Communications	2.1
General Conditions	0.7 to 3
Operations	0.7 to 2.4

Tertiary Canals and final deliveries

The internal indicators that characterize the actual water delivery service at the farm level are summarized in **Table 3**. The water delivery service being provided to the farmers is relatively low. This is a measure of the flexibility, reliability, equity, and measurement of the water supply to individual fields. The social order indicator reflects the degree to which irrigation deliveries are being taken either from unauthorized locations or in quantities greater than allowed. If one considers that many of the direct outlets, which divert up to 30-40% of the total irrigation supply, are not officially sanctioned or managed as part of the rest of the system, then the social order indicator should be much lower.

Table 3. Internal Performance Indicators for the Minors/laterals/Field channels in Hemawathi Project

(Maximum possible value = 4.0, minimum possible value = 0.0)

Internal Performance Indicator	Value (0-4)
Cross regulator hardware	1.2
Turnouts (watercourses) from the Minors/Laterals	1 to 3
Communications	1.8
General Conditions	0.6 to 2.4
Operations	0.7 to 2.4

Table 4. Final Delivery Point Internal Performance Indicators (0-4)

(Maximum possible value = 4.0, minimum possible value = 0.0)

Actual Water Delivery Service to Individual Ownership Units (e.g., field or farm)	<u>RB & UPSTREAM</u> <u>LB (0-130)</u>	<u>DOWNSTREAM</u> <u>LB (130-212)</u>
	<u>0.8</u>	<u>0.2</u>
Measurement of volumes	0.0	0.0
Flexibility	1.0	1.0
Reliability	1.0	0
Apparent equity.	0.75	0

The ratings for the internal indicators describing employees and farmer organizations show significant room for improvement. Employees, especially field operations staff, had little or no incentive to provide excellent service to farmers and were not empowered to make decisions on their own. The farmer organization indicator is low due to the fact that they had little ability to influence the real-time management of the system or to rely on outside help for enforcing rules and policies. Farmer organizations have only minimal input into the day-to-day operation of the system.

Management and Water user societies

Small, few functions and impact, fewer resources
 Things have not improved for farmers
 Will not solve the O&M issue

Table 5. Water User Association Internal Performance Indicators (0-4)
 (Maximum possible value = 4.0, minimum possible value = 0.0)

Water User Associations	0.5
Percentage of all project users who have a functional, formal unit that participates in water distribution	0.0
Actual ability of the strong Water User Associations to influence real-time water deliveries to the WUA.	1.0
Ability of the WUA to rely on effective outside help for enforcement of its rules	1.0
Legal basis for the WUAs	1.0
Financial strength of WUAS	0

The key points from **Tables 1 to 5** include:

- The level of service to individual field outlets is well below what is required to support modern on-farm water management and crop diversification.
- Flow measurement is not being done anywhere in the system. The actual operations are based on staff gauge readings (water levels) downstream of the regulation points. Operators and managers only have a vague idea about how much water (rate or volume) is being delivered at any particular point in the system.
- Communications between the field operators and division/sub-division offices is frequent and reliable. The operators are used to taking regular staff gauge readings, which can be used as the foundation for introducing real-time flow measurement when accurate flow measurement devices are installed.

Step 2. SYSTEM CAPACITY AND SENSITIVITY.

Objective: *Assessing the physical capacity of irrigation structures to perform their function of transport, control, measurement, etc.*

Assessing the sensitivity of Irrigation Structures (offtakes and regulators), identification of singular points. Mapping the sensitivity.

SYSTEM CAPACITY

STORAGE

- Reservoir Existing capacity = 37.1 TMC (1050.63 MCM)
- In most of the years, the project is receiving water more than the planned utilisation
- Storage capacity of the dam is adequate (No reduction due to siltation)
- Because of legal obstacles no additional storage can be developed

Conveyance along MC and DC

- Conveyance is OK to match the design discharge of the project (capacity of initial reach of main canal 4000 cusecs)
- Some problems due to lack of maintenance of the canal network (accumulation of silt) and in some deep cut reaches such along TMC and MMC

Diversion & Distribution

- Offtakes are of orifice type (under shot): capacity to divert the design flow into the distributaries is OK.
- Few proportional semi-modular structures in the distributaries (e.g., km.14 of D-8 of TBC) where flow is affected due to damage caused by the farmers.
- Designed to irrigate 50% of area each season, currently 100% is irrigated each season and therefore water is not enough for tail enders

Control and measurement

- Control structures are not used to regulate water depth.
- Flow measuring devices: no direct measurement at the head of the canal; one flume at Km 151; gauge posts are not calibrated.
- Flows in secondary and tertiary canals are not assessed (only water level observed). Gauge are not properly maintained (see figure below) and no calibration is made.



Figure 8. Left: flume installed along HLBC km 151 – Right post upstream a distributary

Safety

- There are various escape structures along the canal used for evacuating excess flows as well as for feeding tanks.
- The canal is provided with required free board
- in some places dowel bunds are missing to prevent entry of rain water entering and causing damage to the main canal.

Transmission and Communication

- No dedicated communication network but communications are done through mobiles/public phones/messengers
- Mostly one-way
- Feedback from users not systematically collected /communicated
- Transportation (roads) along main canal in fair condition
- Along distributaries and minors: Service roads are not continuous

SENSITIVITY

- Sensitivity of turnouts increases along the canals in particular along HLBC and NBC.
- For NBC Low sensitive up to 72 km (0.3 to 0.7) highly sensitive beyond 72 km (1.5 to 2.0).
- Sensitivity of structures along the secondary and tertiary canals is also varying from low (below 0.5) to high (above 1,5).
- Cross regulators are of low sensitivity (less than 1).
- Due to fluctuations of water level, the discharge of many turnouts with high sensitivity, is erratic.



Sensitivity indicator
Dy 39 at 84 km

$$\text{Head} = (1.70 - 0.90) = 0.80$$

$$S = 0.5 / (0.8) = 0.62$$

Figure 9. Example of low sensitive offtake ($S = 0.62$) when canal is run at FSD



Figure 10. Example of sensitive offtake low head between parent and downstream canals.

STEP 3: THE PERTURBATIONS

Perturbations analysis: causes, magnitudes, frequency and options for coping with.

Origins of perturbations:

- Runoff entering the main canal Inlets with silt traps along the canal.
- Rainfall.
- Return Flows: Ex. Huvinahalli pickup (weir) to the main canal at 196 Km - Thonnur tank at 10 Km of secondary channel D66
- Unauthorized pumping, illegal withdrawals (syphons).
- Overdrawal of water at offtakes.
- Rotation system of distribution.



Figure 11. Inlet from small watershed in TB

Water level perturbations along the main canal

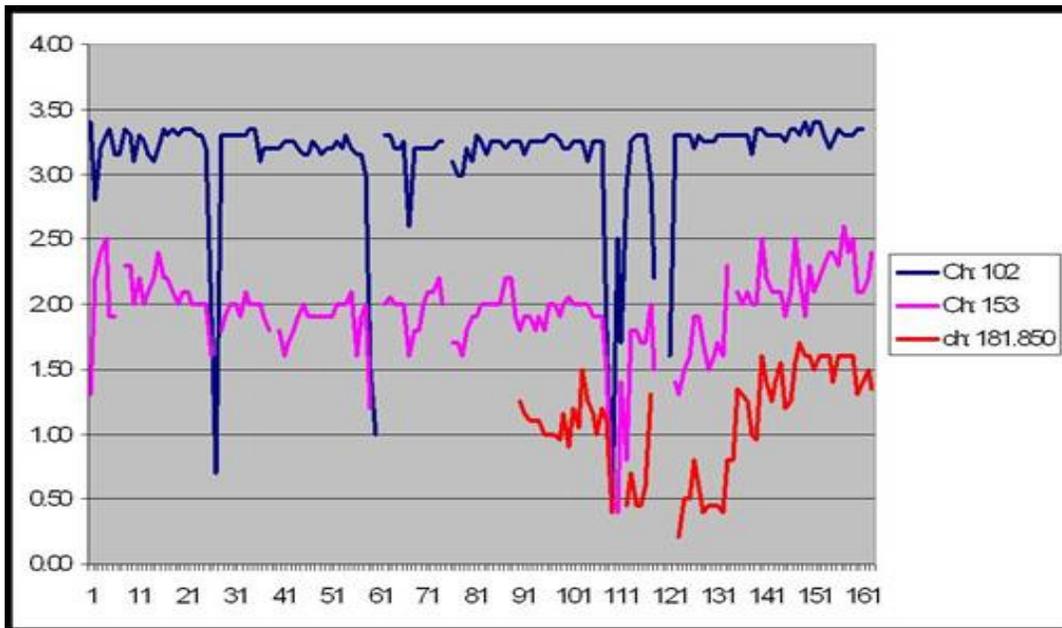


Figure 12. Water level recorded at various location along HLBMC

Discharge perturbations

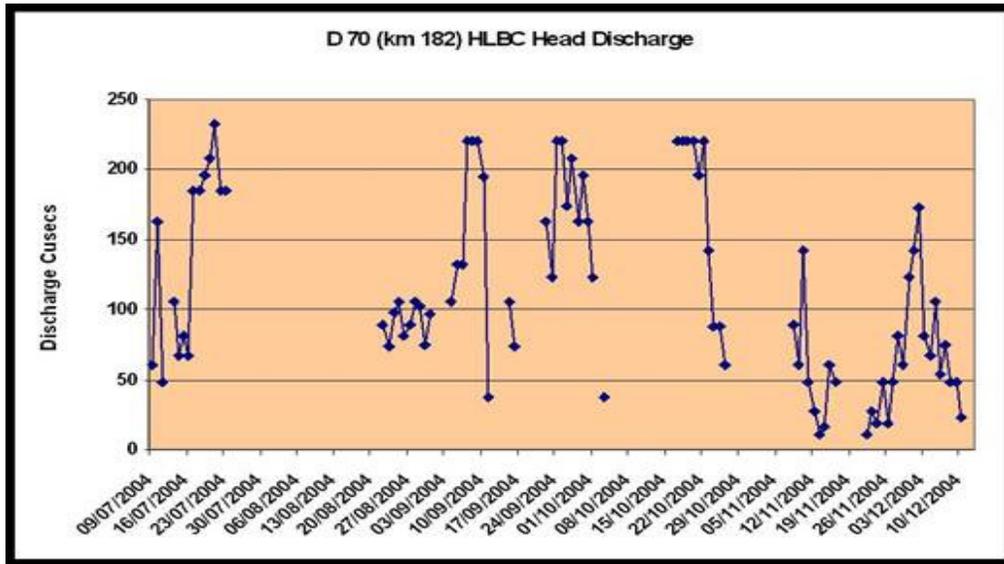


Figure 13. Discharges recorded at Head of a secondary canal D 70

OPTIONS TO COPE WITH PERTURBATIONS

- Buffer storage: Utilizing existing tanks as balancing reservoirs along main canal of TBC. (Bugadanahalli tank in Km.124, Melekote tank in Km 133, Adalapur tank in KM 140)
- Restriction of illegal withdrawals.

