REPORT

Study Tour for Real Time Flood Forecasting System at Europe - Denmark, Austria and Germany

Period: 3 – 10 June, 2012

1.0 Introduction:

The work of implementing real time streamflow forecasting (RTSF) and reservoir operation system (ROS) for Krishna & Bhima river basins in Maharashtra is in progress with the Consultants DHI (India) Water & Environment Pvt. Ltd. New Delhi. This work is a part of vertical extension component under World Bank aided India Hydrology Project Phase II (HP-II). As per the conditions of contract (Page 63, Para- International Study tour) signed with DHI (India), the consultants have to organize international study tour for senior officers as a part of capacity building programme. Such study tour will enable the staff to examine operational guidance systems similar to that to be installed for Water Resources Department, Govt. of Maharashtra at first hand & as demonstrated on sites for inflow forecasting & decision support. In addition, such a study tour will provide unique opportunity to establish & develop long-term relationships with scientists in similar fields around the world.

Considering the provisions under ICB contract for consultancy, the Chief Engineer, Planning & Hydrology, Nashik had submitted a proposal to Government for the study tour to Europe vide letter No. Jvipra/Tansha-3/(27/2011)/430/2012
dated 13th March 2012. The Government of Maharashtra, Water Resources Department, approved the proposal with sanction for nomination of five officers vide order no TG0-2012/409/(85/12)/Estt (Trg), Mantralaya, Mumbai-32 dated 31st May 2012 namely; 1) Shri. Ekanath B. Patil, Principal Secretary (WR) Water Resources Department, Mantralaya, Mumbai, 2) Shri. H. T. Mendhegiri, Chief Engineer (WR) & Joint Secretary, Water Resources Department, Mantralaya, Mumbai, 3) Shri. C. A. Birajdar, Chief Engineer (SP), Water Resources Department, Pune, 4) Dr. P. K. Pawar, Executive Engineer, Hydrometeorlogical Data Processing Division, Nashik, 5) Shri. J. M. Shaikh, Executive Engineer, Irrigation Project Division, Nagpur. However, Shri. Ekanath B. Patil, Principal Secretary (WR), could not participate in the study tour as his programme was cancelled on 2nd June, 2012, just before the start of tour, for urgent and important Government work.

The study tour to Europe, to visit Denmark, Austria & Germany was organized by DHI (India) Water & Environment Pvt. Ltd.; New Delhi. The journey of the remaining 4 (four) members of the team for the foreign study tour had started from Mumbai on 03/06/2012 at 04:40 AM by Qatar Airways flight. The plane journey route was Mumbai-Doha-Copenhagen. The team reached at Copenhagen (Denmark) on 03/06/2012 at 15:30 hrs (local time at Copenhagen). In brief, the proceedings of the study tour is narrated in the following paragraphs.

2.0 **Sunday, June 3, 2012 : Arrival at Copenhagen, Denmark**

The team arrived at Crown Hotel, Copenhagen, Denmark on 03/06/2012.
The team was welcomed by Mr. Gregers Jorgensen, web based modeller & forecasting expert of DHI. The team discussed the study tour programme with tour organizer & then moved to hotel for halt.

Copenhagen is the capital of Denmark and it is most populous city. It is situated on the islands of Zealand and Amager. It is a major regional centre of culture, business, media and science. Life science, information technology and shipping are important sectors, and research and development plays a major role in the city’s economy. Its strategic location and excellent infrastructure with the largest airport in Scandinavia have made it a regional hub and a popular location for regional headquarters and conventions.
Copenhagen city has been recognized as one of the cities with the best quality of life. It is also considered as one of the world's most environmentally friendly cities. The water in the inner harbor is clean and safe for swimming. 36% of all citizens commute to work by bicycle.

