KARNATAKA SURFACE WATER

PROJECT

COMPLETION REPORT

ON

HYDROLOGY PROJECT – II

CHIF ENGINEER
HYDROLOGY AND CMO
BANGALORE

Background Prior to HP-I:

Earlier prior to HP-I, data was being received in hard copies and also data stored in data centre in the form of data sheet. There were no computers nor software for entry and processing of data. HIS was completely managed manually. Data was being received after 2 to 3 months in the data centre. Also there was no uniformity between different states for collection, processing and storage of data. There was no regular exchange of data between central and state agencies. The stations too required upgradation to WMO norms. All these anomalies have been covered during HP-I and HP-II.

HYDROLOGY PROJECT PHASE – I

INTRODUCTION:

Hydrology Project Phase – I was taken up with World Bank Assistance and the project became effective in Karnataka State on 10.12.1996. The project was implemented over a period of seven years and ended on 31.12.2003.

Under Hydrology Project-I infrastructure for collection of Hydrological & Hydro meteorological data was established. 479 rain gauge stations were upgraded, 14 full climatic stations (11 upgraded & 3 new stations), and 40 river gauges (27 upgraded & 13 new stations) were established.

Data from these stations are being collected regularly and entered & validated in SWDES software. The validated data is stored in the data centre for dissemination to users. Data has been supplied to different

users such as Cement industries, Mini Hydel schemes, Research institutions, Thermal power stations etc., Also in the data centre, data is being used regularly for yield calculations for establishing new irrigation projects both Major & Minor Irrigation.

Under HP-I Bathymetric survey equipments have been procured and are being used for conducting sedimentation survey of reservoirs. Already surveys for Tungabhadra, Bhadra and other reservoirs have been completed.

HYDROLOGY PROJECT – II

INTRODUCTION:

Government of India has included the state of Karnataka for participating in the Hydrology Project Phase – II. It had allocated a provision of Rs. 9.09 crores for Karnataka surface water.

After the review of performance of all the agencies, the World Bank and Ministry of Water Resources, Government of India has revised the allocation for Karnataka Surface Water to Rs.11.40 crores.

Hydrology Project – II is a follow up action project of World Bank Aided Hydrology Project – I, wherein infrastructure for collection of data was established.

The project became effective from 5th April 2006 and is scheduled to end on 31st May 2014.

OBJECTIVE:

The overall project development objective is to extend and promote the sustained and effective use of Hydrologic Information System by all potential users, concerned with water resources planning and

management thereby contributing to improved productivity and cost-effectiveness of water related investments.

The Government vide G.O. No.WRD/8/Rajayo/2004, Bangalore Dt: 24.12.2004 has accorded approval to the implementation of the said project with World Bank assistance and as per the Ministry of Water Resources guidelines.

ORGANIZATIONAL SET UP:

The Karnataka component of Hydrology Project is being implemented by two agencies viz Surface Water component by Water resources Department and the Ground Water by Department of Mines & Geology.

HIS Design and development.

Major Achievements of Hydrology project I are as under:

- Construction of Divisional Data Processing Centre at Bagalkote.
- Procurement of Integrated Bathymetric Equipments for reservoir sedimentation survey & provided to KERS Mysore.
- Upgrading existing Standard Raingauge Stations (ORG).
- Upgrading existing Autographic Raingauge Stations (SRRG).
- Upgrading eleven existing Full Climatic Stations (FCS).
- Upgrading existing Gauge Discharge (GD) stations.
- Establishing new GD stations.

- Construction of Level - II Water Quality laboratories at KERS and Munirabad.
- Construction of Water Quality Level - I laboratory at river gauge sites.
- Procurement of vehicles for Gauging and Investigation offices of WRDO.
- Construction of Sediment Analysis labs
- Construction of Residential Quarters at river gauge sites
- Construction of site stores at river gauge sites
- Procurement of Computer packages for State Data center
- Procurement of Computer packages for Divisional and Sub-Divisional Data Processing Centres
- Study of Regenerated flows at lokapavani

Major Achievements since inception of the Hydrology project II are as under:

- Computers and peripherals have been upgraded in the State Data Centre, Divisional Data Processing centers and also in sub divisional data processing centers.
- The training centre at KERS, K.R.Sagar has been upgraded
- A website for Hydrology Project-II for Karnataka Surface Water has been developed and is hosting all the real time telemetric information.
- Real time telemetry system has been established for transfer of rainfall data through SMS:

  The real time data transfer system has been established for transfer of Rainfall data from all 1010 raingauge stations through SMS using GSM Technology to the Central Server located at Bangalore. The data is being hosted on the website:www.karunadu.gov.in/karhp

  In the earlier days collection of data was a very tedious process. Data were collected on daily basis from all 1010 raingauge stations located all over Karnataka and the entire data of the month were sent to the central

offices for the purpose of analysis and storing. This entire process of Collection, transmission& storage was taking 2 to 3months. Now a data transfer system has been developed, in which rainfall data is being received on the same day itself through SMS &can be viewed in the website.

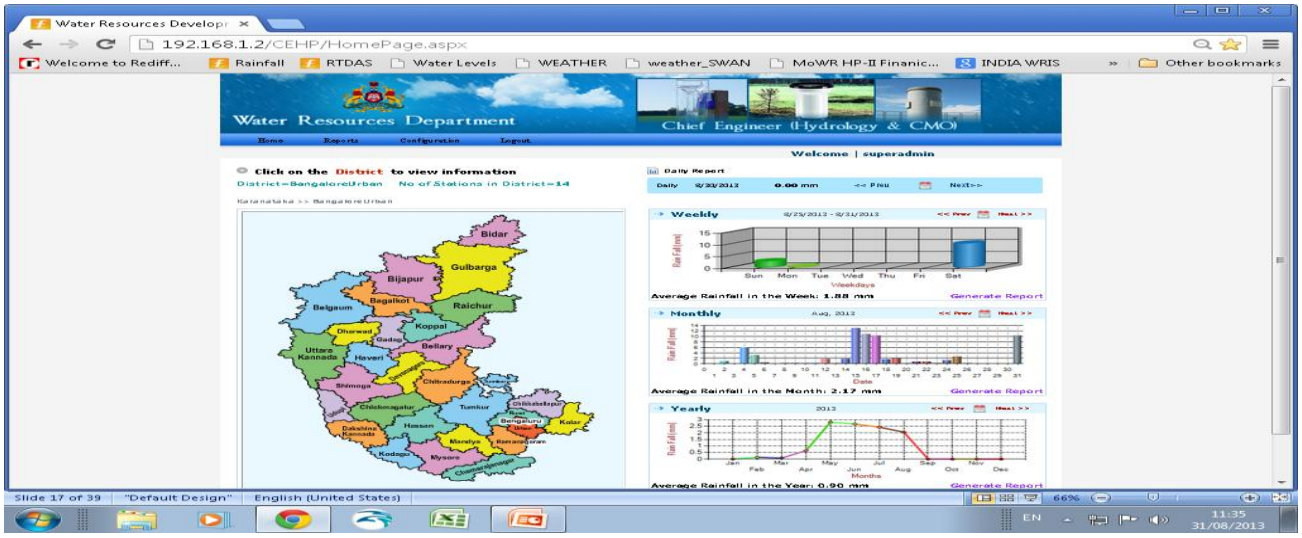
The raingauge reader after observing the rainfall recorded in the raingauge, he will send the value of rainfall through SMS to central server from his mobile instrument which is issued to him. The server will compile all the data received from different raingauge stations and displayed it in the webpage.

This system is working satisfactorily for the last 24 months. The data can be viewed Basin wise, District Wise & taluk wise for any particular period. A facility to download data is also made available in the website.

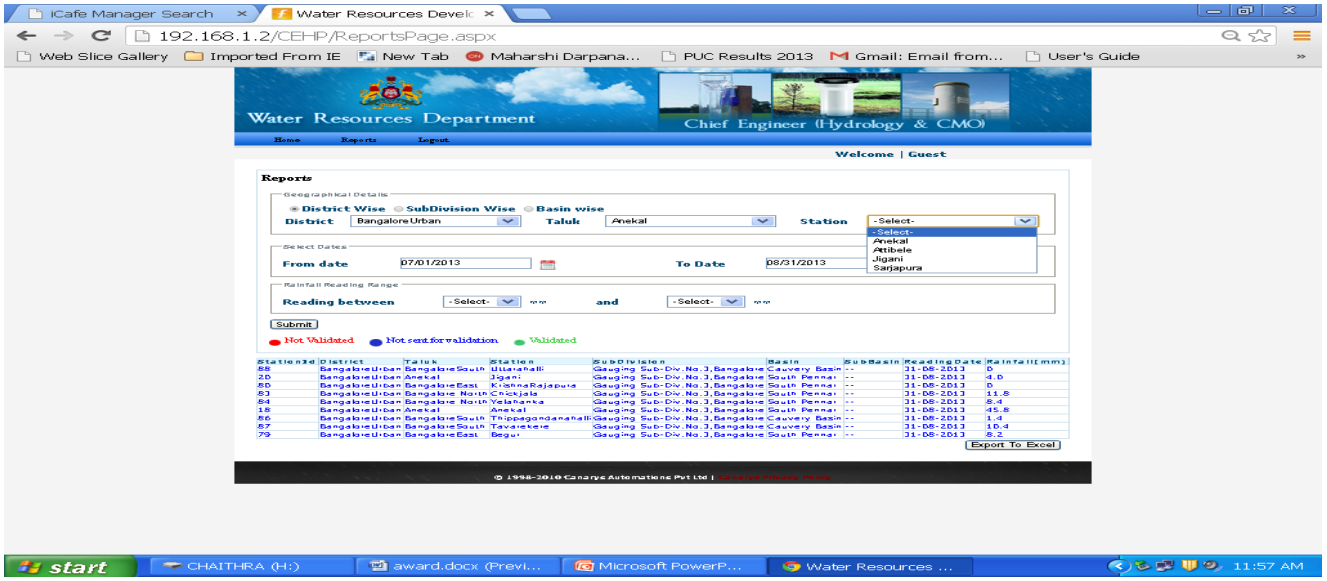
The total cost involved in setting up this data transfer system including the cost of mobile instruments, 2 central servers, software etc. worked out to about Rs.30lakhs, whereas if telemetric raingauges had been established it would have been about 5 to 6 crores. This low cost approach has been appreciated by the World Bank.

A snap shot of website www.karnataka.gov.in/karhp:

Rainfall Data link:



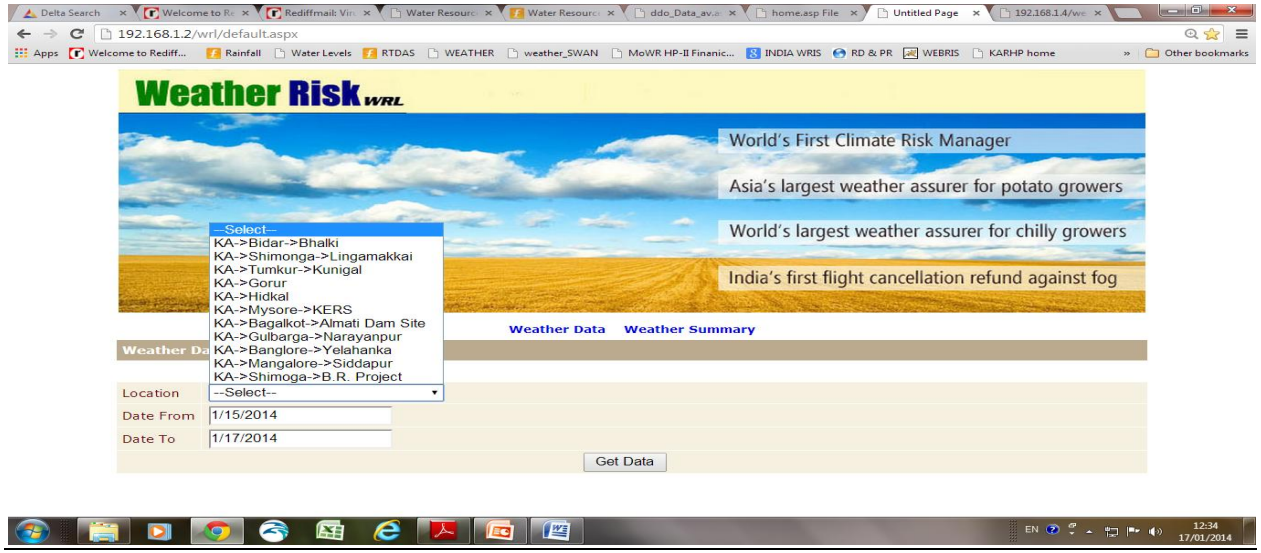
Provisions for disseminating District wise,taluk wise and stationwise rainfall data:



AWS stations have been set up for real time climatic data:

- 21 Automatic Weather Stations have been established under HP-II.
- Weather data from these stations is received every 30 minutes & data is transmitted via GSM/GPRS technology
- The data is hosted on the website:www.karunadu.gov.in/karhp
- Weather data can also be viewed in the following addresses:
  - 117.218.106.122/wrl – Data received from 11 stations
  - 117.218.106.188/weatherweb - Data received from 5 stations