Step 4 MAPPING WATER NETWORKS & WATER BALANCE/ACCOUNTING

Objective: *The objective here is to map the nature and structure of all the streams and flows that affected and are influenced by the command area. It includes assessing the hierarchical structure and the main features of the Irrigation and drainage networks, natural surface streams and groundwater, and the mapping of the opportunities and constraints including drainage and recycling facilities.*

WATER ACCOUNTING:

Water accounting is a fundamental of irrigation water management as well as operation of the canal infrastructure. It is observed that no water accounting is being done for the GLBC project and it is strongly suggested to conduct water accounting studies for GLBC for evolving appropriate modernization strategies at various levels: local management areas as well as for the GLBC.

Project

Physical boundaries of the project:

Drainage network and Measurement:

Spill Measurement:

Monitoring ground water levels :

Cropping Patterns :

INFLOWS

RAINFALL

It is one of the important constituents of inflows. Here, the density of the rain gauge stations and also the area it represents in the command area is an important factor to be considered. If the density is low, the spatial distribution of the rainfall in the command will not be truly reflected as there is wide variation in rainfall distribution, especially if the command is very big.

STREAM FLOW FROM OUTSIDE THE COMMAND

The stream flow due to rainfall from outside the command enters into the command and flow through the drains. Part of the stream flow enters the ground water and helps in recharge of the ground water and the rest flows out of the system.

CANAL WATER APPLICATION

GROUNDWATER

The depth to groundwater is variable of course. An example of annual variation is given in the figure below, which shows that depth to groundwater varies from 10 to 20 meters.

OUTFLOWS

EVAPOTRANSPIRATION:

The Evapotranspiration is the largest and most important component of water balance. This is estimated as the product of cropped area irrigated and evapotranspiration (Etc) for each crop. Etc is the product of ET₀ which is the reference Evapotranspiration based on climatological data and K_c, the crop coefficient, which is specific to each crop. Thus, the quantity of water consumed as Evapotranspiration from the crops in the command can be worked out. Here, it is important to correctly assess the type of crops grown and the correct acreage. The area and crops grown by unauthorized irrigation within the command is to be considered also. If there is any limitation in the optimum use of water for any cropped area and shortage of water, a stress coefficient ranging from 0 to 1 will have to be considered to arrive at the right amount of Evapotranspiration.

As usual the official cropping pattern is not followed by farmers, and in the absence of reliable survey our best guess is the followings partition crop:

rice	40 %
sugarcane	21%
garden (turmeric, bananas)	32 %
Ragi (semi dry)	7 %

DRAINAGE FLOWS:

The surplus water after application to the fields and also to some extent the seepage water enters into the drainage in the command area. Also, the storm water during rains both from outside the command and inside enters the drainage of the system. This is an important component of outflows that need to be measured. The data of drainage flows at key points in the system is necessary to estimate the flows. In a sub-management unit, the flow leaving the unit needs to be measured. The mapping of structures such as Bandharas, barrages and tanks will help the management to know where the surplus flows and seepage water is being recirculated and also to plan new structures for optimum use of water.

Given the shortage of water there is no spills occurring at the end of the canals, main canal or secondary canals.

Water recycling facility

Water Balance: a first proxy

A rough annual water balance in _____ is given in the graph below. This balance considered the following components:

- Canal water for Rabi and Kharif: measured; averaged 2000-2005 = 1170 MCM

- Rainfall over the GCA [181 000ha] measured; averaged 30 years 550 mm = 996 MCM
- the aerial outflows from Evapotranspiration all over the GCA at ETo 1600 mm = 2900 MCM.

The resulting estimated deficit to cover crops needs when rainfall and surface water are accounted for is the net input from external sources, i.e. mainly groundwater. In this estimation the contribution from external sources of groundwater is about 732 MCM.

Comments:

- 1) Rainfall is taken as 100 % because in one way there is no drop of rainfall getting out of the system. Every drop will be i) used directly through evapotranspiration, or ii) recharge groundwater (and reuse) or iii) contribute to the increase the surface streams which are captured by dams along the two major rivers.
- 2) Canal water is considered same as 100% input: direct use, recharge or runoff recycled.
- 3) The Deficit is thus the net external source brought by groundwater laterals flows from the rivers.
- 4) To be conservative the demand for Evapotranspiration has been taken on the high side: considering the entire GCA and not the NCA, and considering ETo as if all crops were having permanently a Kc (crop coefficient) factor of 1.
- 5) If we restrict the demand to the NCA then the value of the deficit drops down to 412 MCM.
- 6) If we further considered an average coefficient of 0.9 instead of 1, then the deficit is reduced to 154 MCM that is 7 % of the total.

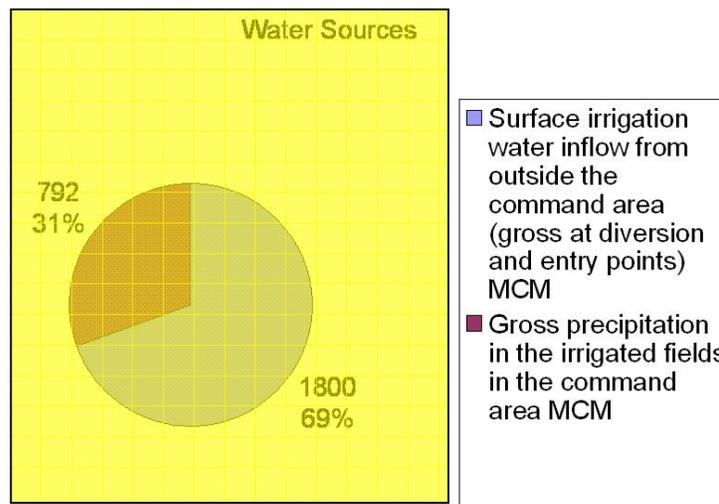


Figure 14. Water Balance in Hemawathi project ????? TO BE REVISED

Step 5 MAPPING THE COST of OPERATION

Objective: the objective is to gather as much as possible elements of costs entering into the operation of the system in order to identify where possible gains should be sought for with the current service and operational set up, and what would the cost of implementing improved service. This step thus focus on mapping the cost for current operation techniques and services, disaggregating the elements entering into the cost, costing options for various level of services with current techniques and with improved techniques.

Cost of Management Operation and Maintenance

420 Millions Rs is the estimated budget for Hemawathi project which accounts for MOM [not including investment in infrastructure expansion].

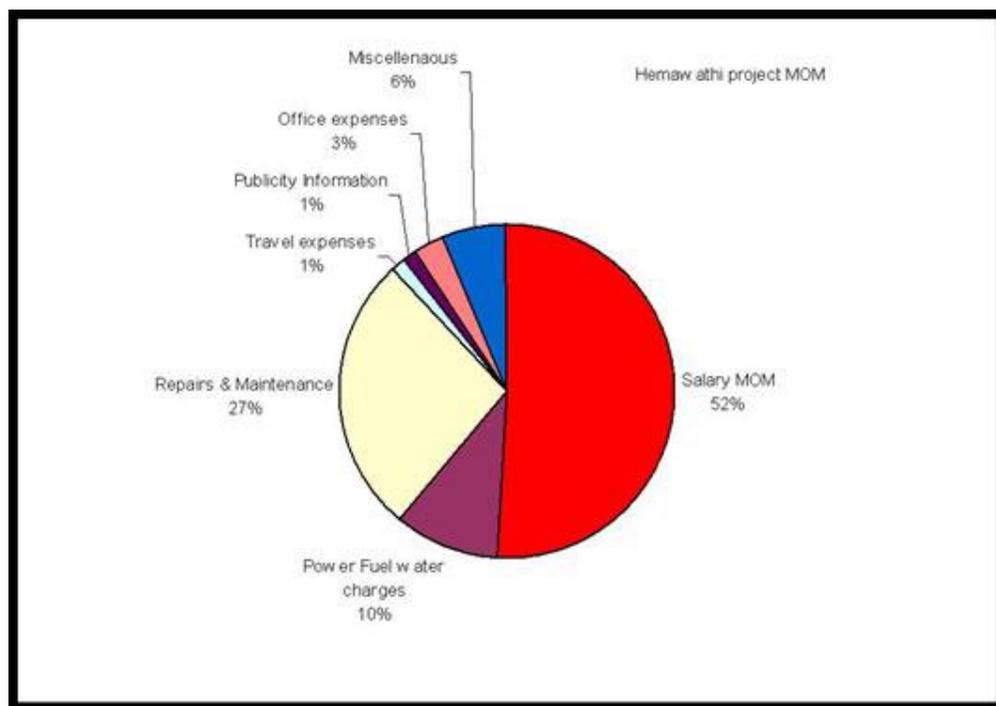


Figure 15. Showing the breakdown of the budget for MOM Hemawathi project

- 42.2 Crores/year 10.3 M \$
- 40 \$/ha for the entire GCA
- 110 \$/ha for an estimated served area of 92000ha

Step 6 SERVICE to USERS

Objective: *Mapping existing and possible options for services to Users with consideration to Farmers and Crops as well as to Other Users of water.*

The service to users is at the heart of the MASSCOTE development process. A single one go is not sufficient to characterise all aspects and options of the water services. Several back and forth are required to converge towards a “service” that is desirable, possible to implement and at an agreed upon cost with the users, consistent with the management constraints and set up.