3.0 Monday, June 4, 2012 : Visit to DHI office, Horsholm, Denmark

The visit to DHI Head office, Horsholm, Copenhagen, Denmark was organized on 04/06/2012. Dr. Jacob Host Madsen (JHM), Director, Dr. Kim Wium Olesen (KWO), Head of Water Resources Department and Mr. Gregers Jorgensen
welcomed the participants. The experts of DHI were available for interactive session. The worldwide applications of state of the art modelling systems for water resources & flood management including flood mapping, flood forecasting, modelling & web based water resources information management were presented.

Dr. Kim Wium Olesen, Head W.R.D., DHI presenting on modeling systems for Water Resources

Visit to hydraulic laboratory & test facilities available were shown. A physical model for coastal area erosion of East of America coast, was shown & discussed during the visit to laboratory.
Visit to DHI Hydraulic Laboratory, Horsholm

The radar system to forecast the meteorological rainfall for Copenhagen city installed at DHI, Laboratory was shown. The visit to DHI head office and interactions revealed that DHI is very calm, quite disciplined and non-profit making excellent research and development organisation in the field of Water, Environment and Health. DHI is able to invest 25% of its human resources in research and development.
4.0 Tuesday, June 5, 2012 : Visit to Danube river, Vienna, Austria

On 5th June 2012, we left Copenhagen for Vienna at around 6.00 AM by air & reached to Vienna 10.00 AM. Mr. Gregers Jorgensen, DHI associated us during the travel. After reaching to Austria Trend Messe hotel, we had a brief discussion with Mr. Gregers & Miss. Silvia Matz, modelling expert DHI Wasy.

Vienna is the capital and largest city of Austria. It is the 9th largest city by population in the European Union. It is a cultural, economic and political centre. Vienna is host to many major international organizations including the United Nations and OPEC.
Vienna is located in northeastern Austria, at the easternmost extension of the Alps in the Vienna basin. The city spans both sides of the meandering Danube river. A city tour to visit Danube river complex was arranged. To avoid flooding, a parallel river stream/channel is constructed to divert flood water, when the ice, from Alps starts melting. The channel so constructed is also used for navigation purposes. The water in Danube river is clean and safe for use. The water quality monitoring is being done regularly. On 5th June, 2012, we halted at Vienna.

5.0 Wednesday, June 6, 2012: Visit to International Forecasting Center in Graz, Austria

We left Vienna for Graz at around 8:30 AM on 06/06/2012 by road and reached Graz at around 11:00 AM. Graz is the second largest city in Austria and the capital of the Federal State of Styria. It is situated on the Mur river and about 200 km southwest of Vienna. Here, the participants visited International Forecasting Center, Graz. Mr. Schatzl Robest from hydrological forecasting unit of department of Steier markische Loubesre giesnug, Graz, Austria welcomed the team & explained the forecasting system. An automated river forecasting system is working in three different basins in Styria, namely Mur, Raab & Enns rivers. The forecasting system is based on MIKE 11, similar to the system proposed to be implemented in Krishna & Bhima river basins in Maharashatra.
Visit to International Forecasting Center, Graz, Austria

A trans-boundary real time flood forecasting system on the Mur river has been implemented. The Mur watershed extends over Austria (10000 Km²), Slovenia (1400 Km²), Hungary (1900 Km²) & Croatia (500 Km²). Real time flood forecasting system implemented presently is for two countries namely Austria & Slovenia. But the model is so developed that it can be easily extended to the remaining two countries namely Hungary & Croatia. The concept behind the project is to have one common flood forecasting system working for all the countries where exchange of real time information, modelling & dissemination can be performed rapidly and accurate working in a robust system, required in a real time forecasting system. The
The transboundary flood forecasting system, consists of one international flood forecasting centre at Graz & two national centres. One national centre for the Austrian part of the Mur watershed, set in Graz & second national centre for Slovenian part of the Mur watershed set at Ljubljana. All the three centres have the same information & data status so that simulations can be executed for the entire
Mur watershed. The final real time system operates from Graz, which automatically receives data from telemetric network in both countries & from meteorological models. Simulations are started automatically each hour with a forecasted period of 48 hours, whereas, the modeling results using meteorological forecasts are made available on the internet within 20 minutes. To include more flexibility in the flood forecasting & flood survey each country also manages its own flood forecasting centre. The meteorological forecasts as well as the flood forecasting system (online data, model setup & results) from the International Mur flood forecasting centre are made automatically available. In each national flood forecasting centre, it is then possible to develop local scenarios adapted to the actual flood event characteristics.