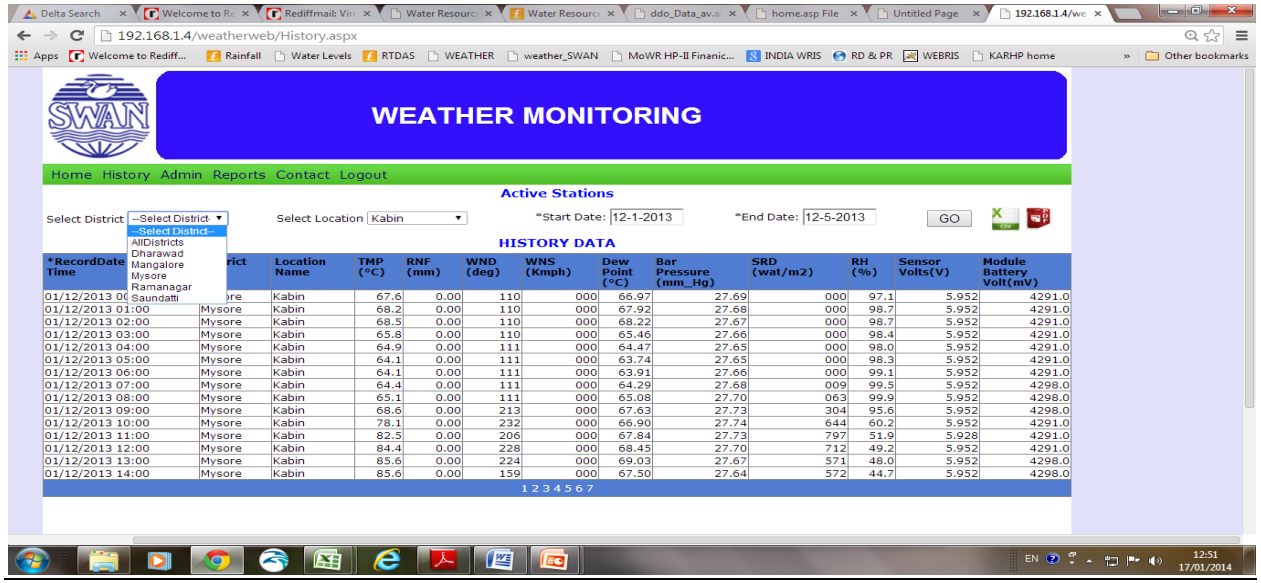
Weather Data link:



Every 30mins data:

Date & Time	Temp (°C)	Rainfall (mm)	Humidity (%)	WindSpeed (m/s)	WindDirection (deg)	VapourPressure (Kpa)	SolarRadiation (w/m²)	EvapRate F
1/1/2014 12:00:00 AM	18.43	0	75.77	0.76	111.25	91.06	0.20	
1/1/2014 12:30:00 AM	17.69	0	78.29	0.43	143.37	91.31	0.10	
1/1/2014 1:00:00 AM	17.73	0	78.53	0.64	148.15	91.2	0.13	
1/1/2014 1:30:00 AM	17.63	0	79.14	0.58	150.32	91.11	0.17	
1/1/2014 2:00:00 AM	17.35	0	79.94	0.7	167.40	91.21	0.13	
1/1/2014 2:30:00 AM	16.98	0	80.87	0.24	149.59	91.2	0.13	
1/1/2014 3:00:00 AM	16.42	0	82.44	0.57	157.91	91.22	0.13	
1/1/2014 3:30:00 AM	16.31	0	83.86	0.54	149.38	91.17	0.17	
1/1/2014 4:00:00 AM	16.15	0	85.62	0.71	154.10	91.21	0.10	
1/1/2014 4:30:00 AM	15.85	0	87.61	0.74	139.05	91.31	0.10	
1/1/2014 5:00:00 AM	16.33	0	90.81	0.55	111.04	91.20	0.17	
1/1/2014 5:30:00 AM	16.11	0	92.04	0.45	117.43	91.09	0.10	
1/1/2014 6:00:00 AM	15.67	0	93.08	0.46	129.53	91.17	0.10	

Weather Data link of 117.218.106.188/weatherweb:



RTDAS FOR FLOW:

Real Time Data Acquisition System for measurement of Levels & flows in major rivers of Karnataka has been established using:

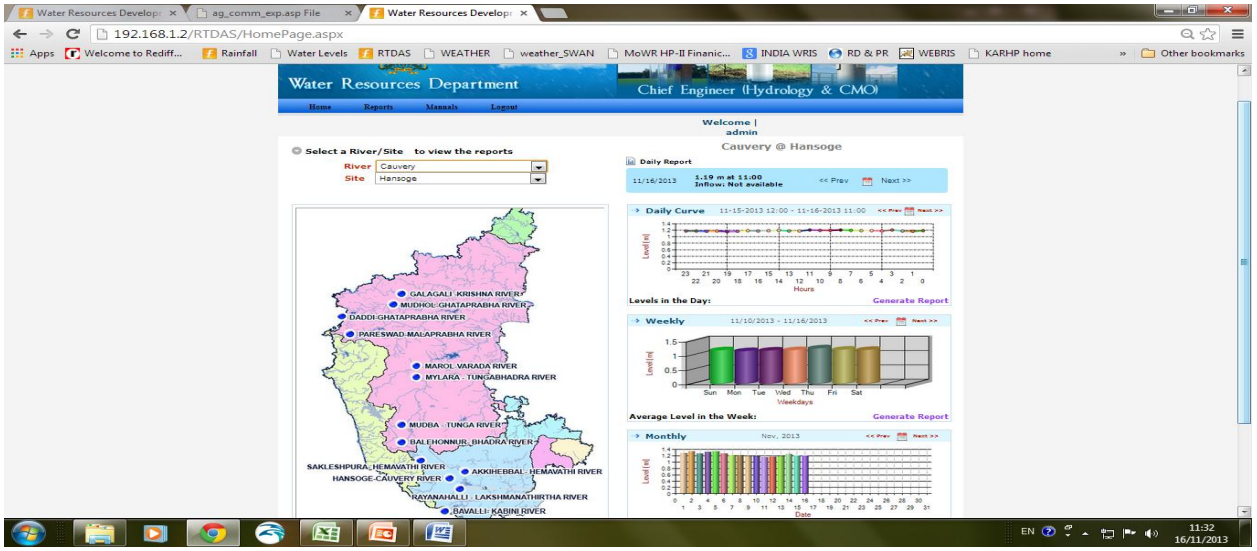
* Radar sensor - 12 locations

* Bubbler sensor - 1 location

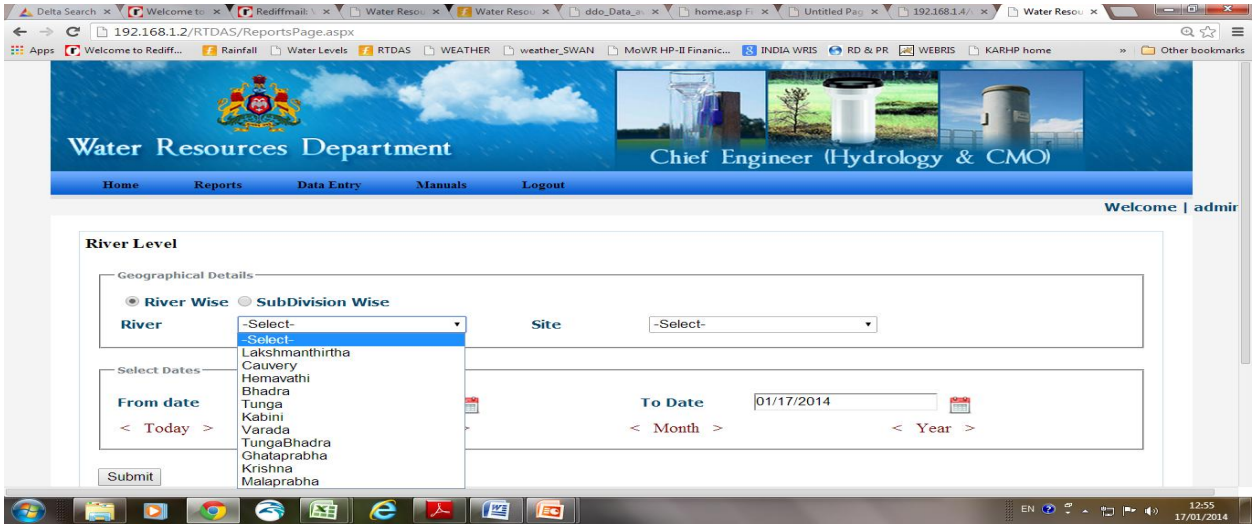
* Acoustic Doppler Current Profiler - 7 locations

The data is hosted on the website: 117.218.106.122/rtdas. The depth of flow in the rivers is proposed to be measured using Radar sensors & flows using Acoustic Doppler Current Profiler & then stage discharge curves will be developed for these locations. After a stable SD curve is developed then only levels will be measured & discharges computed from SD curves. These levels & discharges will be directly received in the server & available for use of project authorities in knowing the discharges flowing into their reservoirs.

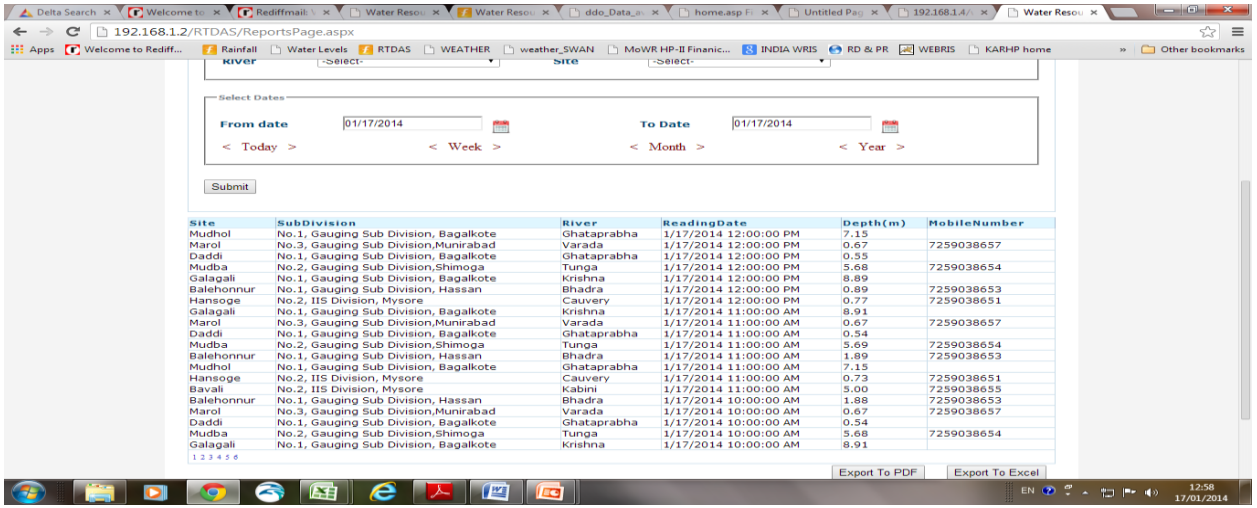
Real time flow and depth measuring system data link:



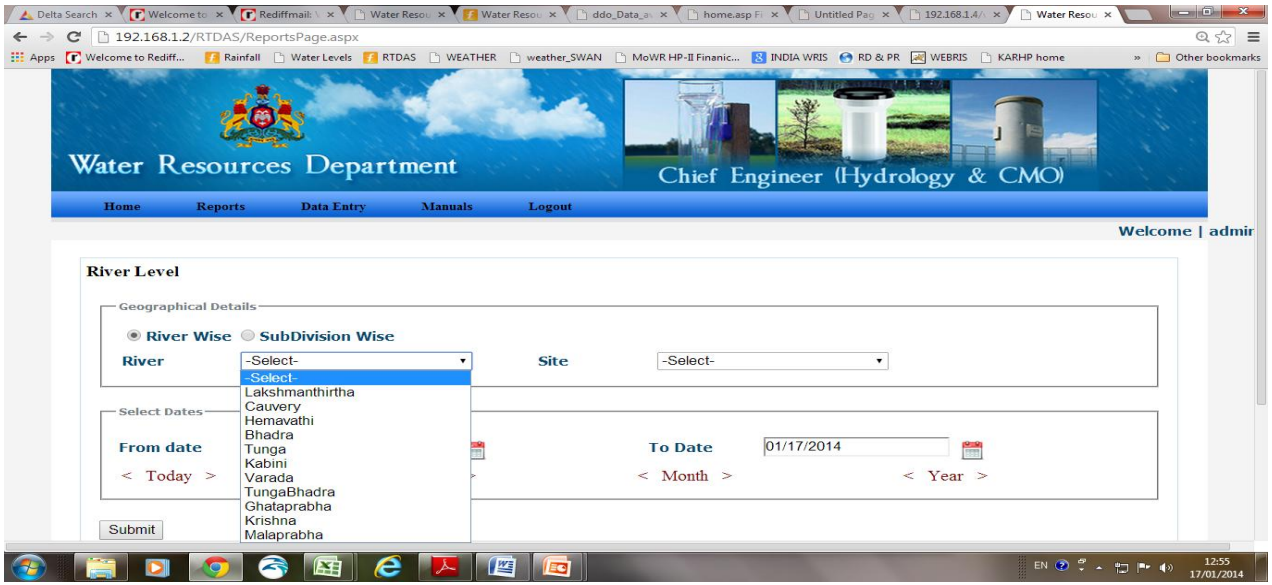
Water level @ various River points:



Hourly Data of Water Level of various river and provision to Export in Excel and Pdf format:



Flow measurement data @ various River points using ADCP instrument:



Web based Water Resources Information System in Karnataka-

The overall purpose of the project is to develop an open source Web based platform for the departmental personnel as well as to public to view with security privileges on the web portal. The developed software on Web GIS system is hosted on Departmental Server 117.218.106.122:8087/webwris. And also the website www.karunadu.gov.in/karhp is hosted on e governance.