Water uses for canal water

1. Irrigation water (farmers) : Farmers are allotted, scheduled & delivered water on volumetric basis depending upon the availability of water in the reservoir and considering the command under each turnout .
2. Drinking water: Designated towns are allotted, scheduled & delivered water to an extent of 8 TMC during the period of flow in canal.
3. Power Generation: No specific allocation is made for power generation; power is to be generated during the period of flow in canal allowed for irrigation.

Complex conjunctive water uses: recycled water, tanks, bandaras and groundwater

Once the canal water enters the CA, it ‘s becoming rapidly difficult to distinguish it from the other water flows (external and internal runoff, tanks, groundwater flows etc..). Thus water use in the command area is covering a much larger area than that of restricted to canal water. This is quite obvious today where canal water does not go beyond 1/3 on some secondary canal while irrigation from others sources is thriving throughout the entire CA. This situation of a complex conjunctive water use is likely to prevail in the future.

Although good management should keep tracks of all water flows below the canal, by assessing regularly main flows, storage level in tanks, in bandaras, and groundwater aquifers it is not realistic to monitor carefully all water flows in the atchkats (CA) under the various sub-command areas. One has to come up with lumped management units, for which outputs are monitored to allow reacting on inputs whenever required.

SCENARIOS

An important element in the design of modernization plans is to envision the future of the agriculture system before discussing the way irrigation management can and will respond to support that vision.

During the Hemawathi workshop 3 scenarios/visions have been investigated with respect to agriculture and water management. They are:

- Scenario 0 Business as Usual
- Scenario 1 Conservative Efficient : Self imposed crop based restriction
- Scenario 2 Liberal Performant : Non imposed & market driven agriculture management

Scenario 0 Business as Usual

The business as usual scenario considers that no changes (technical, design, managerial, institutional, etc..) are brought in the way irrigation systems are developed, managed, operated and maintained. Therefore basically this scenario is the prolongation of current trends and this leads to a non-viable scenario according to the participants, as the current identified problems are likely to worsen to an unacceptable level.

Participants identify the following characteristics/outcomes, most of them negative of this scenario:

- Increase about 10% of wet crops in the initial reaches, further depletes the % of irrigation in the lower reaches
- Violation of cropping pattern is continued
- Uncontrolled flow
- inequity of distribution
- Strain on network and managers increases
- More beneficiaries, additional strain on the system
- Maintenance cost increases
- Flexibility, Reliability & equity reduces
- Vandalism increases
- Tax collection impossible
- Energy consumption increases
- Loss to Govt.
- More GW pumping resulting in further depletion
- Deficit in CNL budget increases

This scenario was considered by participants as non viable and not to be recommended. This means that a strong change needs to be implemented in the management of the project to depart from BAU, and prevent these problems.

Scenario 1 Conservative-Efficient: Self imposed crop based restriction

The idea behind this scenario is to retrieve the path of efficiency and equity on the basis of a self imposed restriction to canal irrigation. Somehow the initial objectives of the project are not changed but the ways to reach them are completely renewed, instead of having a top down imposed cropping pattern and water distribution pattern, these are based on a participatory approach and self discipline by users.

Scenario 2 Liberal –Performant: Volume based management and freedom for cropping pattern

The idea behind this scenario is to make users fully responsible in making agriculture choices, water resources is allocated on volume basis to each user or group of users. Equity is reached by taking into consideration alternative sources of water in setting canal water allocation.

It is anticipated that the cropping pattern will evolve towards more perennial cash crops.

The main characteristics of this scenario as discussed by participants are briefly presented in the following table.

ELEMENTS	SCENARIO - 1 Conservative-Efficient	SCENARIO - 2 Liberal –Performant								
1) AGRICULTURE SYSTEM:	<p>As initially planned during the design stages of the Hemawathi project the agriculture system should restrict itself to what is made possible by limited but equitably shared water resources by favoring low water demanding crops.</p> <p>It is anticipated that somehow the agriculture systems will be closed to what was initially suggested that is:</p> <ul style="list-style-type: none"> • Rice Kharif • Garden (perennial) • Semi dry crops 	<ul style="list-style-type: none"> • Users need based Agricultural System • No specific agriculture system envisioned. • In Market driven agriculture economy, farmers are the Key Actors / Decision Makers for agriculture system and water. 								
2)CROPPING SYSTEM AND IRRIGATED CROPPING PATTERN	<p>Self imposed cropping pattern decided by the users for better equity by involving WUAs and Federations with a specified discharge at the turn-outs of the main canal.</p>	<ul style="list-style-type: none"> • Free cropping pattern with fixed seasonal allocation of water (subject to availability of water) to the WUA. WUA to manage the allocated volume. • Variation with in the season permitted to the WUA with in the allocation and system constraint – savings in Khariff can be carried over to Rabi. 								
3) TYPOLOGY OF WATER USERS :	<table border="0"> <tr> <td>Farmers</td> <td>: 85 %</td> </tr> <tr> <td>Drinking / Tank</td> <td>: 12 %</td> </tr> <tr> <td>Domestic</td> <td>: 1 %</td> </tr> <tr> <td>Others</td> <td>: 2 %</td> </tr> </table>	Farmers	: 85 %	Drinking / Tank	: 12 %	Domestic	: 1 %	Others	: 2 %	<ul style="list-style-type: none"> • – “Completely and sufficiently self-sustaining and able to deliver the water to the final Deliveries in real time” (Right quantum of water in right time) and legally empowered • skilled in integrated water utilization for agriculture, horticulture, poultry, dairy, fishiculture etc • Trained in efficient use of water and improved techniques.
Farmers	: 85 %									
Drinking / Tank	: 12 %									
Domestic	: 1 %									
Others	: 2 %									
4) ALLOCATION OF WATER TO FARMERS: RULES, MANAGEMENT UNDER SEVERE DEFICIT (WET / DRY YEAR)	<ul style="list-style-type: none"> • Based on designed discharge in the secondary canal (based on the extent of area). • ICC comprising of members like elected representatives, Chairman of CADA, President of federations and project authorities. • Decides the period of releases based on the availability of water in the reservoir. • Crop calendar is defined. • Water will be released only for drinking during acute 	<ul style="list-style-type: none"> • Allocation to WUA on per hectare basis (5000 to 6600 cum/ha) • Availability of water at the end of khariff to be assessed and shared among the users equitably during Rabi (access / no access to ground water) • Measurements along main canal and distributories to ensure that there is no inequity problem. • Deliveries of canal water to the tanks are to be measured. 								

	shortage.	
5) SYSTEM NETWORKS: MODERNIZATION OF OPERATION AND MAINTENANCE	<ul style="list-style-type: none"> • System network is adequate. No Conversion required. • Controlling and measuring devices are necessary. 	<ul style="list-style-type: none"> • Complete the canal Networks as planned. • Rehabilitation of structures , maintenance and strengthening of monitoring unit and utilization of regenerated water by recycling • Modernised to suit needs of the water users • LEVEL CONTROLE DEVICES in all levels of canal up to third level introduced. • Measuring devices like Sensors / Data logging etc. introduced.
6) WATER SERVICE: FLEXIBILITY, RELIABILITY, EQUITY, COST	<ul style="list-style-type: none"> • Flexibility : Low. • Reliability : Good. • Equity : Equity at secondary level. • Water rate will be more than present tariff. 	<ul style="list-style-type: none"> • Flexible Cropping pattern. • Highly Reliable water delivery service. • Equity – (access / No access of Ground Water) • Increase in O & M cost per unit water with the enhanced efficiency. • Increased tariff – revised as per needs to support the system.
7) TECHNIQUE AT FIELD LEVEL	<p>A strong effort in developing the farmers’ capacity with regard to the following aspects:</p> <ul style="list-style-type: none"> ➤ Adopting less water consuming-high yielding crops. ➤ Using sprinkler and drip irrigation system wherever possible. ➤ Crops based on properties of soil. ➤ Market oriented crops. ➤ Economics of agriculture. 	<ul style="list-style-type: none"> • Improved surface irrigation (Sprinkler / Drip irrigation), SCADA (Supervisory Control & Data Acquisition)introduced, metering for volumetric measurement introduced. • Co-operative Farming • High yield - low duration crop using modern techniques like <u>SRI</u> (paddy)
8) GROUND WATER	<ul style="list-style-type: none"> • Probable usage of ground water for second crop in the off-season. • Liberty to use ground water. 	<ul style="list-style-type: none"> • Optimum utilization of Ground water by RECIRCULATION and RECHARGE. • Increased water table in command area, supplementing canal water by conjunctive use and supply of water to upper un-command area within the command area allowed.
9) BUDGET AND FINANCE (WATER FEES: TARIFF, RECOVERY,	<ul style="list-style-type: none"> • Revenue will be raised and collected by the WUAs based on the type of crop grown. • Portion of the collected revenue will have to be remitted to the CNL for maintenance. 	<ul style="list-style-type: none"> • Involved and motivated WUA playing crucial role in balancing the operation and maintenance cost with recovery of tariff from farmers. • with reliable water service , operation and maintenance cost recovered in normal years