Thus, the main element in the system is the International Flood Forecasting Centre installed in Graz (Austria), where all necessary online data & meteorological forecasts are automatically collected & formatted for simulations. Furthermore, each hour starts a simulation with a forecasted time of two days where the main results are published on the internet & complete model setup & results are transferred to the two national centers. The national centers analyse the detailed results & develop local scenarios, using modified meteorological forecasts.

Field visit to “Kainach Lieboch” station on tributary of Mur was done to observe real time data collection. Here, the rainguage OTTO Pluvio\(^2\) was installed where weight of water collected is measured continuously. It is a universal precipitation gauge using the balance principle for liquid, solid & mixed
precipitation.

"Kainach Lieboch" Station, Graz : Weighing Precipitation Gauge OTT Pluvio

The submersible pressure transducer system is being used for water level measurement and with sloping gauge patti. Also demonstration for measurement of discharge by Acoustic Doppler Current Profiler (ADCP) was shown. At the time of measurement, the discharge through the tributary was about 16 m3/sec.
“Kainach Lieboch” Station, Graz: Acoustic Doppler Current Profiler

International forecasting centre at Graz was operated by only two officers. Kainach Lieboch station is automated and unmanned. It was told that there is no possibility of theft. High quality and sturdy (robust) instruments are installed, requiring no maintenance. The team was impressed with the physical structure of the station. On 6th June, 2012, we halted in Hotel Weitzer at Graz.

6.0 Thursday, June 7, 2012: Visit to Flood Forecasting Department ARSO (Meteorological office), Ljubljana in Slovenia

We left Graz on 07/06/2012 at about 8.00 AM & started for Ljubljana by road. Ljubljana is the capital of Slovenia and its only centre of international
importance. The city is situated in central Slovenia in the Ljubljana basin between the Alps and the Karst. It is located about 133 km southwest of Graz. At around 11:30 AM, we reached flood forecasting department ARSO (Meteorological office), Ljubljana in Slovenia. Here, the flood forecasting upgrade for the Slovenian rivers Sava & Soča was presented. Soča river basin is about 3412 Km² in Slovenia and Italy. While Sava river basin is 97713 Km² in Yugoslavia, 10880 Km² in Slovenia. ARSO (Meteorological Office of Slovenia) in cooperation with DHI, Denmark, has developed “FLOOD WATCH”, a user friendly decision support system for flood forecasting. Also a comprehensive training programme for ARSO, personnel involved in all aspects of implementation was done by DHI. About 200 personnel are working on the data collection & forecast.

ARSO (Meteorological Office), Ljubljana
The “FLOOD WATCH”, the flood forecasting system is a user friendly platform for real time operation with following features:

- Fast access to forecast
- Automatic/ offline
- Graphical & Tabular view of Water level, Discharge profiles & precipitation
- Detailed station information with online access to WEB Camera
- Easy configuration
- Direct access to Mike11
- Provision of view forecast presented via Google Maps
- Provision to run alternative scenarios.
- Presentation based on Google maps used for preparation of forecasts & flood warnings
- Forecast for next 6 days.
- Forecasting of flow & water levels at 74 locations.
- New forecast each hour 365 days
- Forecast published in media 24 hours in advance after confirmation from 5 different set up to avoid criticism.
- There is a consistent overview of river situation combining measuring & modelling which makes it possible to act faster before & during floods. Thus earlier reactions on flood, leads to saving in property, life, money.
Field visit to river gauge station on Sava river near Ljubljana city was arranged to study the setup of a new automatic telemetric network and measurement techniques.