Layers available in the Software:

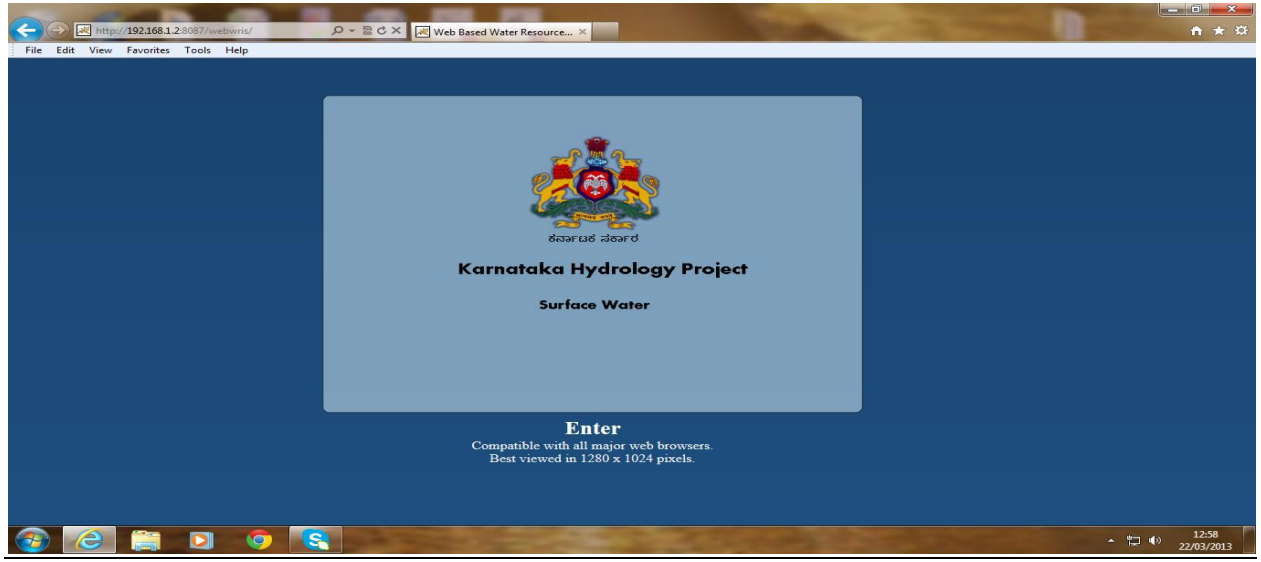
1) **Administrative Boundaries of Karnataka** - State, District, Taluk,Village Basin, Sub Basin, watersheds, MLA & MP Boundaries
2) **WaterBodies**- Rivers , Reservoirs & streams of Karnataka
3) **Water Structures**- Location of Dams with their catchment areas
4) **Gauge Stations** -Raingauge Stations & Automatic weather stations of Karnataka
5) **SOI Grid** – Survey of India Toposheet nos

The idea is to maintain a common interface to access the Real time Hydro meteorological data such as Rainfall data, Automatic weather stations data in map form.

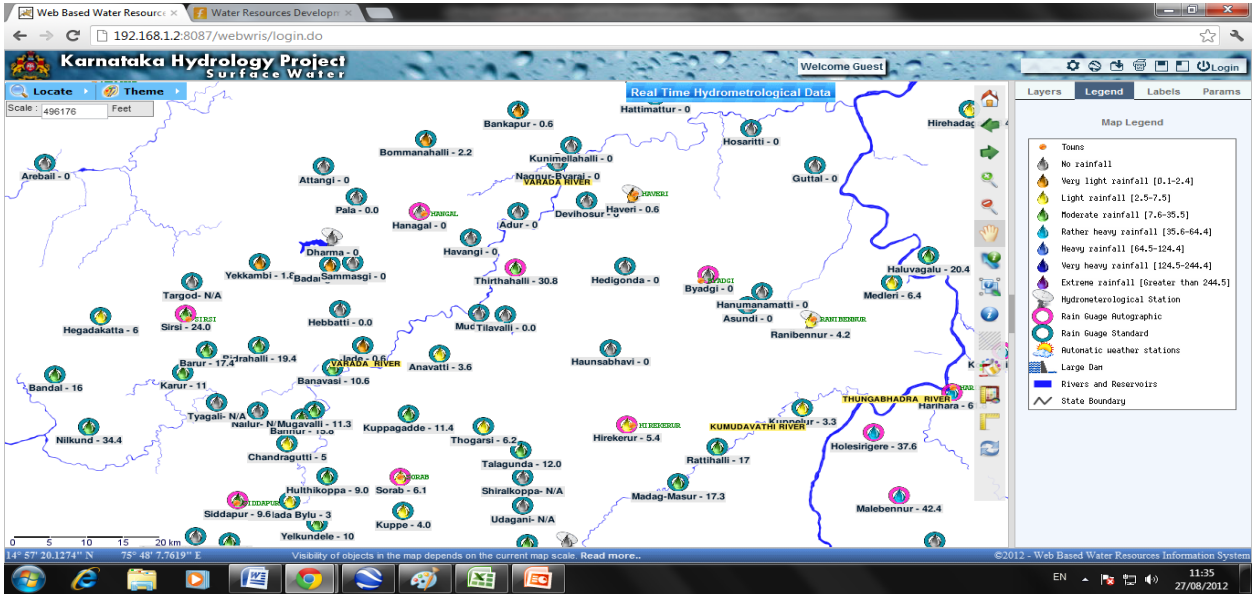
Above layers facilitates in locating & viewing rainfall data of Raingauge Stations such as Autographic raingauge stations, Standard raingauge stations & hydro meteorological raingauge stations spread across the state. The isohyetal maps will be generated daily using the rainfall data of above stations. Temperature data of 11 Automatic weather stations located in the state can be viewed using weather data which is available on our weather data application.

This web site is provided now on GIS platform which shows all water resources information. As the website is user friendly any individual, even without the knowledge of GIS which costs about 5 lakhs to 12 lakhs can view the water resources information on this website

Snap Shots of website are as follows:

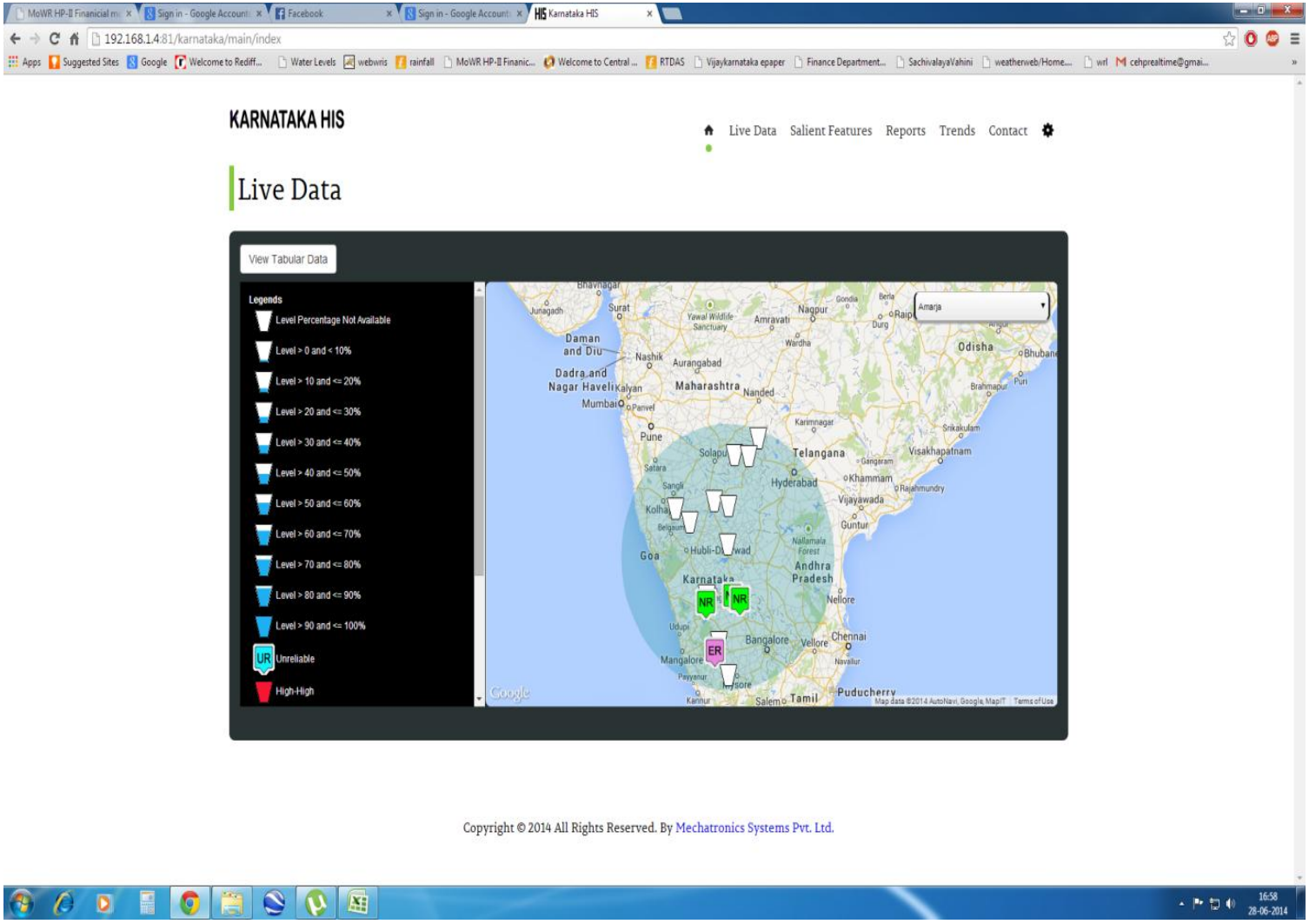


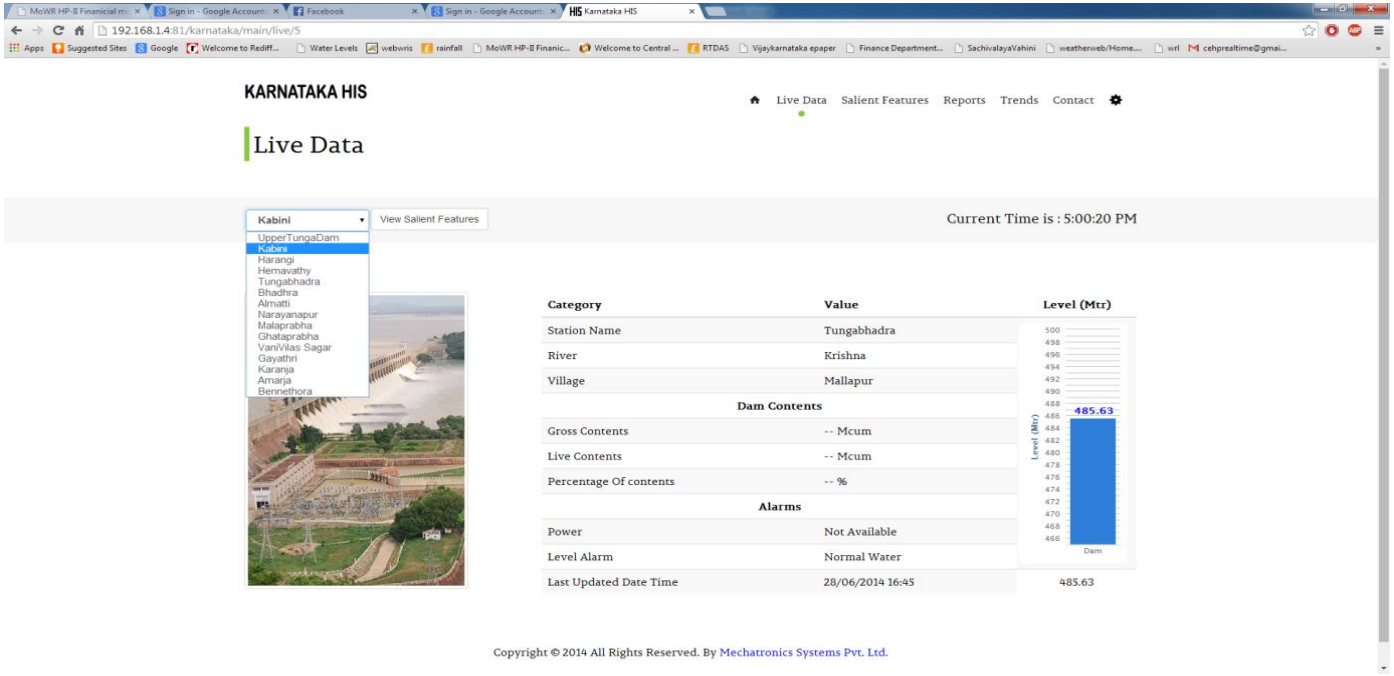
Rain Gauge Stations Representing Rainfall Data



RADAR LEVEL SENSOR:

Supply & Installation of Radar level sensors for measurement of levels in 16 reservoirs are completed and data is being received. Software upgradation is under progress.