<p>FINANCIAL BALANCE)</p>		
<p>10) ROLE OF THE MAIN AGENCY AND OF OTHER BODIES</p>	<ul style="list-style-type: none"> • CNNL – Head works, main canal. • Ensuring supply of required discharge to turn-outs of main canal. • Federations to decide on cropping pattern, and monitor distribution of water from secondary level. • CADA shall be more effectively involved in training the farmers and educating to adopt modern techniques, rotational crops. • More number of trained operators are required. 	<p><u>Main Agency – CNNL :</u></p> <ul style="list-style-type: none"> • Regulation and Maintenance of Head works and Main canals and Branch Canals. • To provide water on volumetric basis to the distributing agencies (Water users Federation) • A performing service provider and also responsible for providing facilities for augmenting canal water with recycling the regenerated water. • To conduct the trainings in water management and improved techniques. <p><u>Water users Federation–</u></p> <ul style="list-style-type: none"> • Overall responsibility and framing policies for effective functioning of LMAs and WUAs. • Responsible for collection water rates through LMAs. <p><u>Local Management Agency (LMA)-</u></p> <ul style="list-style-type: none"> • Size of LMA around 10,000 to 15,000 Ha. • To provide water on volumetric basis to the lower levels. • Maintenance of secondary Level Canals. • Responsible for collection of water rates through WUAs. • Integrated water management (Canal, tanks, Pick ups) • Along with canal water, LMA to deal with tank water up to field of the tank command. <p><u>Water User Association –</u></p> <ul style="list-style-type: none"> • Size of WUAs around 500 to 1000 Ha.Larger WUAs and regrouping encouraged. • Equitable distribution of water among the users.

		<ul style="list-style-type: none"> • Collection of water rates . • Maintenance of tertiary Level.
11) ORGANIZATION OF THE MAIN AGENCY	<ul style="list-style-type: none"> • Reduction in managerial staff. • Increase in trained field staff. (1 / 1000 Ha) 	<ul style="list-style-type: none"> • Organization Service oriented, professionally managed with required efficient and skilled technical and field level staff with very good and reliable communication network. • Reduced establishment cost, increased performance with motivated management.
12) GROUPS OF WATER USERS: IMPORTANCE, ROLE, BUDGETS	<ul style="list-style-type: none"> • Size : 500 to 1000 Ha • Ascertaining equal distribution of water among users. • Maintenance of canal system from secondary level & below. • Collection of water rates. • Portion of water rates collected shall be utilized for maintenance. 	<ul style="list-style-type: none"> • Active participation of users in water management. • Autonomy to WUA groups to operate and maintain. • Group of WUAs playing crucial role in operation, drawal from main canal and equal distribution of water to users. • Budget Allocation out of water rate collected and money generated out of other economic activities.
13) IRRIGATION WATER PRODUCTIVITY	<ul style="list-style-type: none"> • Considerable increase in the quantum of irrigation produce on account of optimal usage of water. • Improvement in economical and social status. • Salinity in initial reaches will be reduced. 	<ul style="list-style-type: none"> • Reformed irrigation system giving higher yield per unit of water. • Higher Productivity achieved through periodic water Balance studies
<u>OPPORTUNITIES</u>	<p>Ideally this scenario would lead to:</p> <ul style="list-style-type: none"> • No violation of cropping pattern. • Contemplated command area is irrigated. • Equitable supply of water at the turn-outs of main canal. • No strain on the canal system. • No vandalism. • More active participation of WUAs. • Increase in social and economic status. <p>this scenario was felt uncertain !!!!!</p>	<ul style="list-style-type: none"> • Improved Socio-economic condition of farmers. • Improved Environmental conditions. • Diversification of economic activities by WUAs such as Dairy, Poultry, Horticulture, Floriculture, Medicinal crops etc... • Development of Small Scale Industries – ex: coir, jaggery, sericulture, edible oil etc... • Development of Agro-based Industries. • High productivity achieved.
<u>RISKS ASSOCIATED</u>	<ul style="list-style-type: none"> • Farmers may not agree to grow imposed cropping pattern which are not economically viable. • Improper revenue recovery may result in collapse of the Nigam/Federation. 	<ul style="list-style-type: none"> • Cost of operation and management is high.HIGH SERVICE AT HIGH COST • Change of mind set of farmers is time consuming (farmers will have to pay high fees for high service). • Undue pressure to fill the Tanks under command area (tanks are included in the command and managed by LMA)

SERVICE to USERS for the merged scenario S 1-2.

After the initial round of investigations it was agreed by all participants that only one scenario merging as far as possible S1 and S2 would be further elaborated. On this basis the next section is presenting the result of the group discussion on SERVICE to USERS in relation to the mixed scenario S1-2

The proposed overarching principles of the Service throughout the system are as follows:

1. The first principle is that equity should consider all types of water (canal, rainfall, tank, groundwater, recycled, etc..) thus canal water complement other sources.
2. The second principle is that water allocation will be managed from/by the local management units. In self imposed option cropping pattern (S1) they will try to restrict the demand from crops to availability by adjusting beforehand the cropping pattern. In the liberal option (S2) availability of water throughout the season will defined the a priori allocation per areas no matter what the cropping pattern.
3. The third principle is that within the annual allocation, the seasonal balance should be left to local management units.
4. The fourth principle is that scheduling of irrigation should be permanently adjusted to the demand (due to climatic variations, rainfall, etc..)

Characteristics of Delivery Service

The characteristics of the delivery services are described at three main levels: at the interface between the main system and the local users (LMA Local Management Agency) and at the interface between the LMA and the WUAs, and finally at the interface between WUA and users. These characteristics take into consideration the previously described principles and aspects of allocation and scheduling.

Table XX below presents the procedures of water allocation and scheduling in the project at various level of the system. Table xx describe the service delivery characteristics.

	Allocation Annual/Seasonal	Scheduling
Dam to Local Users	<p>Annual allocation to be adjusted to the existing and expected availability in the reservoir.</p> <p>Balance between seasons to be decided by local users within physical constraints of the system (storage, canal peak flows)</p> <p>Delivery is made for full season in a ratio of 60% from June to October and 40% from October to February</p> <p>Seasonal: Crops to be decided prior to start of season and crop calendar and water budget requests to be given by WUAs to main agency through LMAs not later than 1st June every year for Khariff and not later than 1st of October for Rabi Season.</p> <p>Drinking water: 8 TMC of Water to towns on annual basis</p> <p>Power generation: No separate allocation is done for power generation (by-product)</p>	<p>water will be allowed for Khariff and Rabi Season throughout the season with constant discharge</p> <p>permanent adjustment (mainly reduction) is considered to account for rainfall contribution and variation of the demand.</p> <p>While allowing water for irrigation, water required for drinking water is also included</p>
Tanks	<p>The tank and its CA should be considered as a Local Units and should be allocated some water from the main reservoir depending on its water situation.</p>	<p>Scheduling of water to the tanks should be separate from that of to other users.</p> <p>The tanks should be used to compensate the perturbations within the CA by managing flexible flows.</p>
Ground water	<p>No specific allocation of groundwater is provided to local units.</p> <p>Potential of ground water use is assessed for each local units, and canal allocation is adjusted according to this.</p>	<p>No scheduling</p>
Rainfall	<p>As a principle rainfall pattern is to be considered in a priori allocation of canal water (low rainfall areas should receive more canal water).</p> <p>Actual allocation should then be adjusted to current rainfall.</p>	<p>The scheduling of canal water takes into accounts the current rainfall pattern in the areas.</p>
Surface return flows	<p>Pick up systems should be incorporated into the overall water management. No specific allocation should be made for them.</p>	<p>No scheduling BUT monitoring of their supply is a plus to ensure they are not short of water or they are not receiving too much drainage flows.</p>

	SERVICE INDICATORS				CANAL OPERATION IMPLICATIONS
	Equity	Reliability	Flexibility	Accuracy control/ measurement	
MSM to LMA	HIGH Equity warranted among LMAs through pre-allocations based on average water supply conditions.	Agreed upon water deliveries changes are met within a day (once time lag accounted) and not more than 3 days.	In dry period flexibility is allowed on request but subject to transport peak capacity. During Kharif flexible (prompt reduction of supply) is HIGH to accounts for rain fall contribution.	Flows are controlled within 10 %	Flows along canals will be regulated at FSD with proper cross regulators. Accurate flow measurements devices at headwork of secondary canals.
LMA to WUA	HIGH Equity warranted among WUAs through pre-allocations based on average water supply conditions.	Agreed upon water deliveries changes are met within a day.	In dry period flexibility is allowed on request but subject to transport peak capacity. During Kharif flexible (prompt reduction of supply) is HIGH to accounts for rain fall contribution.	Flows are controlled within 10 % variation	Flows along secondary canals will be regulated at FSD with proper cross regulators. Accurate flow measurements devices at headwork of tertiary canals.
WUA to Users	HIGH Equity warranted among Users through pre-allocations based on average water supply conditions.	Rotation is followed	Schedules are fixed according to the rotation of delivery.	Flows are controlled within 20 % variation	

Step 7 PARTITIONING IN MANAGEMENT UNITS

The irrigation system management should be partitioned into few level of management and the command area should be divided and subunits (subsystems and/or subcommand areas) that are held homogeneous and/or separate from one another by a singular point or a particular borderline.