The river water level is being measured with radar sensor fitted to bridge soffit and also with sloping gauge patti. High quality and sturdy (robust) instruments are installed, requiring no maintenance. The team was impressed with the physical structure of the station. The dedicated team of Hydrologists, Meteorologists and Maintenance crew is working at ARSO.

The visit to ARSO, Sloveina, was over by 5 PM. Mr. Gregers Jorgensen, web based modeller & forecasting expert presented at Ljubljana airport the overview of
RTSF & ROS model development for Krishna & Bhima river basins of Maharashtra. The primary model development stage in the absence of real time data & detailed river cross sections was explained.

We left Ljubljana on 07/06/2012 at about 18.30 PM by air for Munich, Germany. Miss. Silvia Matz, DHI Wasy associated during travel from Ljubljana to Munich (Germany). We halted at Hotel Germania at Munich on 07/06/2012.

7.0 Friday, June 8, 2012 : Visit to Munich, Germany

Munich is the capital and the largest city of the German State of Bavaria. It is located on the river Isar north of the Bavarian Alps. Munich was the host city of the 1972 Summer Olympics. Modern Munich is a financial and publishing hub and a frequently top ranked destination for migration and expatriate location in livability rankings.

During the morning session on 08/06/2012, the discussions with DHI expert was done. Miss. Silvia Matz, made presentation on flow forecasting system for hydro-power projects & river water quality in Germany. Forecast model E-Watch was explained. It has following features:

- Developed for forecast in DACH areas in Germany.
- Initially developed for flood forecast & later for energy forecast.
- Catchment size 500-1000 Km²
- Used for 565 catchments & 101 rivers divided into grid of 4 km, with 1500 real time stations for meteorological data
- Web Crawler for data collection of over 2000 stations
- Flood warning levels at 500 stations
- Energy forecast for the hydropower station (< 5 MW) in the German Tenne T Zone (= 20000 Km²) for trading issue.

Miss Silvia Matz, DHI Wasy presenting flow forecasting system in Germany

The hydro power forecast models involve forecast for discharge in a rainfall-runoff model, based on gauging stations, precipitation & temperature forecast. Discharge is linked to Energy production of hydro power stations by statistical models. The hydro power forecast models have been developed for 730 water power stations (< 5MW). The overall system involves 166 sub catchments, 174 gauging stations, 818 precipitations stations, 412 temperature stations. During the
presentation, Ecological forecast model was also explained. It involves, forecast for discharge, temperature & oxygen. The forecast of the ecological parameters, like oxygen & temperature is required to plan the operation of the power plant in Germany. In Germany, there are regulations on how much cooling water they can take out depending on how much discharge (Q) at certain point of river. Also, there are regulations on with what $\Delta T$ they are allowed to release the cooling water depending on discharge (Q) & temperature (T) of river water. Also, there are regulations for cooling water depending on the oxygen content of the river. The model application to Elbe, river catchment was shown.

During the afternoon session, the visit to Danube river system was done. At 16.00 hrs, the study tour programme was completed. The return journey was performed as per convenience and availability of economical air tickets.

8.0 Summary:

This study tour to Europe on operational real time flood forecasting system gave an insight into developed technologies in real time environment for Mur and Slovenian rivers’ watersheds, extended over four Europe countries, namely; Austria, Slovenia, Hungary & Croatia. The structure that has been established / built out of one international flood forecasting and two national centers illustrates how a transboundary flood forecasting system can operate. Demonstrations by DHI experts on various other real time models such as E-watch for environmental
parameters and power plant energy forecast was also very useful. The study tour will be very much helpful in implementation of ongoing real time streamflow forecasting & reservoir operation system under development, for Krishna and Bhima basins in Maharashtra.

The DHI officials and local officials at Graz and Ljubljana have taken lot of efforts to make the study tour successful in transfer of knowledge/technology. We are very much grateful for them. We are thankful to the Government of Maharashtra, Water Resources Department for giving us this opportunity to attend this study tour at Europe.

This report is submitted jointly by all four team members for perusal and information please.

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