KARNATAKA HIS
Live Data
Salient Features
Reports
Trends
Contact
Live Data
Kabini
View Salient Features
Current Time is : 5:00:20 PM
UpperTungaDam
Kabini
Harangi
Hemavathy
Tungabhadra
Bhadhra
Almatti
Narayanapur
Malaprabha
Ghataprabha
VaniVilas Sagar
Gayathri
Karanja
Amarja
Bennethora
Category
Value
Level (Mtr)
Station Name
Tungabhadra
River
Krishna
Village
Mallapur
Dam Contents
Gross Contents
-- Mcum
Live Contents
-- Mcum
Percentage Of contents
-- %
Alarms
Power
Not Available
Level Alarm
Normal Water
Last Updated Date Time
28/06/2014 16:45
485.63
Level (Mtr)
Dam
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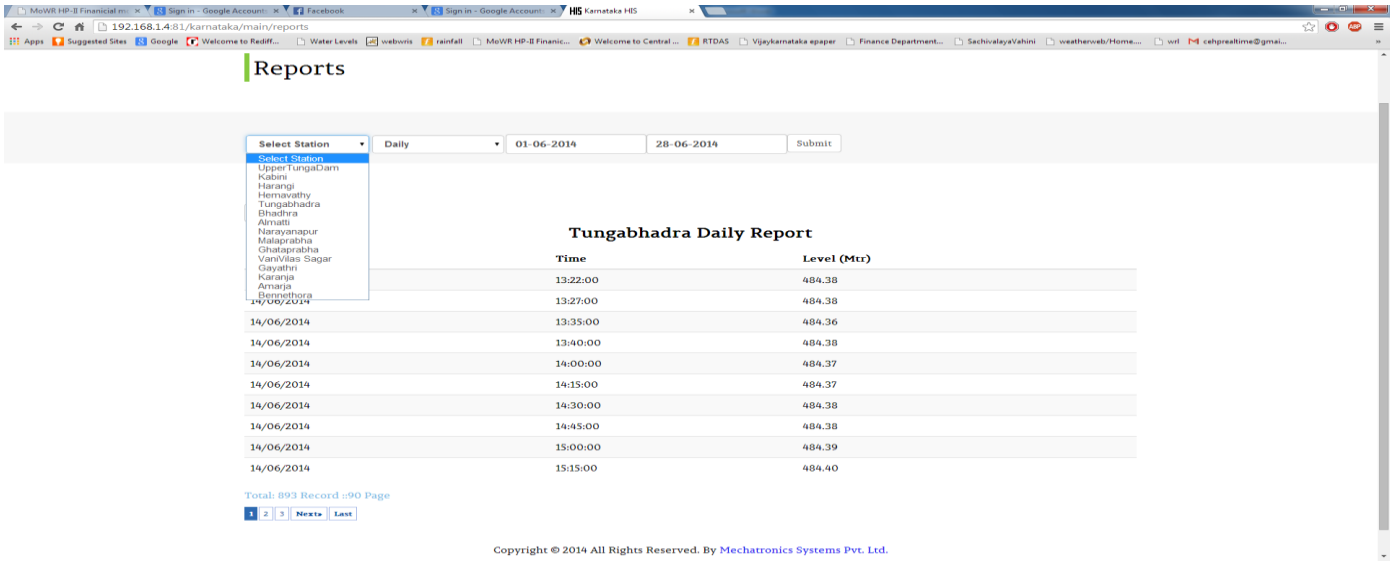
Reports
Select Station
Daily
01-06-2014
28-06-2014
Submit
Tungabhadra Daily Report
Time
Level (Mtr)
13:22:00
484.38
13:27:00
484.38
14/06/2014
13:35:00
484.36
14/06/2014
13:40:00
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Total: 893 Record ::90 Page
Nexts
Last
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CAPACITY BUILDING UNDER HYDROLOGY PROJECT:

As part of institutional strengthening under the project, a number of trainings were organised for water resources Engineers in the field of computers, Specialised hydrological softwares like SWDES, HYMOS, DSS etc. Also Engineers were exposed to GIS and trained in ARC GIS software. The necessary software was also procured and installed in the data centre. A few of the trainings, workshops organised under HP-II is as under:

S.No	Name of course	Place where the training was conducted	Period and Duration of Course	Number of participants	Names of the implementing Agencies represented by the participants
1	training in Basic Computers	Bangalore	25-02-2008-29-02-2008	35	Water Resources Department
2	trained in SWDES	Bangalore	17-03-2008 to 20-03-2008.	20	Water Resources Department
3	FMR Training	Hassan	29-07-2008 to 30-07-2008.	2	Water Resources Department
4	Basic Computers and SWDES training		03-03-2010 to 05-03-2010	31	Water Resources Department
5	DSS training	Bangalore	10-05-2010 to 14-05 2010	3	Water Resources Department
6	Dam safety training at NWA Pune	NWA PUNE	08-02-2010 to 12-02-2010	35	Water Resources Department
7	Training on Hymos software from	Bangalore	08-11-10 to 10-11-2010	ALL ENGINEERS	Water Resources Department
8	MS EXCEL and MS Power point	Bangalore	19-12-2010.	2	Water Resources Department

9	Basic Computer Training	Kers, K.R.Sagar	22-12-2010 to 24-12-2010	15	Water Resources Department
10	SWDES Training	NIE Mysore, Karnataka	22-12-2010 to 24-12-2010	31	Water Resources Department
11	Basic Computer Training	NIE Mysore, Karnataka	27-12-2010 to 29-12-2010.	34	Water Resources Department
12	Basic Computer Training at NIE Mysore from	NIE Mysore, Karnataka	30-12-2010 to 01-01-2011.	31	Water Resources Department
13	GIS Training at Bangalore	Chief Engineer office.Hydrology and CMO SWDC building Bangalore	24-01-2011 to 25-01-2011	10	Water Resources Department
14	EXCEL and Power point at SWDCBuilding Bangalore on	Chief Engineer office. Hydrology and CMO SWDC building Bangalore	27-01-2011.	38	Water Resources Department
15	GIS Training at SWDCBuilding Bangalore	Chief Engineer office.Hydrology and CMO SWDC building Bangalore	31-01-2011 TO 02-02-2011.	10	Water Resources Department
16	GIS Training at SWDCBuilding Bangalore	Chief Engineer office. Hydrology and CMO SWDC building Bangalore	28-02-2011	6	Water Resources Department

17	Training on Hymos software	Kers,K.R.Sagar,Karnataka	25-04-11 to 26-04-2011	27	Water Resources Department
18	Training on DSS software installation, by Carter Borden and ramaprasad	Bangalore	12-05-2011 to 18-05-2011.	2	Water Resources Department
19	Water Quality Training(GW),	conference hall, KanijaBhavan,Bangalore	16-08-2011 TO 19-08-2011.	3	Water Resources Department
20	Training on Design Flood Estimation at NWA Pune	NWA Pune	16-08-2010 to 20-08-2010.	33	Water Resources Department
21	Awareness Raising Workshop onHIS under world bank aided Hydrology Project-II	Hotel THE CAPITOL.. Bangalore.	15-12-2010	Data users and Engineers	Water Resources Department
22	GIS Training at SWDC Building Bangalore	Chief Engineer office.Hydrology and CMO SWDC building Bangalore	03-11-2011 to 05-11-2011.	8	Water Resources Department
23	Training on Design Flood Estimation at NWA Pune	NWA Pune	10-11-2010 to 12-11-2010.	26	Water Resources Department

24	Revision of DSS,(P), pertaining to Runoff and correlation from by Shri . B. Venktesh.	Chief Engineer office.Hydrology and CMO SWDC building Bangalore	18-11-2011 to 19-11-2011	3	Water Resources Department
25	Training on DSS,(P), from by Shri . B. Venktesh and Shri. Carter Borden at BANGALORE.	Chief Engineer office.Hydrology and CMO SWDC building Bangalore	21-11-2011 to 23-11-2011	5	Water Resources Department
26	Hymos training	ESC KERS KR SAGAR.Karnataka	27-12-2011 to 29-02-2011	20	Water Resources Department
27	Basic Computers training	ESC KERS KR SAGAR.Karnataka	23-01-2012 to 25-01-2012	29	Water Resources Department
28	Training on DSS,(P), from by Shri . B. Venktesh and Shri. Carter Borden at Bangalore	Chief Engineer office.Hydrology and CMO SWDC building Bangalore	12-03-2012 to 16-03-2012	5	Water Resources Department
29	Training on Basic GIS from at ATI, Mysore.	Administrative Training Institute. Mysore .Karnataka	19-03-12 to 22-03-2012	27	Water Resources Department
30	Regional Awareness Raising Workshop conducted at Munirabad	Munirabad, Karnataka	28-02-2012.	162	Water Resources Department

31	SWDES Training	KERS,Mysore	19-03-14-21-03-14	32	Water Resources Department

SUPPORT FROM CENTRAL AGENCIES.:

As part of Hydrology project a number of central agencies were also involved in implementation of the project. Data exchange between IMD and CWC has been initiated under the project and rainfall data has been sent to IMD for validation upto 2012. Similarly data is also being sent to CWC for validation of flow data. NIH, was responsible for procuring consultants for DSS. They also organised a number of trainings at Roorkee on DSS and other Hydrology related subjects. NWA, Pune was a nodal training centre under both HP-I and HP-II. TAMC consultants assisted the state in preparation of Bid documents, finalisation of specifications and finalisation of Bid evaluation reports. As part of institutional strengthening, engineers were deputed to various trainings and workshops organised by central agencies as under.:

S. No	Name of course	Names of the Implimenting Agencies Conducting the course	Place where the training was conducted	Period and Duration of Course	Number of participants
1	International programme on procurement procedure for World Bank aided project	ESCI	Hyderabad	09-10-06 to 20-10-06.	1
2	Training programme on Hydrological Information System	ESCI	ESCI, Hyderabad.	16 - 19 Oct - 2006	3

3	Training on ‘‘Project Hydrology at NIH Roorkee” on	ESCI NIH Roorkee	NIH Roorkee	24-02-2008 to 29-02-2008	3
4	Training course on DSS Planning for IWRDM (River Basin Management)	NWA Pune	National Water Academy (NWA) Pune	16-26 September 2008.	2
5	Training course on ‘‘Applications of Remote Sensing and GIS in Water Resources Management”	NIH Roorkee	NIH Roorkee	October 20-24 2008	3
6	Organisation of training course on Water Quality and Management	NIH Roorkee	HRBC NIH, Belgaum	02-02-2009 to 06-02-20009	5
7	HYMOS training at National Water Academy, Pune	NWA Pune	National Water Academy (NWA) Pune	28-04-2009 to 08-05-2009.	2
8	MIS online Training at New Delhi	MOWR		on 28-08-2009.	1
9	Training on DSS(Planning) at NIH Roorkee	NIH Roorkee	NIH Roorkee	26-10-2009 to 06-11-2009.	3
10	Design Flood Estimation for ungauged catchment areas	NIH Roorkee	NIH Roorkee	18-01-2010 to 22-01-2010.	4
11	Training on DSS(Planning) at NWA PUNE	NWA PUNE	NWA PUNE	25-01-2010 to 05-02-2010.	3
12	Remote Sensing and GIS training at NIH Roorkee	NIH Roorkee	NIH Roorkee	08-03-2010 to 12-03-2010.	3

13	FMR training at NWA Pune	NWA Pune	NWA Pune	11-03-2010 to 12-03-2010	3
14	Surface Water Data Validation using Hymos Software	NWA Pune	NWA Pune	28-06-2010 to 02-07-2010.	2
15	Organisation of 5 Days training workshop on prediction in ungauged basins	NIH Roorkee	NIH Roorkee	July 26-30 2010	3
16	Application of GIS in water sector, at NWA Pune	NWA Pune	NWA Pune	22-11-2010 to 03-12-2010	1
17	Training on Hydrologic Extremes- Prediction, Management & Mitigation	NIH Roorkee	NIH Roorkee	06-12-2010 to 10-12-2010	5
18	Training on DSS(Planning) at NIH Roorkee	NIH Roorkee	NIH Roorkee	07-02-2011 to 21-02-2011.	3
19	Training Workshop on “Hydrology Process in an ungauged catchment under HP-2 at NIH Roorkee	NIH Roorkee	NIH Roorkee	25-07-2011 to 29-07-2011	2
20	Training course on PROJECT HYDROLOGY at NIH Belgaum	NIH Roorkee	HRBC NIH, Belgaum	12-09-2011 to 16-09-2011.	4
21	Training course on Water Quality Management on Lakes and Reservoirs at NWA Pune	NWA Pune	NWA Pune	17-10-2011 to 21-10-2011.	3

22	Training on DSS,(P), from 16-01-2012 to 20-1-2012 at NWA Pune.	NWA Pune	NWA Pune	16-01-2012 to 20-01-2012	2
23	Training course on Climate change and its impact at NIH Belgaum	NIH Roorkee	HRBC NIH, Belgaum	06-02-2012 to 10-02-2012.	5
24	Training on HAD and preparation of PMP Atlas at CWC New Delhi	CWC New Delhi	New Delhi	07-02-2012 to 09-02-2012.	2
25	Training on FMR At NWA Pune	NWA Pune	NWA Pune	01-03-2012 to 03-03-2012	1
26	Training on "Advanced Techniques/models for Hydrological Design Aids"	NWA Pune	NWA Pune	21-05-2012 to 25-05-2012	4
27	Second TOT on "Assessment of Water Resources Potential Availability/ Yield assessment"under HAD	NWA Pune	NWA Pune	10-09-2012 TO15-09-2012	4
28	Training on application of Remote Sensing and GIS in hydrology	NIH Roorkee	HRBC NIH, Belgaum	11-09-2012 to 13-09-2012	6
29	Third TOT on "Estimating of Design Flood"under HAD	NWA Pune	NWA Pune	07-01-2013 to 12-01-2013	3
30	Organisation of training course on 'Environmental hydrology with special reference to surface and ground water quality '	NIH Roorkee	HRBC NIH, Belgaum	29-01-2013 to 31-01-2013	5

31	Training programme on 'Preparation od Detailed Project Report of Water Resources Projects'	NWA Pune	NWA Pune	17-06-2013 to 21-06-2013	2
32	Organisation of training on 'Climatechange and Imapact on Water Resources '	NIH Roorkee	HRBC NIH, Belgaum	27-08-2013 to 29-08-2013	3
33	**WORKSHOPS**				
34	Project launch Workshop of HP_II at New Delhi,		New Delhi,	19-04-2006 to 21-04-2006.	2
35	Workshop on preparedness review for DSS (Planning)	NIH Roorkee	NIH Roorkee.	12-07-2006 to 13-07-2006	2
36	Workshop on Financial management in HP-II		New Delhi	11-09-2006 to 13-09-2006.	1
37	Workshop on DSS at Roorke,	NIH Roorkee.	NIH Roorkee.	Nov. 23rd to 25th 2006.	1
38	Workshop on FMR at New Delhi.		New Delhi.	24th & 25th Jan 2007	3
39	Workshop on Financial Reporting at NWA, Pune	NWA, Pune	NWA, Pune	24-25 May 2007.	2
40	One day workshop on procurement and Financial Management issues,		CMRS Building, New Delhi	30-07-2007	4
41	Three days workshop on DSS at Roorkee	NIH Roorkee.	NIH Roorkee.	21-08-2007 to 23-08-2007	2