Management needs to be reorganized to move from construction phase to management phase.

One important motivation here is to reduce drastically the cost of management (see STEP 5), which remains very high compare to similar system in Karnataka. The second important motivation is to raise the efficiency of management and the quality of service provided.

It is anticipated to reorganize the management with a Main System Management, Local Management Agencies and WUAs

An initial plan was discussed during the workshop at MSM for reorganization/reduction in the project. Main actions proposed are:

from 2 C.E	–	1 C.E
3 S.E	-	2 S.E
14 E.E	–	6 E.E
55 A.E.E	–	24 A.E.E

Although it looks as a significant 50 % REDUCTION of staff cost compare to the current situation it is not felt by large sufficient. Just the fraction of staff engaged into construction work for the expansion of the irrigation system has been removed from the organigram which places the cost for MOM to the level estimated in STEP5 42 Crores which is estimated to be too high. Furthermore this set-up does not include the levels below the MSM: The cost of MOM for LMA as well as for WUAs. When everything is added up this solution if too expensive still and cannot be retained.

A more drastic reduction of staff should be sought for in Hemwathi project.

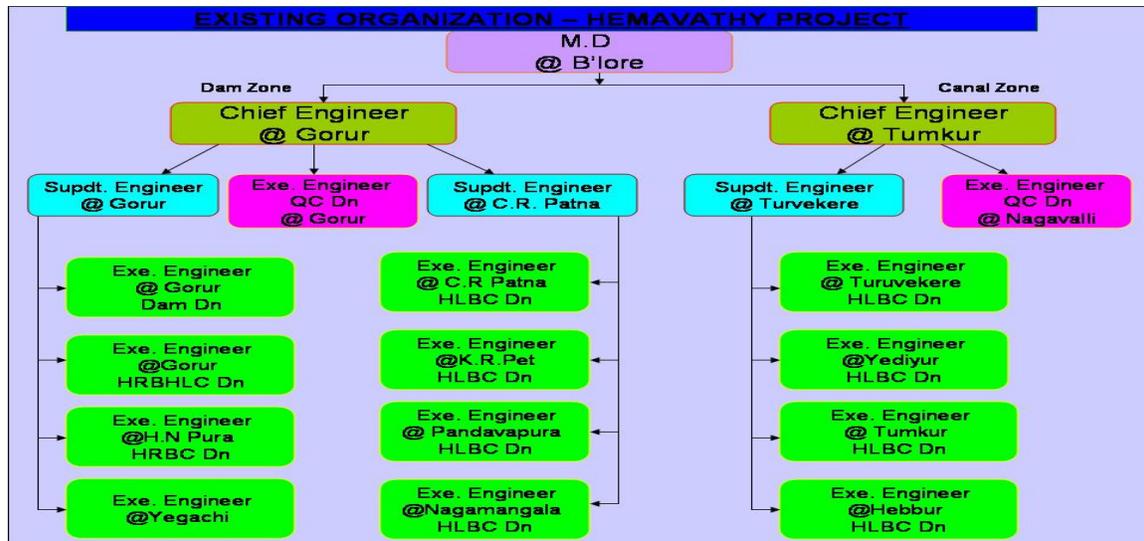


Figure 16. Current organization at Hemavathi project

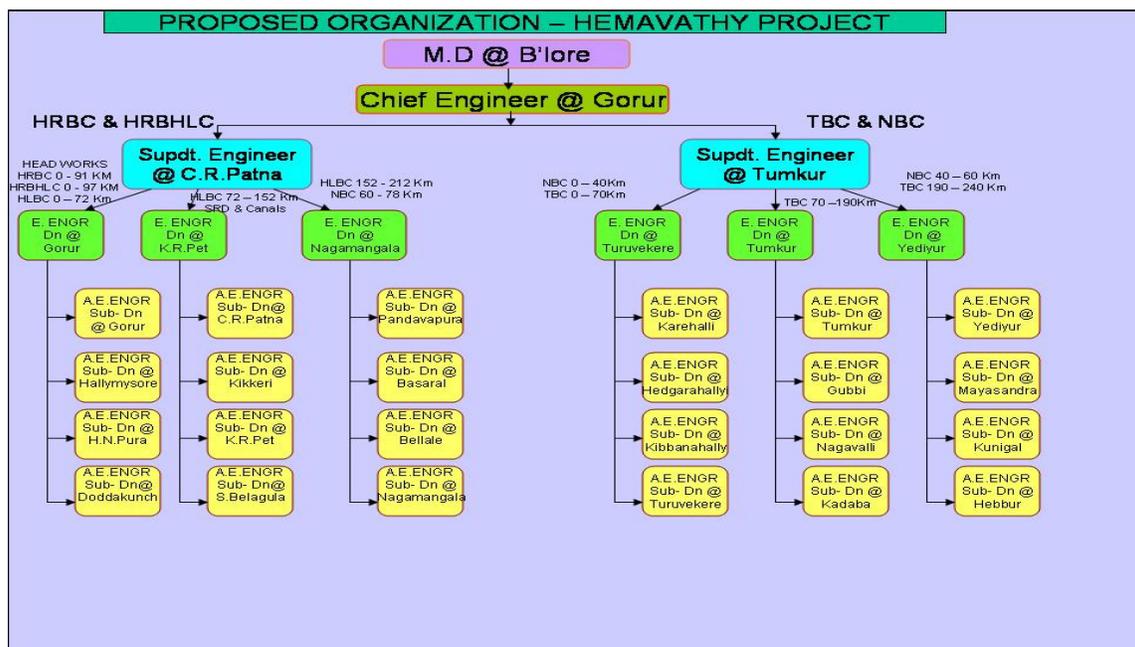


Figure 17. After reorganization at Hemavathi project

The proposed management levels

As already discussed in STEP 6 on SERVICE and Vision, it is contemplated that the management will be partition into 3 levels,

Main System Agency: Main level/corporate role

- Overall water management and development in the area
- Service to Local Management Agencies (Sub-GCA).
- Provide services to low level management in dealing with conjunctive use and IWRM

Modernization of management should be:

- Service Orientation Management
- Improve Main System Operation for water delivery (cost and effectiveness)
- Introduce volumetric management
- Moving towards a responsive management

Local Management Agency (LMA): Second level/professional unit

Role: Operate the subsystem to serve WC, Disty or FG

- Develop professional skills at lower management
- Develop sound governance for IWRM at lower level.

End-users groups (WUAs) : Third level/professional societies:

- With a minimum skills to ensure the last distribution level
- Stakeholders of the 2nd level association

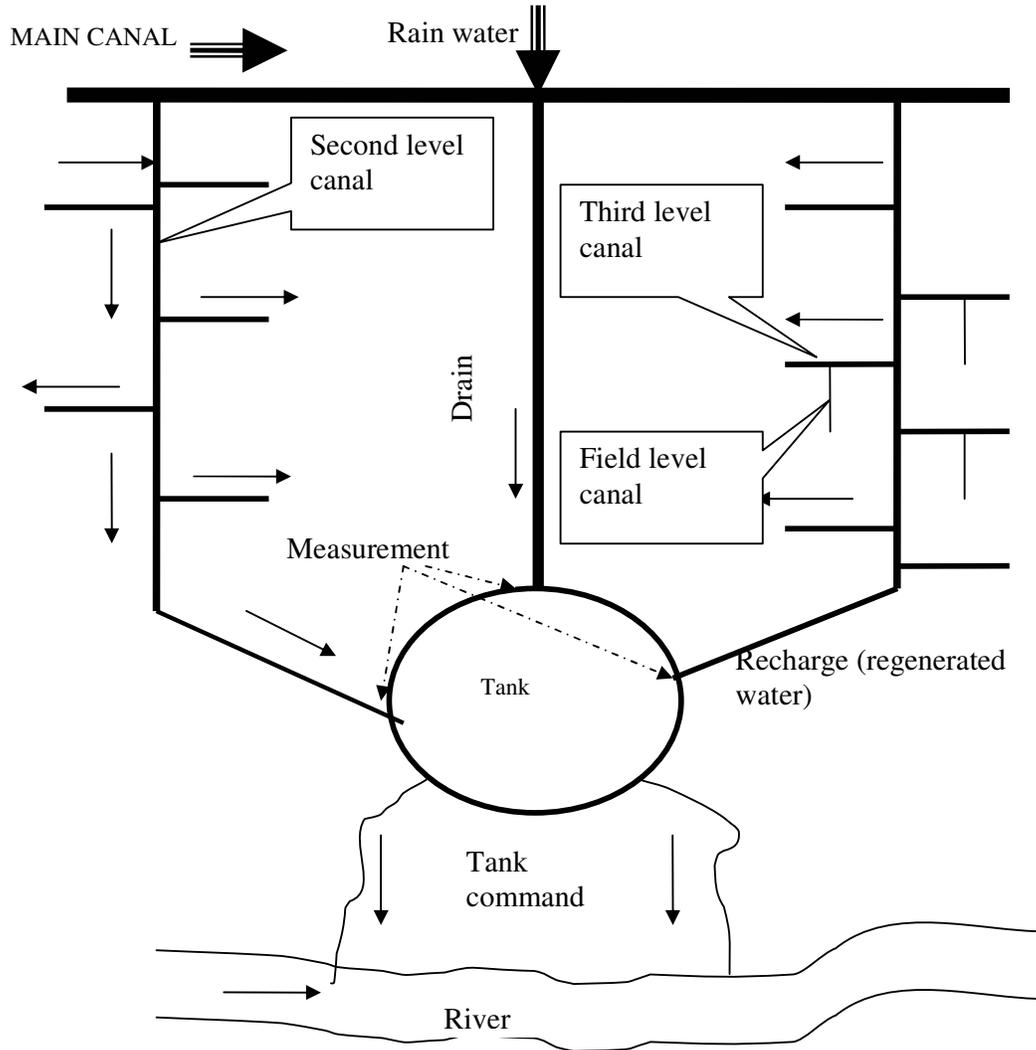


Figure 18. Typical sub-command area in Hemawathi project

Step 8 MAPPING THE DEMAND FOR CANAL OPERATION

*Objective: Assessing Means, opportunity & demand for Canal Operation
A spatial analysis of the entire command areas, with preliminary identification of Sub-Command Areas (Management, service,..)*

Step 9 CANAL OPERATION IMPROVEMENTS

This step cannot be addressed at this stage when the previous one and particularly on partitioning have not received clear responses.