42	Implementation support and review workshop New Delhi on Workshop on client connection		New Delhi.	5-9-2007,	2
43	Inception workshop for DSS(P) consultancy New Delhi		Conference hall 5th floor (Room No.523(S) CWC Sewa Bhavan, New Delhi	on 09-02-2009 to 10-02-2009.	4
44	DSS Inception Workshop from			2 to 6th of March 2009	35
45	Workshop on WISDOM conducted by Rolta at -2009	NWA, Pune	NWA, Pune	NWA, Pune	2
46	Two days workshop on procurement and preparation for mid-term review		CSMRS Building HauzKhas, New Delhi	from 04-06-2009 to 05-06-2009	2
47	Workshop on DSS(P) for the decision makers of the DSS(P) Implementing Agencies		New Delhi at CWC Sewa Bhawan	11-11-2009.	2
48	RTDSS Workshop Development of Real Time Decision support system,H.P-II.		(Hotel park grand) sector,43/B,Chandigarh	11/12/2009	2
49	DSS Model conceptulisation workshop at CWC NewDelhi		CWC NewDelhi	07-01-2010.	2

50	HIS Awareness raising Workshop		Kanija Bhavan R.C.Road Bangalore	22-04-10 to 23-04-10	3
51	Workshop on HDA(SW)underHP-11		conference room, Sewa Bhawan, R.K.Puram New Delhi	04-06-2010.	2
52	Workshop on Data Base Developmentfor DSS(P) .on		Conference room sewa bhawan New Delhi	11-06-2010.	2
53	Seminar on latest advances in flood forecasting and early warning systems		Conference room sewa bhawan New Delhi	25-06-2010.	2
54	DSS Software Demo at DHI office Okala New Delhi		DHI office Okala New Delhi	31-07-2010.	2
55	Workshop on “Training of Trainers” at NWA Pune	NWA Pune	NWA Pune	27-09-10 to 01-10-10.	1
56	Workshop on”hydrological aspects and preparation of DPR” AT cwc Newdelhi		AT cwc Newdelhi	08-11-2010 to 12-11-2010	2
57	Workshop on Generic DSS(P) Development at CWC SEVA BHAVAN New DELHI		CWC SEVA BHAVAN New DELHI	07-1-2011.	1
58	Workshop on “Challenges ahead in water resources sector.”Held in CPRI Auditorium			23rd and 24th of March 2011.	7
59	Workshop on DSS(P), at seva bhavan NEW DELHI,		Seva bhavan NEW DELHI	25-11-2011.	2
60	Workshop on DSS(P) Application	NIH Roorkee	NIH Roorkee	4-10-2012.	1

61	DSS (P) Sustainability issues and further plan	NIH Roorkee	CWC NewDelhi	29-08-2012	1
62	International workshop on Real time hydrological information system network in india	NWA PUNE	NWA PUNE	23-07-2012 TO 27-07-2012	8
63	Hydrological Design Aids (SW)	NWA PUNE	NWA PUNE	21-05-2012 to 25-05-2012	4
64	Assesment of water Resouces Potential Availability under HAD	NWA PUNE	NWA PUNE	10-9-2012 to 15-09-2012	4
65	Design Flood Estimation	NWA PUNE	NWA PUNE	7-01-2013 to12-01-2013	3
66	Preparation of detailed project report (DPR) of water resources projects	NWA PUNE	NWA PUNE	17-06-2013 to 21-06-2013	2
67	Climate change and its Impact on Water Resouces	NIH Belgaum	NIH Belgaum	27-08-2013 to 29-08-2013	3

68	Ground water Resources Management	NIH Belgaum	NIH Belgaum	11-12-2013 to 13-12-2013	3
69	Storm Analysis Preparation	NWA PUNE	NWA PUNE	16-12-2013 to 21-12-2013	4
70	Storm Analysis Preparation	NWA PUNE	NWA PUNE	13-1-2014 to 17-01-2014	4
71	Drought Disaster Assesment And management	NIH Roorkee.	NIH Roorkee.	10-03-2014 To 14-03-2014	4
72	Interaction meet & workshops under water Quality Domain	CWC New Delhi	CWC New Delhi	27-03-2014 to 29-03-2014	3
73	Integrated Water Resources Management Applications	Mowr, newdelhi	Newdelhi	28.01.2014	1
74	Hydrological Analysis using Statistical and Stocahastic technique .	NIH Roorkee.	NIH Roorkee.	24-2-2014 to 28-02-2014	1

C. Number of persons deputed for international training

S.No	Name of course	Names of the Implimenting Agencies conducting the course	Place where the training was conducted	Period and Duration of Course	Number of participants
1	International Training on DSS(P) Software	**DHI Denmark**	Denmark	19-09-2011 to 07-10-2011.	1

Component –II: Vertical Extension

Purpose Driven Study:

A Purpose Driven Study under HP-II "Study of river water samples at various sites in Southern Karnataka" has been taken up by Karnataka Engineering Research Station, Krishnarajasagara. The study was estimated for Rs. 17.20 Lakhs and commenced during the month of December 2009.

Rivers in Cauvery basin were considered for assessing quality characteristics of surface water in the purpose driven study.

The study was intended for a period of two years from the month of commencement and accordingly the last samples were collected in the month of December 2011.

OBJECTIVES:

- To assess the general trend in quality of water.
- To assess the suitability of water for various uses.
- To classify the monitoring stations for future monitoring.

METHEDOLOGY:

11 rivers (River Cauvery and some of its major and minor tributaries) at 14 different location sites were selected for the study to assess the variation in water quality due to various activities in the catchments. The monitoring location sites were so selected that the various activities leading to possible pollution may be identified. For the convenience of sampling, all the sample collection points were selected at the bridge locations.

The samples were collected once in every month and tested for 27 parameters. List of parameters analyzed is given vide Annexure -III. The samples so collected were analyzed for field parameters, general parameters and coliform group.

The field parameters such as colour, odour, temperature, pH, Electrical Conductivity and DO were tested immediately after the collection of sample.

For general parameters, the samples were collected and immediately transported to the laboratory in a polythene-can of 5 litres capacity placing it in an ice box i.e., maintaining a temperature of 4 ^{o} C.

The samples for dissolved oxygen were collected using DO sampler in a BOD bottle of 300 ml capacity. The sample meant for final DO test was placed in the ice box and transported to the laboratory for further incubation for a period of either 3 days at 27^{0} C or 5 days at 20^{0} C.

The samples for Coliform group were collected in the pre-sterilized bottles and transported to lab in sterile condition placed in ice box. Initially the coliform tests were done without dilution and hence the maximum value reported is 1600 MPN /100 ml. Later dilution of samples was carried out and the values are reported accordingly.

TEST RESULTS:

The monthly test results of all fourteen monitoring station over two year period is averaged to obtain the overall quality of water. The test results obtained are compared for variation with respect to tolerance limit for both drinking and irrigation purpose as per relevant IS. Tolerance limit for drinking and irrigation are given vide Annexure V and VI respectively.

The result data were verified for outliers using statistical method. The high and low outliers were not considered in averaging the monthly data.

In order to assess the suitability of water for various uses, water quality index is calculated using Canadian Council of Ministers of Environment (CCME) water quality index -1.0.

Separate water quality index is calculated for **Class A with Total Coliform, Class A without Total Coliform** and **Class B** as per use based classification of surface water. Use based classification of water is given vide Annexure – VII. The water quality index for irrigation purpose is calculated taking into consideration the parameters mentioned in IS 11624 -1986.

To represents the average concentration of each parameter at all the monitoring stations, graphs are plotted with average concentration in the ordinate and monitoring stations in the abscissa.

DISCUSSION:

Generally it is observed that DO at all the stations is above 6 mg/l except in Suvarnavathy. Higher DO is found in Shimsha because of turbulent and low depth of flow. In Chiklihole, the DO is higher because of photosynthetic activity of algae.

Total Alkalinity concentration is above 200 mg/l in Taraka, Lakshmanatheertha near Bilikere, Shimsha and Suvarnavathy. This is due to soaps and detergents entering the water body because of laundry activity. Coliform of both types are found higher in Taraka, Suvarnavathy and Lokapavani because of human activities and lean flow during most of the months.

CONCLUSION

- pH at all the fourteen monitoring stations are in the range of 6.5 to 8.5 as per IS stipulation.

- Dissolved Oxygen at all the stations is above 6 mg/l except in Suvarnavthy near Kollegala.
- Total Dissolved Solids at all the points is well within permissible limit of 500 mg/l.
- The average BOD level at all the stations is less than 3 mg/l.
- The water is relatively soft in Chiklihole, Cauvery near Kushalanagar, Harangi, Yagachi, Lakshmanatheertha near Hangodu and Kabini (i.e., total hardness less than 100 mg/l)
- Alkalinity above 200 mg/l is observed Taraka, Lakshmanatheertha near Bilikere, Shimsha and Suvarnavathy.
- Higher coliform are found in all the river monitoring points and this is attributed to human activities.
- All other parameters are well within permissible limit as stipulated by the IS.
- Chiklihole can be grouped under Class A, as per use based classification since its water quality index is 78.
- All other river water has a water quality index in the range of 50 to 60 for Class A and above 80 for Class C.
- The water at all the points is most suitable for irrigation purpose.

The water at all the stations confirm to Class C specifications as per use based classification. The overall quality of water at all the monitoring points is not much affected by present activities in catchment area and hence does not need regular monitoring. However in order to ascertain any change in quality due to future variation in land use pattern, it is desirable to monitor these rivers twice a year (i.e., pre monsoon and post monsoon).

DSS:

The Pilot basin selected was Tungabhadra left bank canal for conjunctive use of surface & Ground water. DSS is developed by using MIKE Basin Software.

The water resources issues identified for the Tungabhadra Command Area are water logging, water scarcity for tail end users, and increasing soil salinity. Common practice is for the head users of the canal to

take the water first, flooding the fields and leaving irrigators at the tail end of the canal with limited irrigation water. For the head users, the excess water applied to fields raises groundwater levels that in turn leach salts from the black cotton soils towards the ground surface. Tail end users use groundwater to augment crop water requirements when surface water is short which creates declining groundwater levels. In the light of these problems in the command area, a DSS Application was developed to assist GoK SWD to evaluate the conjunctive use of surface and groundwater in the command area). It is envisaged to look for methods to solve water logging and reclaim the land and also to improve the groundwater levels in the tail end of the command area.

Background

Supplying water to the TCA is the Tungabhadra Reservoir. The Tungabhadra Reservoir, constructed in 1958, is located at Munirabad in Bellary District, and has a catchment area of 28,177 km2, a reservoir capacity of 3,751 Mm3, and an annual yield of 11,528 Mm3. The ex- tent of the TCA is 5,050 km2 and lies in the Bellary, Raichur and Koppal Districts of Karna- taka. The right bank canals also service the command area in Andhra Pradesh. This multi- purpose reservoir provides service to the irrigation, domestic/municipal, and hydropower water use sectors. The combined installed capacity of the hydropower units is 63 MW.

Irrigation waters are released from the reservoir during the Kharif season (June to November) and the Rabi season (December to March). Water is released in four canals: the left bank lower canal (224 km in length), left bank high canal (15 km in length), right bank lower canal (349 km in length), right high canal (196 km in length). The left bank canals service the command area in the Koppal and Raichur Districts and the right bank canals service the command areas in the Bellary District. Water distribution in the left bank canals distributories is controlled/measured by the SoK. For the right bank canals, the water distribution in the canals is controlled/measured by the SoK at the diversion off the main canals. The DSS for the TCA is to

be developed to address the water resource issues in the left bank lower canal. Land use within the TCA is primarily agricultural.

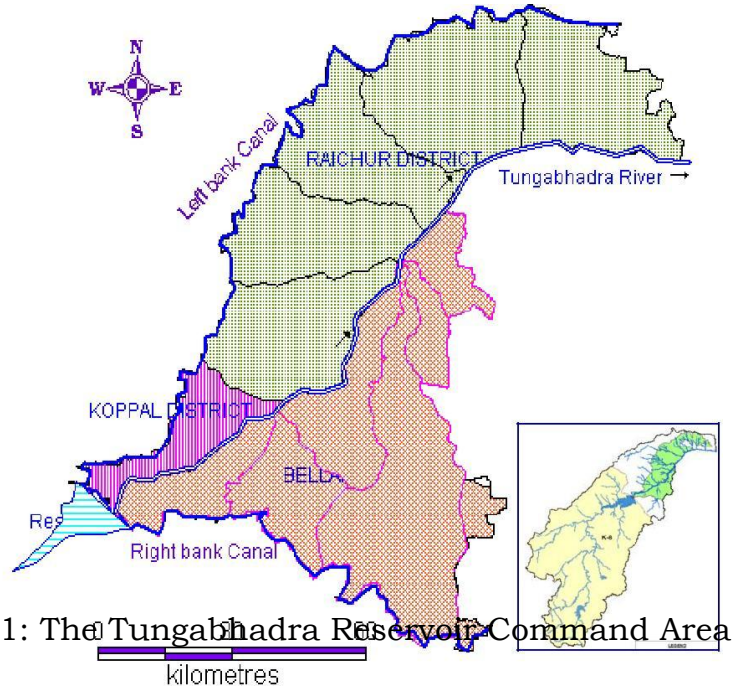


Figure 6-1: The Tungabhadra Reservoir Command Area

Groundwater in the TCA is primarily extracted from black cotton soils (up to 10 m) for dug wells and late Achaean granites and gneisses with varying degree of weathering for bore wells. Red sandy/loamy soils are noticed in the elevated areas and along hill slopes. Associated with the black cotton soils are high salinity concentrations (5,000 - 10,000 ppm).

Model Development

Supporting the TCA DSS Applications are River Basin Models (RBMs) that has been developed for the Tungabhadra Reservoir Left Bank Canal Command Area using MIKE BASIN. These models enable GoK SWD to evaluate possible changes in the water demands, water delivery strategies, and general water management etc. The work was carried out by the modeling teams GoK SWD with support from the Consultant and NIH.

Figure 6-2.The Tungabhadra Reservoir Command Area

The Tungabhadra Command Area RBM is defined by 17 catchments each including water user nodes representing irrigation (Figure). Catchment runoff and ground water recharge were computed using the NAM model and imported to the RBM. All catchments employed MIKE BASIN's 2-layer model for simulating groundwater use and availability. Domestic water use was deemed insignificant in comparison to irrigation practices and thus excluded from the RBM.