Step 10 AGGREGATING AND CONSOLIDATING MANAGEMENT

This step cannot be addressed at this stage when the previous one and particularly on partitioning have not received clear responses.

Appendix 1 Results of the RAP

Indicator Label	Primary Indicator and Sub-Indicator Name	System	
		Actual	Stated
	SERVICE and SOCIAL ORDER		
I-1	Water Delivery Service to Individual Ownership Units (e.g., field or farm)	0.5	0.5
I-1A	Measurement of volumes	0.0	0.0
I-1B	Flexibility	1.0	1.0
I-1C	Reliability	0.5	0.0
I-1D	Apparent equity.	0.5	1.0
		Actual	Stated
I-3	Water Delivery Service at the most downstream point in the system operated by a paid employee	0.7	0.7
I-3A	Number of fields downstream of this point	0.0	0.0
I-3B	Measurement of volumes	0.0	0.0
I-3C	Flexibility	1.0	1.0
I-3D	Reliability	1.0	1.0
I-3E	Apparent equity.	1.0	1.0
		Actual	Stated
I-5	Actual Water Delivery Service by the Main Canals to the Second Level Canals	0.8	1.4
I-5A	Flexibility	1.0	1.0
I-5B	Reliability	1.0	2.0
I-5C	Equity	0.0	2.0
I-5D	Control of flow rates to the submain as stated	1.0	1.0
I-7	Social "Order" in the Canal System operated by paid employees	1.0	
I-7A	Degree to which deliveries are NOT taken when not allowed, or at flow rates greater than allowed	1.0	
I-7B	Noticeable non -existence of unauthorized turnouts from canals.	1.0	
I-7C	Lack of vandalism of structures.	1.0	
	MAIN CANAL		
I-8	Cross regulator hardware (Main Canal)	2.4	
I-8D	Travel time of a flow rate change throughout this canal level	3.0	
I-9	Turnouts from the Main Canal	2.5	
I-10	Regulating Reservoirs in the Main Canal	3.0	
I-11	Communications for the Main Canal	1.0	
I-11E	Existence and frequency of remote monitoring (either automatic or manual) at key spill points, including the end of the canal	0	
I-12	General Conditions for the Main Canal	1.2	
I-12B	General lack of undesired seepage (note: if deliberate conjunctive use is practiced, some seepage may be desired).	2.0	

I-13	Operation of the Main Canal	1.0
I-13B	Existence and effectiveness of water ordering/delivery procedures to match actual demands.	0
I-13C	Clarity and correctness of instructions to operators.	1.3
	Second Level Canals	
I-14	Cross regulator hardware (Second Level Canals)	1.4
I-15	Turnouts from the Second Level Canals	3.0
I-16	Regulating Reservoirs in the Second Level Canals	0.0
I-17	Communications for the Second Level Canals	2.1
I-17E	Existence and frequency of remote monitoring (either automatic or manual) at key spill points, including the end of the canal	0.0
I-18	General Conditions for the Second Level Canals	1.4
I-19	Operation of the Second Level Canals	1.6
	Third Level Canals	
I-20	Cross regulator hardware (Third Level Canals)	
I-21	Turnouts from the Third Level Canals	2
I-22	Regulating Reservoirs in the Third Level Canals	0.0
I-23	Communications for the Third Level Canals	1.8
I-24	General Conditions for the Third Level Canals	0.6
I-25	Operation of the Third Level Canals	1.3
	Budgets, Employees, WUAs	
I-26	Budgets	1.2
I-26A	What percentage of the total project (including WUA) Operation and Maintenance (O&M) is collected as in-kind services, and/or water fees from water users?	0.0
I-26B	Adequacy of the actual dollars and in-kind services that is available (from all sources) to sustain adequate Operation and Maintenance (O&M) with the present mode of operation.	3.0
I-26C	Adequacy of spending on modernization of the water delivery operation/structures (as contrasted to rehabilitation or regular operation)	0.0
I-27	Employees	1.2
I-27A	Frequency and adequacy of training of operators and middle managers (not secretaries and drivers). This should include employees at all levels of the distribution system, not only those who work in the office.	2.0
I-27B	Availability of written performance rules	4.0
I-27C	Power of employees to make decisions	1.0
I-27D	Ability of the project to dismiss employees with cause.	1.0
I-27E	Rewards for ememplary service	1.0
I-27F	Relative salary of an operator compared to a day laborer	0.0
I-29	Mobility and Size of Operations Staff: Operation staff mobility and efficiency, based on the ratio of operating staff to the number of turnouts.	0.0
I-28	Water User Associations	
I-28A	Percentage of all project users who have a functional, formal unit that participates in water distribution	0

I-28B	Actual ability of the strong Water User Associations to influence real-time water deliveries to the WUA.	1	
I-28C	Ability of the WUA to rely on effective outside help for enforcement of its rules	2	
I-28D	Legal basis for the WUAs	1	
I-28E	Financial strength of WUAs	1	
I-29	Mobility and Size of Operations Staff: Operation staff mobility and efficiency, based on the ratio of operating staff to the number of turnouts.	0.0	
INDICATORS THAT WERE NOT PREVIOUSLY COMPUTED			
I-32	Ability of the present water delivery service to individual fields, to support pressurized irrigation methods	0.0	
I-33	Changes required to be able to support pressurized irrigation methods	0.0	
I-36	Turnouts/Operator: (Number of turnouts operated by paid employees)/(Paid Employees)	0.1	
I-37	Main Canal Chaos: (Actual/Stated) Overall Service by the Main Canal	0.54	
I-38	Second Level Chaos: (Actual/Stated) Overall Service at the most downstream point operated by a paid employee	1	
I-39	Field Level Chaos: (Actual/Stated) Overall Service to the Individual Ownership Units	1	

Appendix 2. HEMAVATHI project compared to other systems for Selected Internal Indicators

[From FAO Water Report 19 and other RAPs carried out by FAO]

This appendix provides a comparative assessment with the 16 international irrigation projects that were evaluated as part of the FAO Water Report 19, *Modern Water Control and Management Practices in Irrigation- Impact on Performance*, plus some more system that have experienced RAP since 2000. A total of 31 systems are in the base.

The internal indicators results are compared to the values from the GLBC RAP for discussion purposes. This section includes graphs of selected internal indicators to illustrate key modernization concepts shown in **Figures B-1 to B-5**. The results of the GLBC RAP have been added to the graphs of the internal indicators from the report in order to provide a relative comparison with the other projects.

Actual service indicators are shown in **BLUE** and stated service indicators are shown in **PINK**.

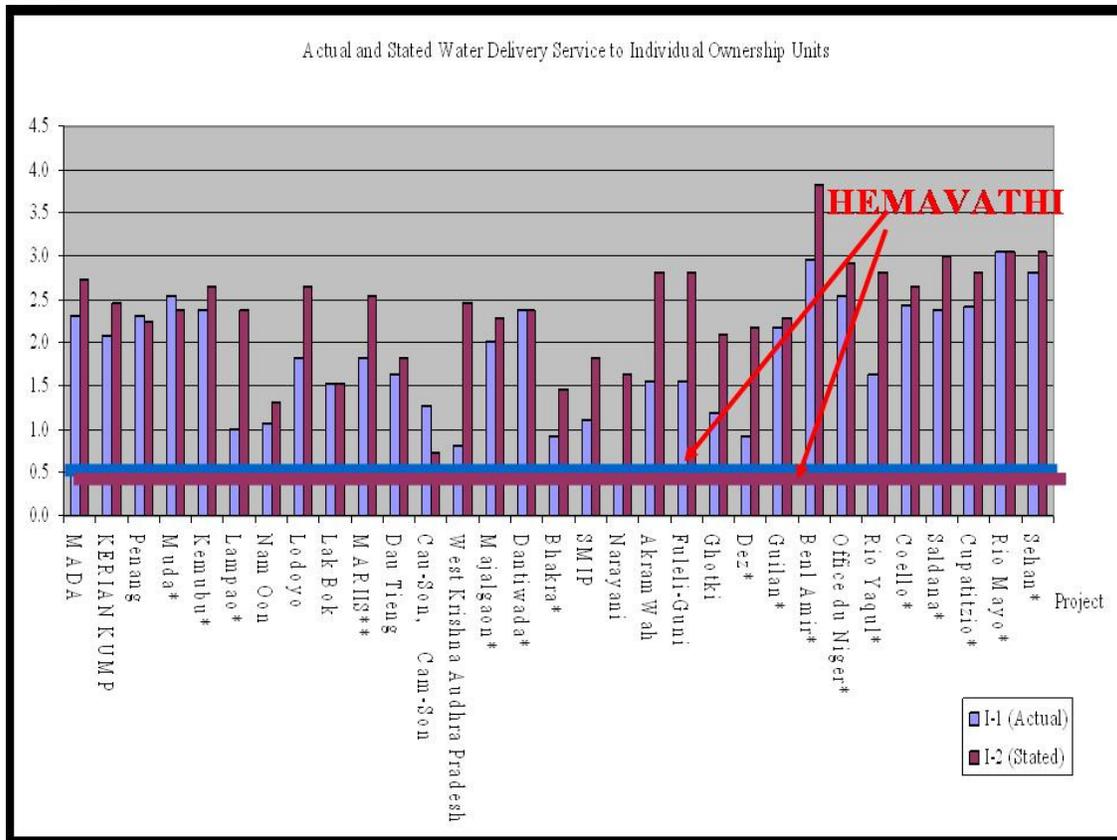


Figure B-1. Comparison of stated vs. actual water delivery service to individual fields

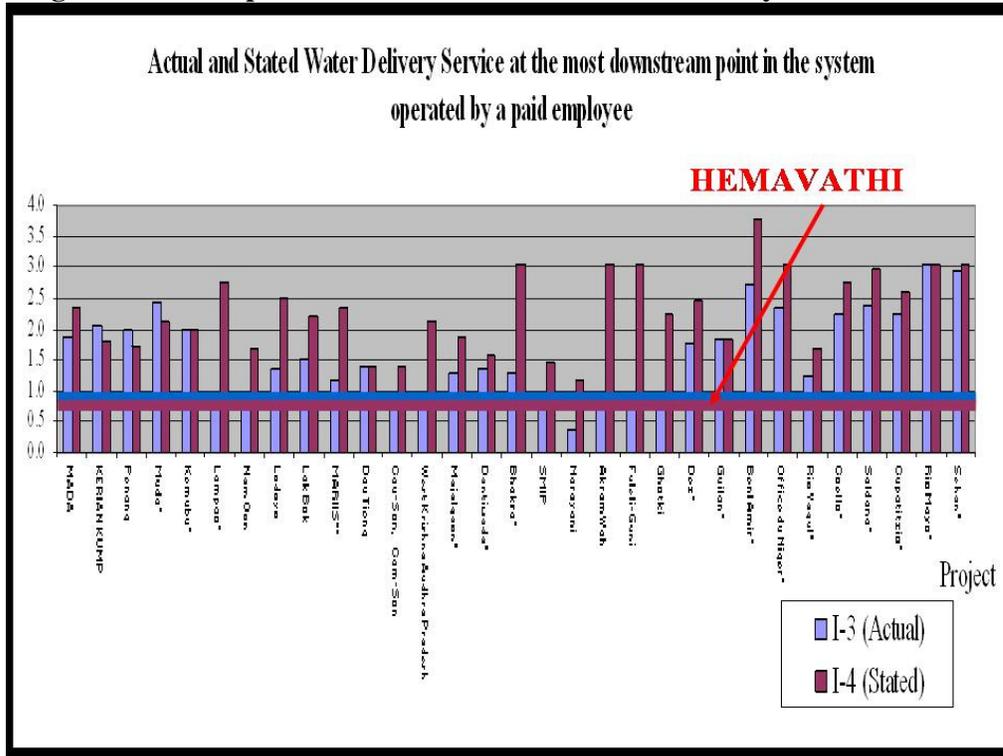


Figure B-2. Comparison of stated vs. actual service by main canals to sub-main canals

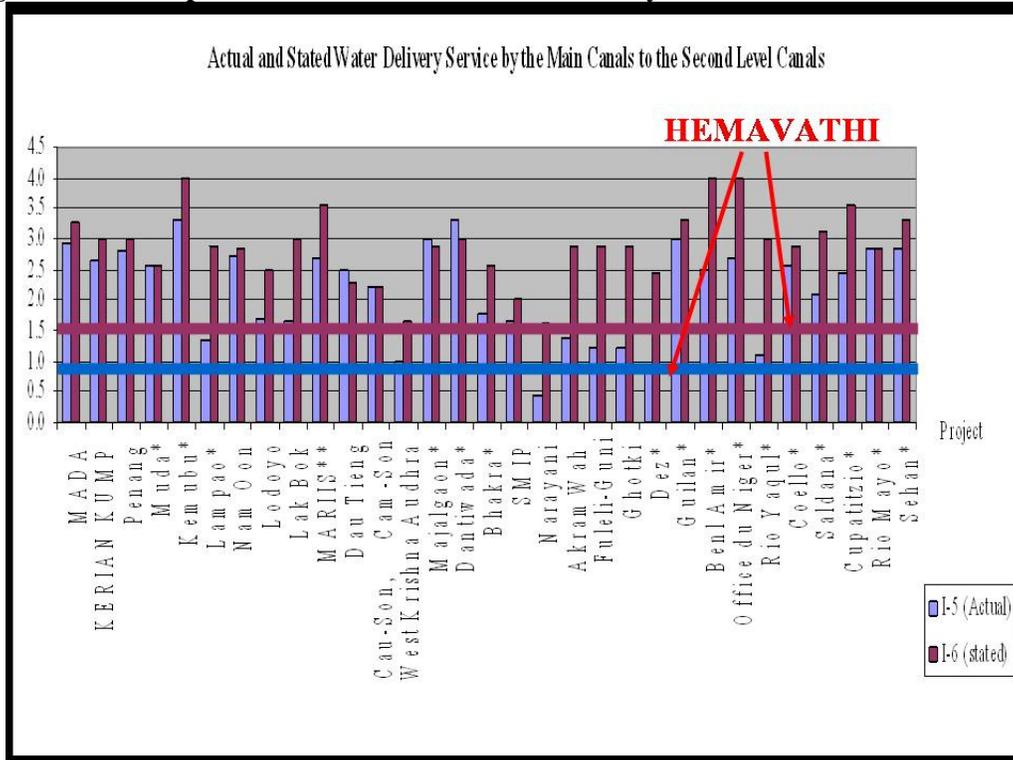
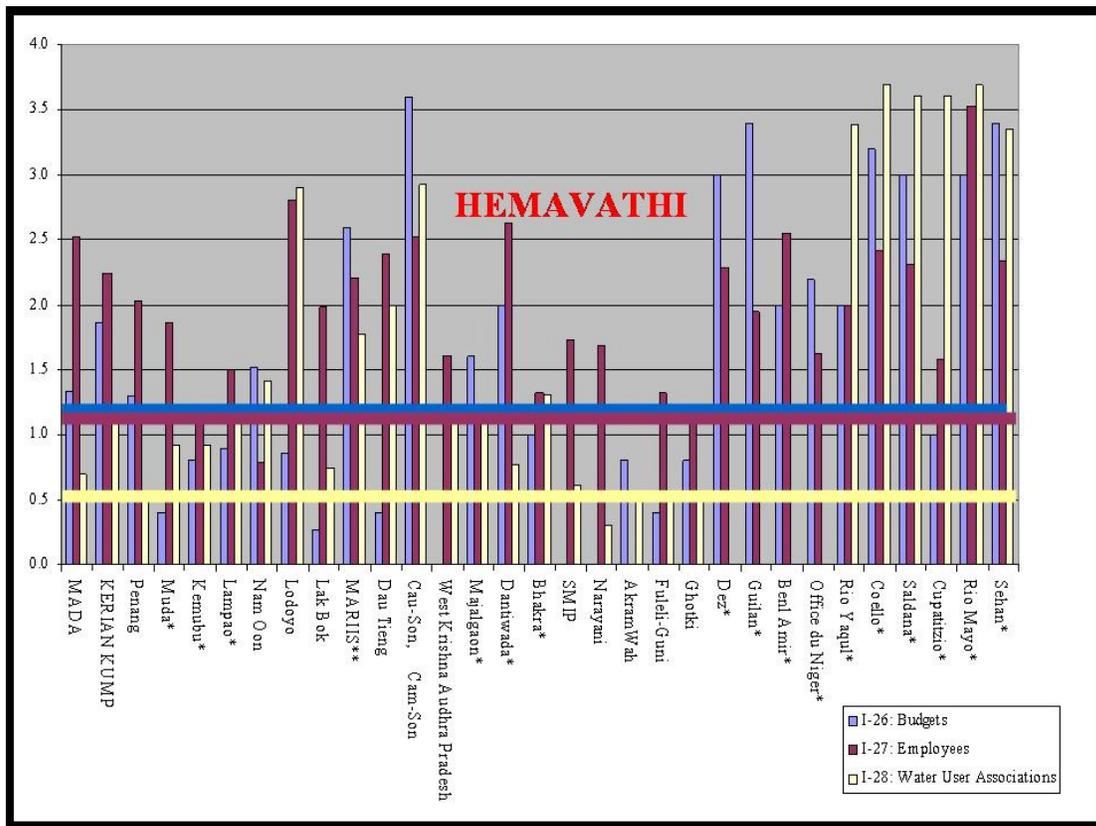


Figure B-4 is a Management and social index.