The irrigation demand for the water use within each catchment in the command area was calculated by determine the areal extent of irrigation in the command area from land use cover maps and applying literature values from GoK Department of Agriculture for crop water requirements per area. The 2004, 2007 GEC 97 data sets (for census of crop types and well counts) were used to validate the values. In the model, water supplied to each irrigation node can be delivered from both canals and groundwater. To regulated inflow from the canal, the ditch capacity associated with the inflow link channel is set to the desired amount delivered via the canal system with the balance being supplied by available groundwater. This allows the decision maker to change the quantity delivered by the canal to test conjunctive use alternatives in each catchment. Return flow quantities return to both the stream network and underlying groundwater catchment.

Using time series information from the TCA model, two additional models were constructed to demonstrate evaluation of conjunctive use management within the D25 Distributary (Figure 6-4) and

between the D25 and D54. These models were conceptually identical to the regional scale model in network configuration and methodology used to generate catchment inflow, groundwater recharge, and water demand time series. The exceptions are the network were developed as schematics of the system and, for the D25 Distributary, an additional node was introduced that represents GW pumped back to the stream network for use downstream. This addition was included to allow water managers to test this as a potential mitigation for lowering GW in the upper reaches of the distributary and supplying additional surface water flow to the lower reaches.

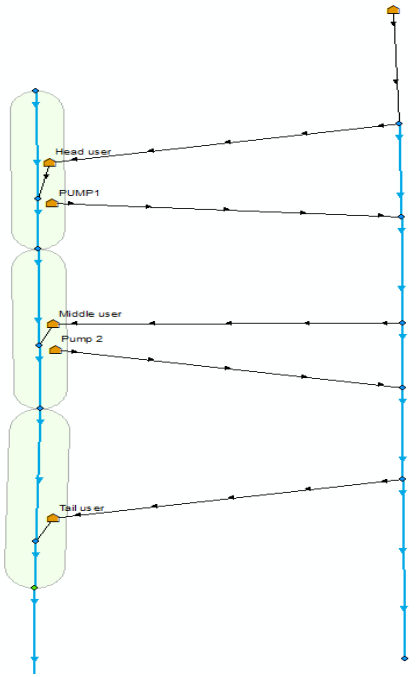


Figure:6.3 Schematic model of the T25 distributary in the TCA. The three polygons to the left represent the upper, middle, and lower portions of the distributary.

DSS Applications

Three DSS Applications regarding conjunctive use of ground and surface water were under- taken in the TCA: i) for the D25 Distributary, ii) between the D25 and D54 Distributaries, and iii) throughout the LBC command area. The former two applications were used to refine and demonstrate the analysis with the latter application using finding from the first two examples in a system wide analysis.

Each application consists of compared Baseline and Proposed scenarios. For the Baseline Scenario, representing current conditions, users divert the maximum surface water necessary to fulfill their demand thus precluding downstream users from obtaining surface water supply. In contrast, the proposed scenarios restricts upstream users to divert only a portion their demand from surface water, thus letting canal water proceed downstream for other users. The demonstration objectives were to increase overall delivery of surface water, maintain or improve ground water levels, and increase delivery. Customized DSS interfaces were developed to support these analyses (Figure). Brief descriptions of the DSS Applications are presented below.

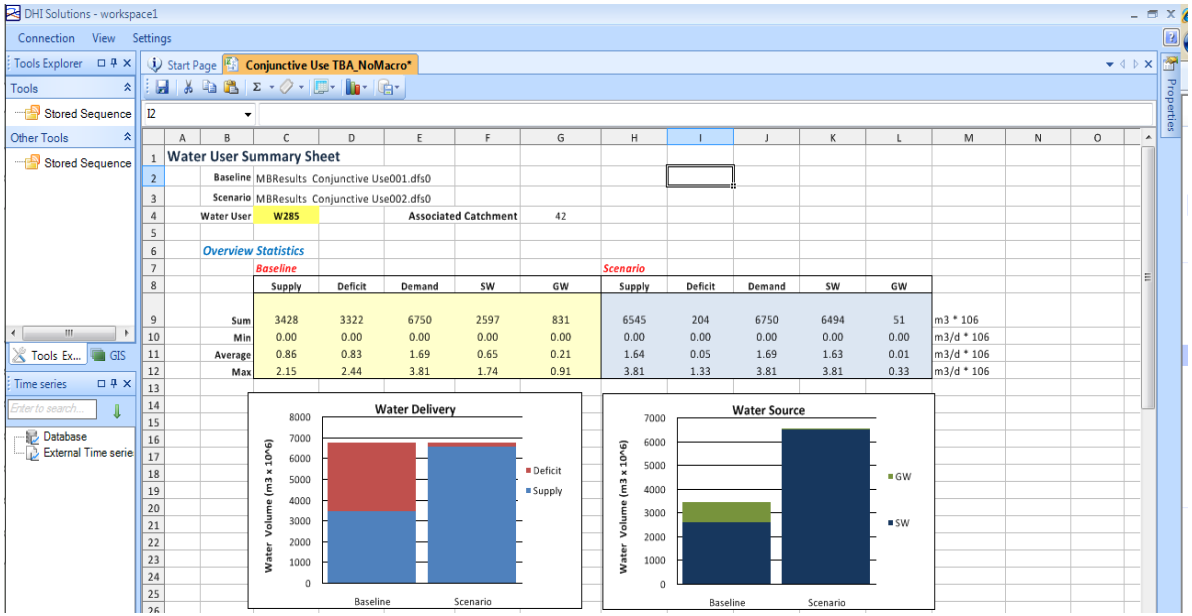


Figure:6.4 Example of output for an irrigation water use in the TCA DSS interface

Within the D25 and D54 Distributary Conjunctive Use Study

An analysis has been carried out in examining the issues of water logging and areas of critical water deficit zones within the TCA LBC D25 and D54 Distributaries. A schematic RBM has been set up for each of the D25 Distributary with the total command area for each of the distributaries has been divided into sub-command areas as Head, Middle and Tail Sub-Command Areas (Figure). The D25 and D54 Distributaries have command are- as of 132 km2, which have been divided equally into the three sub-command areas of 44 km2 (D25 Distributary).

Associated with each sub-command area is a water user node and for the Head and Middle Sub-Catchments, a node representing groundwater pumped back to the canal system. The total irrigation water demand for the command areas has been made available from GoK SWD. However, the demands for each of

the sub-command areas within the distributaries are not available, therefore it was assumed the head, middle and tail user demands be allocated as 45%, 30%, and 25% of the total demand, respectively. For all users, surface water from the canal is taken first with the balance being supplied by groundwater. In both distributaries, the base condition is for the head user to withdraw the maximum water, leaving no or less water for the tail user.

Due to a discrepancy between the design crop and what is currently planted, a water deficit exists in all sub-command areas as the distributary capacity was designed for crops requiring less water. Therefore, groundwater is required in all sub-command areas to augment irrigation requirements. All the scenarios have been modeled with the assumption that there is a flow loss of 5% in the canal, and the return flow from the user is 40%, with 30% of the return flow lost through seepage. However for the tail user it is assumed that all the 40% of the return flow contributes as seepage loss.

Different scenarios have been modeled that partition available surface water from the canal network amongst the users and with different rates of abstractions of groundwater. The groundwater abstractions are tested to draft only the percentage of the fraction of the remaining demand (after surface water is supplied), to determine the groundwater depth. Pumping scenarios of ground water from the Head and Middle Sub-Command Areas, back to the distributary, to minimise the deficit at the Tail Sub-Command Area, has also been modeled. The goal is to maximize water delivery in the distributary while maintaining sustainable groundwater levels. The D25 and D54 Distributaries have been modeled separately.

Results:

D25 Scenarios and Results

Nine scenarios were simulated with varying degrees of groundwater supply and pump back to the stream. The description of the simulations and results are presented below.

Baseline Scenario: This scenario has been modelled using only the available surface water from

the distributaries. No groundwater has been used in this scenario.

- Baseline Scenario: No groundwater abstractions, uses only the surface water from the Distributaries

Scenario 1-5: These scenarios have been modelled by using the available surface water from the distributaries, with various amount of groundwater abstraction. The abstraction has been carried out with various fraction of the percentage of the remaining demand after utilising the surface water.

- Scenario 1: With groundwater abstraction fraction (GWAF) of 1, i.e. abstracting 100% of the remaining demand from groundwater in all the sub-command areas

- Scenario 2: GWAF = 0.6, in all sub-command areas

- Scenario 3: GWAF = 0.65 (from Head), 0.55 (Middle), 0.4 (Tail)

- Scenario 4: GWAF = 0.70 (from Head), 0.50 (Middle), 0.30 (Tail)

- Scenario 5: GWAF = 0.90 (from Head), 0.50 (Middle), 0.30 (Tail)

Scenario 6-9: Same configuration as the above scenarios, but with varying amounts of pumping of groundwater from the Head and Middle Sub-Command Areas. The pumped wa-ter augments flows to down canal distributaries.

- Scenario 6: GWAF = 0.90 (from Head), 0.50 (Middle), 0.30 (Tail), 0.1 m3/s Pumping from each of Head and Middle Sub-Command Areas to the distributary

- Scenario 7: GWAF = 0.90 (from Head), 0.50 (Middle), 0.30 (Tail), 0.15 m3/s Pumping from each of Head and Middle Sub-Command Areas to the distributary

- Scenario 8: GWAF = 0.90 (from Head), 0.50 (Middle), 0.35 (Tail), 0.10 m3/s Pumping from each of Head and Middle Sub-Command Areas to the distributary

- Scenario 9: GWAF = 0.90 (from Head), 0.50 (Middle), 0.4 (Tail), 0.10 m3/s Pumping from each of Head and Middle Sub-Command Areas to the distributary

Results:

Based on the overall delivery and sustainability of groundwater level in all the sub-command areas, Scenario 8 as the most favourable one (Figure 6-6-Figure 6-8, Table 6-1). From Figure 6-6, it can be seen that in the Head Sub-Command Areas, about 90 % of the remaining demand (0.26 TMC/year), after using surface water, can be safely extracted from groundwater. About 50 % and 35% of the remaining demand can be extracted safely from the Middle and Tail Sub-Command Areas respectively, which amounts to 0.38 TMC/year and 0.46 TMC/year. This includes the pumping of groundwater 0.1 m3/s each from Head and Middle Sub-Command Areas back to the canal network for use downstream. Therefore the total safe abstractable groundwater in D25 is 1.11 TMC/year. The total sup-ply is 4.79

TMC/year with a deficit for Scenario 8 is 1.12 TMC. Scenario 9 is slightly large in supply (4.84 TMC/year), but the groundwater levels are unsustainable. Therefore, Scenario 8 is the best option for the D25 Distributary.

Table 6-1 Results from the Baseline and Scenarios 1-9 for the D25 Distributary. All results are in TMC/year.

	Head	***Middle***	***Tail***	***Head***	***Middle***	***Tail***	***Total***
	TMC	***TMC***	***TMC***	***TMC***	***TMC***	***TMC***	***TMC***
Demand	2.66	1.77	1.48	2.66	1.77	1.48	5.90
Surface	2.50	1.17	0.08	2.50	1.17	0.08	3.75
Groundwater	0.00	0.00	0.00	0.16	0.60	0.83	1.59

Pumping							
Supply	2.50	1.17	0.08	2.66	1.77	0.91	5.34
Deficit	0.16	0.60	1.40	0.00	0.00	0.56	0.56
	Head	***Middle***	***Tail***	***Head***	***Middle***	***Tail***	***Total***
	TMC	***TMC***	***TMC***	***TMC***	***TMC***	***TMC***	***TMC***
Demand	2.66	1.77	1.48	2.66	1.77	1.48	5.90
Surface	2.50	1.24	0.17	2.50	1.17	0.08	3.75
Groundwater	0.09	0.32	0.79	0.10	0.33	0.56	0.99
Pumping							

Supply	2.59	1.55	0.96	2.60	1.50	0.64	4.74
Deficit	0.07	0.21	0.52	0.06	0.27	0.83	1.16
	Head	***Midldle***	***Tail***	***Head***	***Midldle***	***Tail***	***Total***
	TMC	***TMC***	***TMC***	***TMC***	***TMC***	***TMC***	***TMC***
Demand	2.66	1.77	1.48	2.66	1.77	1.48	5.90
Surface	2.50	1.16	0.07	2.50	1.16	0.07	3.73
Groundwater	0.11	0.30	0.43	0.15	0.30	0.43	0.88
Pumping				0.00	0.00	0.00	
Supply	2.61	1.46	0.50	2.65	1.46	0.50	4.61
Deficit	0.05	0.30	0.98	0.01	0.30	0.98	1.30
	Head	***Midldle***	***Tail***	***Head***	***Middle***	***Tail***	***Total***
	TMC	***TMC***	***TMC***	***TMC***	***TMC***	***TMC***	***TMC***
Demand	2.66	1.77	1.48	2.66	1.77	1.48	5.90
Surface	2.50	1.24	0.17	2.50	1.28	0.21	4.00
Groundwater	0.15	0.27	0.39	0.15	0.24	0.38	0.77
Pumping	0.11	0.11	0.00	0.17	0.17	0.00	0.34
Supply	2.65	1.51	0.56	2.65	1.52	0.60	4.76
Deficit	0.01	0.26	0.91	0.01	0.25	0.88	1.14

Scenario 8: GWA with GWF = 0.90, 0.50, 0.35, 0.1,0.1 PUMPING					***Scenario 9 : GWA with GWF = 0.90, 0.50, 0.4, 0.1,0.1 PUMPING***				
	Head	***Middle***	***Tail***	***Total***		***Head***	***Mid-dle***	***Tail***	***Total***
	TMC	***TMC***	***TMC***	***TMC***		***TMC***	***TMC***	***TMC***	***TMC***
Demand	2.66	1.77	1.48	5.90	***Demand***	2.66	1.77	1.48	5.90
Surface	2.50	1.24	0.17	3.91	***Surface***	2.50	1.24	0.17	3.91
Ground water	0.15	0.27	0.46	0.88	***Ground water***	0.15	0.27	0.52	0.93
Pumping	0.11	0.11	0.00	0.23	***Pumping***	0.11	0.11	0.00	0.23
Supply	2.65	1.51	0.63	4.79	***Supply***	2.65	1.51	0.69	4.84
Deficit	0.01	0.26	0.84	1.12	***Deficit***	0.01	0.26	0.79	1.06

D54 Scenarios and Results

Nine scenarios were simulated with varying degrees of groundwater supply and pump back to the stream. The description of the simulations and results are presented below.