Appendix 3. MASSCOTE CNNL-FAO TRAINING WORKSHOP HEMAVATHY Irrigation Project 18 – 29/06/2007, Hassan

<u>DAY 1 Monday 18 June</u>
10:00 – 11:00 Opening Ceremony of the training workshop
11.00-11.30 Introduction, overview, and relevance of RAP and MASSCOTE (Daniel Renault, FAO)
11.45 – 13.00 Keynote addresses by CNNL Engineers & presentation on Hemavathy project (SE/EE, Hemavathy, CNNL)

<u>DAY 1 Monday 18 June</u>	<u>Speaker</u>
Modernization of irrigation management	
14:00 Modernization: Concepts and Vocabulary and principles of Service Oriented Management	Thierry Facon
16:00 Modernization: (continued)	

<u>DAY 2 Tuesday 19 June</u>	<u>Lecturer</u>
MASSCOTE Introduction to FAO tools for Modernization plans.	Daniel Renault
8:30 IRRIGATION STRUCTURES	Daniel Renault
- Hydraulic principles- control levels and flows	
- Basic Structures: orifice and overflows, free flow -submerged	
10:30 Sensitivity Analyses and Performance Multiple Roles of Irrigation Systems	Daniel Renault
14:30 SYSTEM OPERATION	Thierry Facon
Flow control Organisation: Upstream control - Downstream Control – Procedures for scheduled and unscheduled operation Operation organisation: from structures to systems	
16:30 WATER MANAGEMENT Water Balance	Daniel Renault

<u>DAY 3 Wednesday 20 June</u>	<u>Lecturer</u>
8:30 Measurements - Perturbations	Daniel Renault
9:30 Groups constitutions	PS Rao
10:30 RAP: Rapid Appraisal Procedure	Shivkumar
10:30 Presentation of RAP	
11:30 Detailed Review of RAP worksheets	
14:30 RAP Project Office Interviews with Management Staff	Respective Group Leaders will facilitate
15:00 RAP Site visit to Main Canal headworks , and main structures and transfer to field site accommodations (4 groups).	

<u>DAY 4 Thursday 21 June FIELD VISIT</u>	
7:00 RAP Visit: 4 groups and visit to the Main Canal - Travel down the main canal stopping at all cross regulators - Interview main canal operators	Respective Group Leaders will facilitate
14:00 RAP Visit of secondary and sub-secondary canals: (4 groups) Interviews with operations staff and tour of control structures	

DAY 5 Friday 22 June FIELD VISIT	
7:00 RAP Visit of secondary and tertiary canals: (4 groups) Visit to Water User Associations - Interviews WUA personnel	Respective Group Leaders will facilitate
DAY 6 Saturday 23 June	
Morning GROUP: RAP Completion of the RAP worksheets, computer entry (4 groups)	
Afternoon: 16h00 Presentation of key points by the 5 groups	
DAY 7 Sunday 24 June <i>Free day</i>	
MASSCOTE STEPS	Mix of Plenary/groups work
DAY 8 Monday 25 June	
9h00 14h00 Examination and refinement of RAP Sheets	
15h00 MASSCOTE a 10 step process: Presentation of the methodology STEP 2 - Capacity and Sensitivity and STEP 3 – Perturbations Group work on STEP-2 & 3	
DAY 9 Tuesday 26 June	
8h30: Group presentations & discussions STEP 2 & 3	
10h00 Presentation on STEP 5 – Cost of Service and reminder of STEP 4 – Water Network & Water Accounting/Balance	
11h00 RAP in Jamiakou	
11h30 STEP 6 – Services to Users & Vision	
Special Groups to work aside on STEP-4 & 5 (Gathering data)	
12h30 Group works on STEP-6 Session1	
14h30 : Group works on STEP-6 Session2	
17h15: STEP-6 Group presentations & discussions	
18h30 CROPWAT Presentation (G. Munoz)	
DAY 10 Wednesday 27 June	
8h30: STEP 6 – Services to Users & Vision Group works on STEP-6 Session2	
11h00 Plenary to define 3 scenario (BU S1 and S2)	
12h00 STEP 7 – Partitioning – Management Units	
14h30 5 Groups: BU S1 S2 Management WB	
17h00 Plenary reports on 4 groups	
DAY 11 Thursday 28 June	
8h30 Canal Lining	
9h45 Continuation of Group work on Scenario	
11h15 Presentation of scenario and vote for a mixed scenario 1+2	
12h00 Presentation of Step 4 (WB) and 5 (Cost) and 7 (Partitioning)	
Masscote STEPS 8, 9 & 10	
14h00 Bennithora Gondorinola project follow up	
15h00 STEPS – 8, 9 & 10	
GRID analysis for 1) SERVICE 2) Modernization: Demand, Improvements and Monitoring & Evaluation for scenario medium term interventions	
DAY 12 Friday 29 June	
Morning: Preparation of the reports and presentations	
Afternoon: Presentation of MASSCOTE-RAP outcomes by participants	

Appendix 4. Working plan for Hemawathi MASSCOTE Follow up [July 2007]

Part A lists is some key activities to be carried out before end of 2007.

Part B reviews the investigations made so far and listed that of to be done for completion of MASSCOTE STEPS.

A) Working plan for 2007

ACTIVITIES	HORIZON
1. Finalisation of the Masscote survey for the whole CA: cropping pattern, groundwater, and water balance.	End 2007
2. Study of the reorganization of the management: main canal reorganization and determination of LMAs and carrying out of MASSCOTE for each LMA.	End 2007
3. Finalisation of a Modernization plan: Management set up, canal operation improvements, investments.	Early2008

B) Status of Masscote's steps as of 15th JULY 2007

In the following are reviewed the status of the investigations with respect to Masscote steps, and identification of intervention that are needed to complete the work in the entire CA.

STEP 1: RAP external indicators: a more precise cropping pattern and climatic data needed

There are water flows/contribution that cannot be measured, in particular the groundwater contributions from the river aquifers. Basically they are estimated by closing the balance. Depending on the assumptions on the main terms of the water balance are having an important impact on the closure (Deficit or external inputs may vary from 154 to 732 MCM). Further studies on the WB terms should target reducing the range of variation.

		ACTIONS/PRODUCTS NEEDED	STATUS
Beyond the average rainfall we need more precise data for several consecutive years.	1.1.	Monthly rainfall for the last 5 years in 4 rainfall stations within of close to the CA	
The demand for crops should be further refined by considering the actual cropping patterns and calendar as well as climatic historical data.	1.2.	Cropping pattern and calendar by zones: Upstream and Downstream reaches of HLBMC – HRBMC - TUMKUR B – Nagamangala B	
	1.3.	Climatic data for the last 5 years in representative stations	

STEP 2 Capacity and Sensitivity of the canal structures

		ACTIONS/PRODUCTS	STATUS
Main canal and branch canal A systematic survey of all canal structures with for each, indication of their capacity in fulfilling their functions, indications of the problems noticed, estimation of the sensitivity from the head and the type of flow.	2.1.	Capacity of each structure with respect to its specific function	Should be done after decision on the management partitioning
	2.2.	Sensitivity estimation for each Offtakes: from evaluation of type of flow and head	same
	2.3.	Conditions of water level at each main offtaking point.	same
Buffer storage potential capacity: special attention much be given to the potential for buffer storage OUTSIDE the CANAL or INSIDE the CANAL.	2.4.	Mapping of the buffer capacity along the main and branch canal	
	2.5.	Mapping of the functional architecture of the streams and storages (surface and groundwater)	

STEP 3 PERTURBATIONS

		ACTIONS/PRODUCTS	STATUS
	3.1.		
	3.2.		

Step 4 WATER NETWORKS & WATER BALANCE/ACCOUNTING

		ACTIONS/PRODUCTS	STATUS
<u>Monitoring ground water levels :</u>	4.1.	Analyse groundwater level fluctuations per sub-zones and produce relevant graphs and diagnosis on the groundwater potential	
<u>Cropping Patterns :</u>	4.2.	Done through action 1.2	
<u>Canal water</u>	4.3.		
STREAM FLOW FROM OUTSIDE THE COMMAND	4.4.	Mapping the external watersheds (area) and characterize the contribution (effective run-off)	
LAND USE MAPPING & CONSUMPTION BY TREES AND VEGETATION	4.5.	Produce a more accurate mapping of the land use in the project with updated area values: irrigated crops – non irrigated crops- non agriculture crops – others –natural	

Step 5 SERVICE to USERS

		ACTIONS/PRODUCTS	STATUS
No specific investigations at this stage. Service to users will have to be discussed once the management set-up would have been defined.			

Step 6 MAPPING THE COST of OPERATION

		ACTIONS/PRODUCTS	STATUS
<p>Mapping the Energy and Cost of pumping groundwater The cost in terms of energy spending of having one m3 lifted at field level is the critical value that conditions many aspects of the management strategy in the command area. A sound strategy of interventions on seepage, water management and operation of canal water supply should be based on reliable figures of this cost.</p>	6.1	Mapping the depth to groundwater varies as well as the drawdown to be considered for the pumping.	
	6.2.	Estimating energy and cost spent for 1 m3 lifted for different situations with respect to groundwater depth.	
<p>Finalize Costing of operation: for MSM for LMA for WUA</p>	6.3.	Further breakdown of the budget with inputs for “operation” [Staff-transport-management]	

Step 7 PARTITIONING IN MANAGEMENT UNITS

		ACTIONS/PRODUCTS	STATUS
<p><i>A preliminary partitioning of the CA into LMAs</i> As one of the recommendation of the workshop participants a preliminary partition should be right away initiated to start rapidly the process of investigation on water management and the negotiation with users.</p>	7.1.	A proposal of partition of the CA into manageable units (LMA) basis of the drainage network. WS etc	
	7.2.	Preliminary investigation on the water balance of each LMA.	

Step 8 MAPPING THE DEMAND FOR CANAL OPERATION

		ACTIONS/PRODUCTS	STATUS
<p><i>Mapping of the vulnerable areas with limited or no access to alternative source water</i> Areas with little or no access to alternate source of water should received much more attention than others as far as the canal service is concerned</p>	8.1.	Mapping by grouping the CA into 3 categories with respect to access to alternative source of Water: Easy and cheap– Not easy and expensive– No access	

Step 9 CANAL OPERATION IMPROVEMENTS

		ACTIONS/PRODUCTS	STATUS
<p>No specific investigations at this stage. Canal improvements will be tackled when the others steps will have been properly investigated/agreed upon.</p>			