Base Scenario: This scenario has been modelled using only the available surface water from the distributaries. No groundwater has been used in this scenario.

- Baseline Scenario: No groundwater abstractions, uses only the surface water from the Distributaries

Scenario 1-3: These scenarios have been modelled by using the available surface water from the distributaries, with various amount of groundwater abstraction. The abstraction has been carried out with various fraction of the percentage of the remaining demand after utilising the surface water.

- Scenario 1 : With GWA= 0.3, i.e. abstracting 30% of the remaining demand from groundwater in all the sub-command areas

- Scenario 2 : GWA = 0.3 (from Head), 0.2 (Middle), 0.2 (Tail)

- Scenario 3 : GWA = 0.4 (from Head), 0.15 (Middle), 0.15 Tail)

Scenario 4-8: Same configuration as the above scenarios, but with varying amounts of pumping of

groundwater from the Head and Middle Sub-Command Areas. The pumped wa-ter augments flows to down canal distributaries.

- Scenario 4 : GWA = 0.40 (from Head), 0.15 (Middle), 0.15 (Tail), 0.1 m^3/s Pumping from Head
- Scenario 5 : GWA = 0.40 (from Head), 0.15 (Middle), 0.15 (Tail), 0.3 m^3/s Pumping from Head
- Scenario 6 : GWA = 0.40 (from Head), 0.15 (Middle), 0.15 (Tail), 0.3 m^3/s, 0.15 m^3/s Pumping from Head and Middle
- Scenario 7: 0.50 (from Head), 0.15 (Middle), 0.15 (Tail), 0.3 m^3/s, 0.15 m^3/s Pump-ing from Head and Middle
- Scenario 8: 0.40 (from Head), 0.15 (Middle), 0.20 (Tail), 0.3 m^3/s, 0.15 m^3/s Pump-ing from Head and Middle

Results: The analysis for D54 from of the relative depth to groundwater shows sustainabil-ity in the depth to deep groundwater plot in Scenario 8 (Figure 6-9-Figure 6-11, Table 6-2). This scenario shows that approximately about 40%, 15% and 20%, of the remaining de-mand can be safely extracted from Head, Middle and Tail Sub-Command Areas, in addition to pumping of 0.3 m^3/s and 0.15 m^3/s from the Head and Middle Sub-Command Areas to the distributary. The total safe abstractable ground water in distributary D54 is 2.97 TMC.

Table 6-2. Results from the Baseline and Scenarios 1-8 for the D54 Distributary

aseline Scenario : No GWA					*Scenario 1: GWA = 0.3*				
	Head	**Middle**	**Tail**	***Total***		**Head**	**Middle**	**Tail**	***Total***
Demand	*9.26*	*6.17*	*5.14*	*20.57*	***Demand***	*9.26*	*6.17*	*5.14*	*20.57*
Surface	*7.74*	*0.26*	*0.00*	*8.00*	***Surface***	*7.74*	*0.25*	*0.00*	*7.99*
Groundwater	*0.00*	*0.00*	*0.00*	*0.00*	***Groundwater***	*0.46*	*1.78*	*1.54*	*3.78*
Pumping					***Pumping***				
Supply	*7.74*	*0.26*	*0.00*	*8.00*	***Supply***	*8.20*	*2.03*	*1.54*	*11.77*
Deficit	*1.52*	*5.91*	*5.14*	*12.57*	***Deficit***	*1.06*	*4.14*	*3.59*	*8.80*
Scenario 2: GWA =0.3, 0.2, 0.2					***Scenario 2a:GWA = 0.3, 0.15, 0.15***				
	Head	**Middle**	**Tail**	***Total***		**Head**	**Middle**	**Tail**	***Total***
Demand	***9.26***	***6.17***	***5.14***	***20.57***	***Demand***	***9.26***	***6.26***	***5.14***	***20.66***
Surface	***7.74***	***0.26***	***0.00***	***8.00***	***Surface***	***7.74***	***0.26***	***0.00***	***8.00***
Groundwater	***0.46***	***1.18***	***1.02***	***2.67***	***Groundwater***	***0.46***	***0.89***	***0.77***	***2.12***
Pumping					***Pumping***				
Supply	***8.20***	***1.44***	***1.02***	***10.67***	***Supply***	***8.20***	***1.24***	***0.77***	***10.20***
Deficit	***1.06***	***4.73***	***4.11***	***9.90***	***Deficit***	***1.06***	***5.02***	***4.37***	***10.45***

Scenario 3 : GWA = 0.4, 0.15, 0.15					*Scenario 4: GWA = 0.4, 0.150, 0.15, 0.1m3/s Pumping from Head*				
	Head	**Middle**	**Tail**	***Total***		**Head**	**Middle**	**Tail**	***Total***
Demand	***9.24***	***6.26***	***5.14***	***20.63***	***Demand***	***9.25***	***6.16***	***5.14***	***20.54***
Surface	***7.74***	***0.26***	***0.00***	***8.00***	***Surface***	***7.74***	***0.35***	***0.00***	***8.09***
Groundwater	***0.61***	***0.89***	***0.77***	***2.26***	***Groundwater***	***0.61***	***0.88***	***0.78***	***2.26***
Pumping					***Pumping***	***0.1***			
Supply	***8.33***	***1.24***	***0.77***	***10.34***	***Supply***	***8.33***	***1.22***	***0.78***	***10.33***
Deficit	***0.90***	***5.02***	***4.37***	***10.29***	***Deficit***	***0.91***	***4.94***	***4.36***	***10.22***

	Head	**Middle**	**Tail**	**Head**	**Middle**	**Tail**	***Total***
Demand	***9.25***	***6.16***	***5.14***	***9.25***	***6.16***	***5.15***	***20.55***
Surface	***7.74***	***0.51***	***0.01***	***7.74***	***0.51***	***0.14***	***8.38***

Groundwater	*0.61*	*0.84*	*0.77*	*0.77*	*0.84*	*0.74*	*2.35*
Pumping	*0.3*			*0.3*	*0.15*		
Supply	*8.33*	*1.36*	*0.78*	*8.49*	*1.36*	*0.89*	*10.74*
Deficit	*0.91*	*4.80*	*4.36*	*0.75*	*4.80*	*4.26*	*9.81*

D25 and D54 Distributaries Conjunctive Use Study

To demonstrate how water mangers could use the TCA DSS to assess conjunctive management strategies between multiple distributaries, a case study was conducted involving distributaries D25 and D54. Both the distributaries use surface water from the distributary of LBC of TCA. Distributary D25 is located upper LBC and has an irrigated area of 131.75 km2 and D54 is located mid-LBC, irritating 464.18 km2 with a combined source surface water from the Tungabhadra LBC and groundwater. For D54, the crops grown are primarily paddy which requires more water than the design crops and thus the supplying distributary capacity is insufficient to supply the full requirement. The objective of the study was to determine the impacts of limiting canal water delivery to D25 and augmenting canal delivery to D54 as well as limiting the groundwater supply. The metrics for comparison of the scenarios were supply and deficit to the water users, source of supply to water users, and depth of groundwater

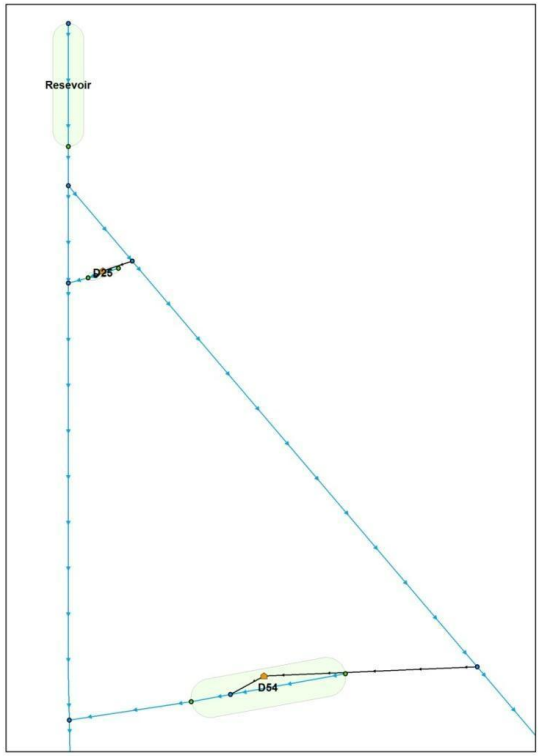


Figure 6-12. Schematic model for Command Area D25 and D54 of the distributary

Supporting the example, a schematic RBM was constructed for the two distributaries that first uses surface water from the LBC followed by available groundwater to fulfill the remaining demand (Figure 6-12). Demand of 5.79 and 20.14 TMC, was given for D25 and D54, respectively. Canal losses within the distributaries were set to 5% and the return flow from the user is set to 40% whereas the seepage loss for return flow reach is set as 30%. Simulations were run over an 11 years period, 2000-2010, to capture a variety of hydrologic conditions.

Five scenarios were simulated with varying degrees of groundwater supply (Table 6-3). In terms of delivery, Scenario 4 is best with a combined delivery of 18.56 TMC/year and a deficit of 7.37 TMC/year. The results indicate that for the D25 Distributary, 50-55% of available groundwater can be extracted safely which is about 1.06 – 1.17 TMC/year without exceeding the depth to deep groundwater. For the D45 Distributary,

3.10 TMC/year of groundwater can be extracted safely.

Table 6-3 Statistics for the Baseline and Scenarios 1-6 of the D25 and D54 Distributaries. All units are in TMC.

D25 Distributary	**Baseline**	**Scenario 1**	**Scenario 2**	**Scenario 3**	**Scenario 4**
Groundwater Fraction of Remaining Demand	**0.35**	**0.40**	**0.45**	**0.50**	**0.55**
Demand	5.79	5.79	5.79	5.79	5.79
Supply	4.40	4.51	4.61	4.72	4.83
SDeficit	1.38	1.28	1.17	1.06	0.96
Surface Use	3.66	3.66	3.66	3.66	3.66
Groundwater Abstraction	0.74	0.85	0.96	1.06	1.17
Stream Seepage	0.53	0.54	0.55	0.57	0.58
D54 Distributary					**Absolute Demand**
Groundwater Fraction of Remaining Demand	**1.00**	**0.75**	**0.00**	**0.75**	**1.2**
Demand	20.14	20.14	20.14	20.14	20.14
Supply	10.11	10.09	7.75	13.84	8.75
Deficit	10.03	10.05	12.40	6.30	11.39
Surface Use	7.75	7.75	7.75	7.75	7.74
Groundwater Abstraction	2.37	2.35	0.00	6.10	1.02
Stream Seepage	1.21	1.21	0.93	1.66	1.05

Hydrological Data user Group:

During HP-I Government constituted Hydrology Project group vide GO No.ID_151_MTZ_92(part-2),Bangalore.dated:15.7.1996 at state level with its 33 Government users as members .

The purpose of setting up of HDUG was to provide common platform for discussion between hydrological data users and providers. A number of meetings of HDUG was conducted and HIN Needs were collected from several users.

During HP-II, government reconstituted HDUG with 16 members and expert in the field of hydrology/water sector from academy, industry, consultants, etc as invitees vide Government order No.WRD 10 RAJAYO 2009, Bangalore, Dated: 26.06.2009. Two meetings were conducted and availability of data was explained to all the members.

The main functions of the group was:

- To advise on the use of data bank and to suggest how to make data bank as user-friendly as possible.
- To advice the type of services to be provided by the data centre.
- Advice on formats of reporting to make data and on data quality.
- Provide feedback on the practical use of data and data quality.
- Advise on changes for services on the data centre where applicable.
- Provide links various data users when they represent and assist the state and central agencies in connection With the public.

- Assist in identifying priority areas for Data collection management and dissemination through the data centres.

Awareness Raising activities:

During HP-II Two workshops were organized as part of awareness raising activities. The state level workshop on HIS was organized at Bangalore and about 110 top level officers of various departments, academicians and professionals in the field of Water resources participated in the workshop. A regional workshop at Munirabad was also organized on HIS and DSS as Tungabhadra basin was selected for DSS development. About 162 participants participated in the above workshop.

Future Plans and needs.

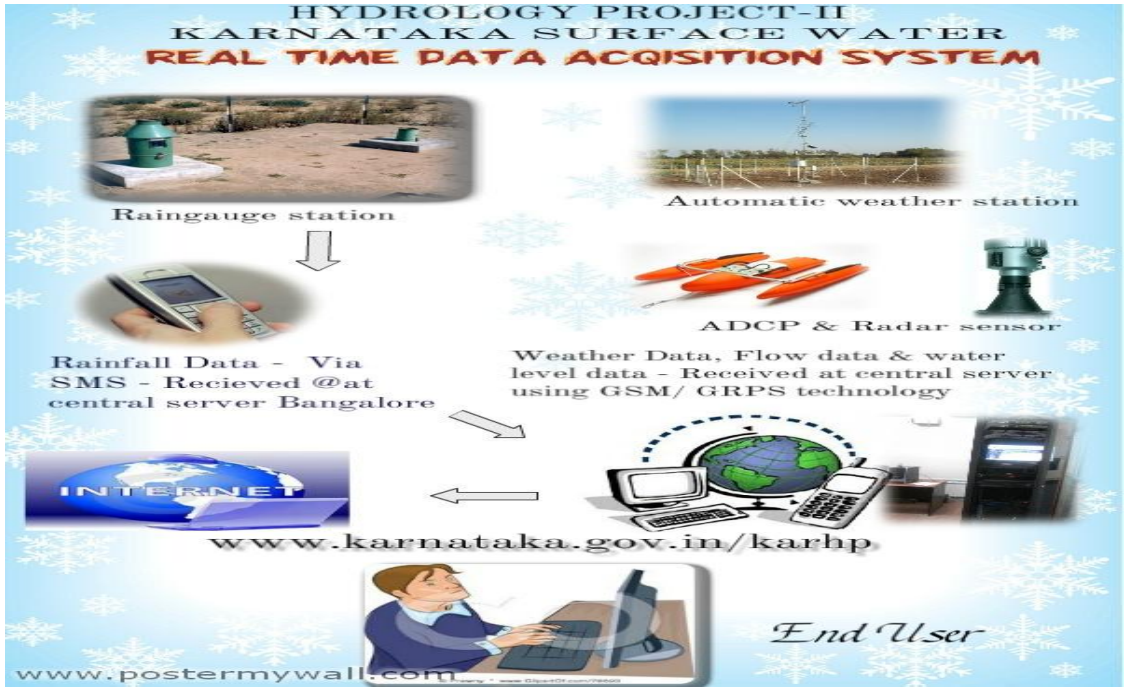
- It is proposed to extend Real Time Data Acquisition System using ADCP, Radar Sensors & mobiles to other important gauge sites in the state and establishing Telemetric Raingauges and Automatic Weather Stations for obtaining data in realtime from station spread all over the state.
- Apart from realtime activity it is also proposed to extend the DSS activity to other basins.
- E-swis software to be implemented after its introduction by CWC.

Lesson learnt under Hydrology project Phase II:

- Software development under the project should be completed during the initial 3 years of the project and implemented in the remaining 2 to 3 years.
- Major training should be organized in the respective states for successful implementation of softwares.

Success Stories under Hydrology project Phase II:

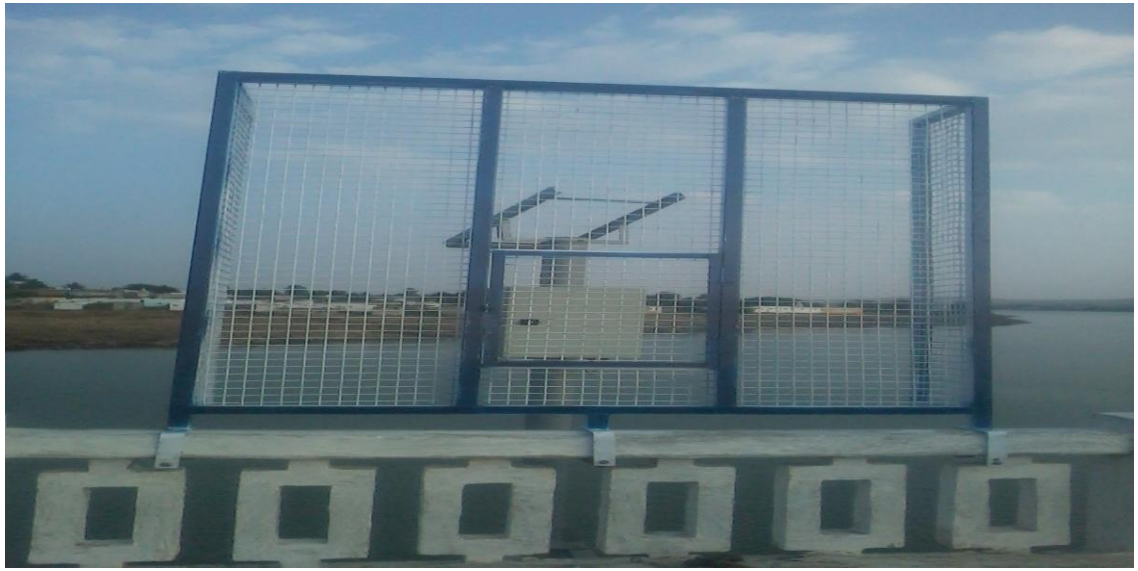
- The real time data transfer system has been established for transfer of Rainfall data from all 1010 raingauge stations through SMS using GSM Technology to the Central Server located at Bangalore. The system is working satisfactorily for the last 3 years. The data is hosted on the website:www.karunadu.gov.in/karhp. The data can be viewed Basin wise, District Wise & taluk wise for any particular period. A facility to download data in excel and pdf format is also made available in the website. The total cost involved in setting up this data transfer system including the cost of mobile instruments, 2 central servers, software etc. worked out to about Rs.30lakhs, whereas if telemetric raingauges had been established it would have been about 5 to 6 crores. This low cost approach has been appreciated by the World Bank.



- Measument of flows using ADCP:

Earlier flow data was measured using current meter and the gauge data was observed manually. However under Hydrology project II RADAR'S are installed for automatic measurements of Levels and flows are measured using ADCP. This has ensured that levels in the rivers are monitored continuously to give advanced warning to reservoir authorities and manage the reservoir effectively.

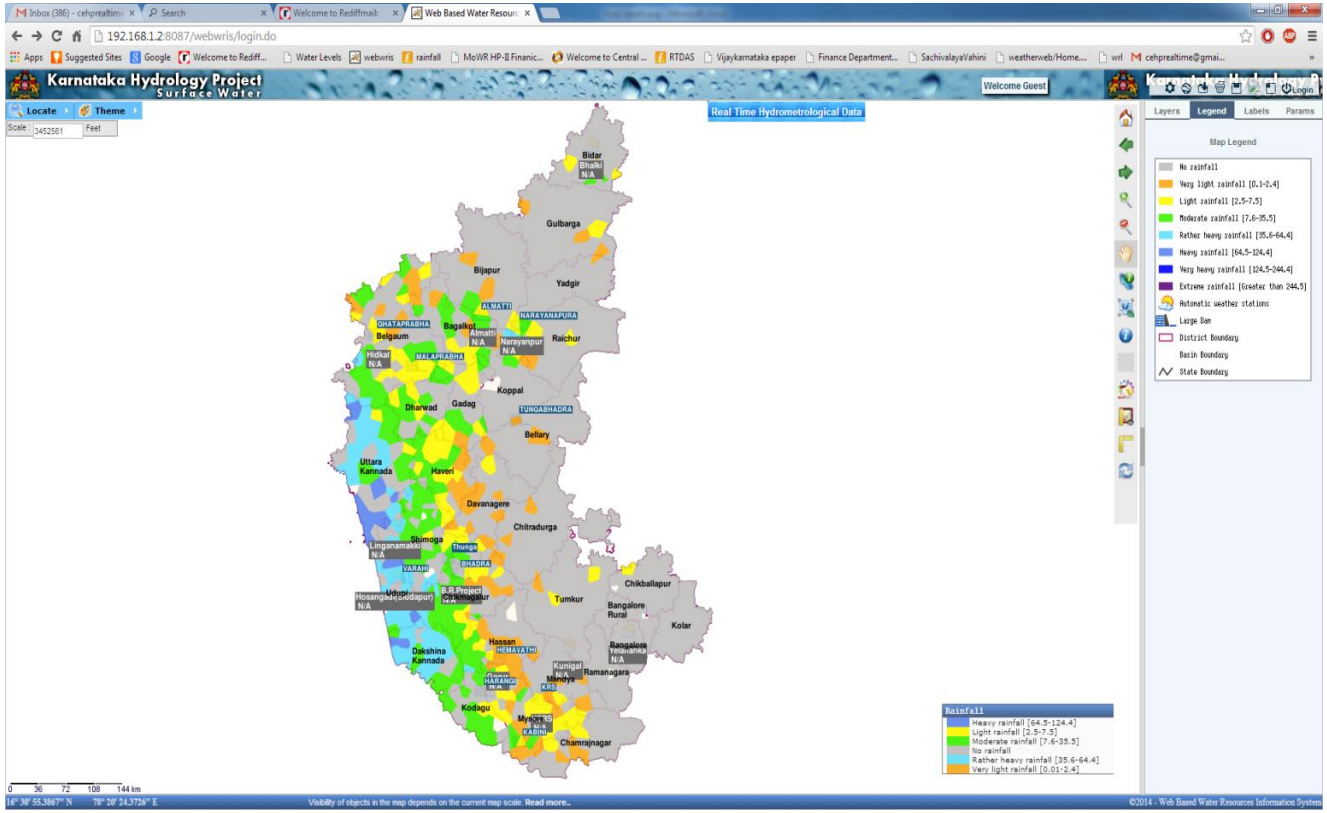
NON CONTACT RADAR SENSOR FOR LEVEL MEASUREMENT



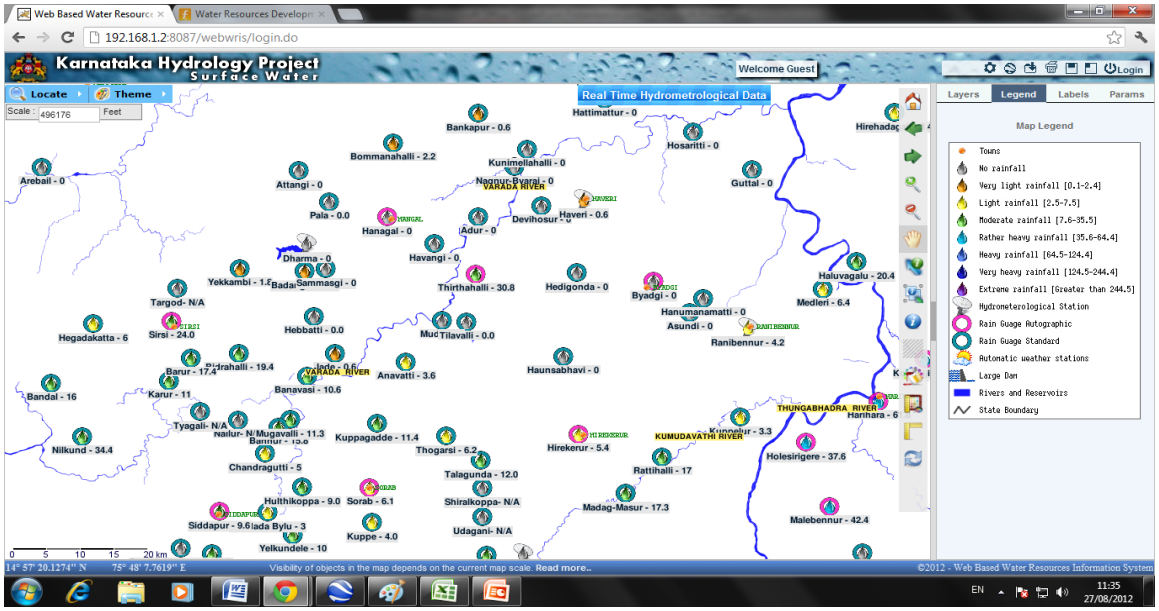
AUTOMATIC DOPPLER CURRENT PROFILER FOR FLOW MEASUREMENT

- Web water resource information system:

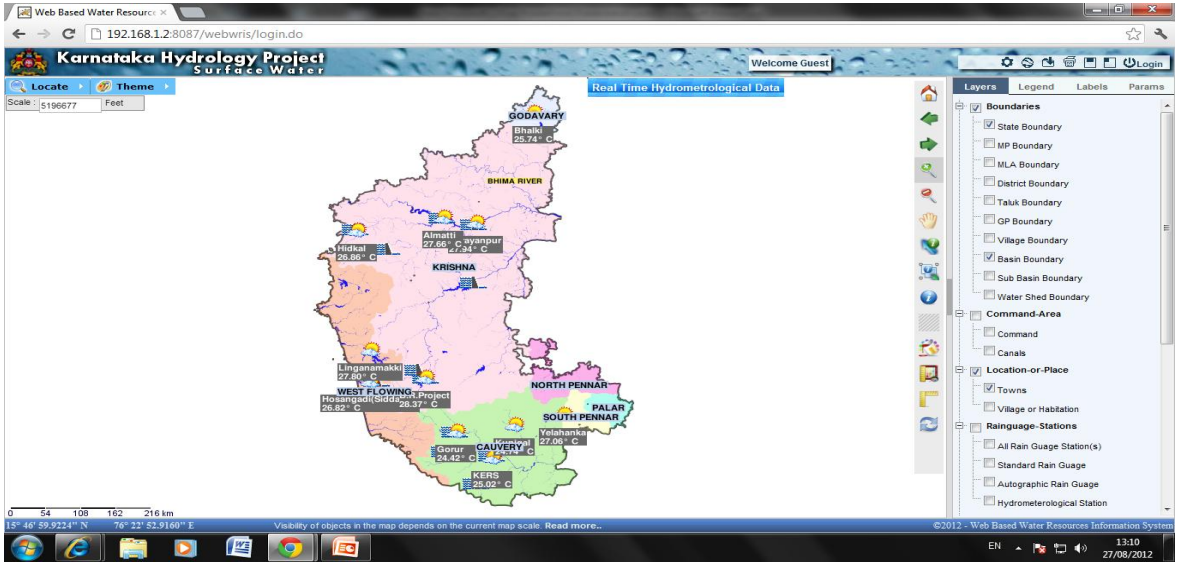
A link to www.karunadu.gov.in/karhp web site is provided on GIS platform showing all water resources information. The cost of software's like arc view, arc GIS, etc is about Rs 5 lakhs to Rs 12 lakhs. Without using such special software, engineers can view the water resources information on this website. Telemetric rainfall data also has been linked to this website and maps showing intensity of rainfall all over the state can be obtained in real time.



Real time rainfall data



Raingauge stations reprensenting rainfall data



Location of Automatic Weather stations representating weather Data

Financial Target and Achievements under HP-I:

All figures in Rs. Crores

Component	Target	Achievement
Surface Water	22.34	22.34
Ground Water	12.52	12.52
Total	**34.86**	**34.86**

Financial Target and Achievements under HP-II:

Allocation under the project as per PIP - 9.09 crores

- As per approved revised cost tables 2013 - 11.40 crores
- Expenditure during FY 2013-14 (upto 30.06.2013) - 37.94 lakhs
- Expenditure upto May 2014 - 9.70 crores
- Likely expenditure beyond May 31, 2014 but before Aug 31, 2014 - 0.77 crores
- Total likely Expenditure under the project - 10.47 crores

Chief Engineer
Hydrology and CMO