EXECUTIVE SUMMARY

Worst situations create when there is heavy rainfall, sudden release from 10 dams upstream of Ukai, release from Ukai dam, spring tidal wave effect from Arabian Sea and Surat also facing heavy rainfall at same time. Surat has been blessed by the flow of Tapi; however, it has also suffered a lot because of floods in Tapi since historic time. There have been several flood events known to us since late 19th century; which has done great damage to this city. The most unforgettable and severe event was the flood of 2006. Tapi has degraded its flood water carrying capacity (4lac Cusecs) due to many reasons. Surat is fast developing and city like industry hub. The flood also resulted in total losses of Indian Rupees 21000 Crores in the year 2006. Keeping in view, the serious concern of revised Ukai dam reservoir operation for flood protection & control. It feels the research in that direction for minimization of Tapi river flood impacts –Surat (Gujarat) is of vital importance. Organization of this thesis listed below.

In Chapter No. 1 – Introduction:

In this chapter details of floods in India, its hazard, remote sensing in GIS system help in flood management, details of Tapi river basin and its tributaries, Ukai Dam multipurpose project detail, flood situation in Surat city and Hazira twin city, impacts of past floods in Surat city, causes of Tapi river flood-2006, flood protection works, physical model prepared by GERI and its limitation, existing flood forecasting system, drawbacks - disadvantages and limitations of existing models and policy, necessity of research , research study area and objectives are included.

Objectives of Research Study:

(1) To suggest Ukai dam revised optimal reservoir gate operation policy/schedule after 1998 and 2006 flooding events. i.e. Policy which satisfy supply, demand, inflow and outflow.

(2) To prepare a right model which shows the flood water surface profile for Tapi River in each flood frequency and different scenario while passing through Surat City and meets Arabian Sea.

(3) To determine actual Tapi River flood carrying capacity along with development of Surat City.

(4) To prepare a Flood Forecasting Based on Real time Operation program (FBRO).

(5) To study flood frequency probability and flood routing analysis.

(6) To prepare a flood risk and flood hazard map of whole Surat city by using GIS.

(7) To identify and suggest optimal solutions for minimization of Tapi River flood.

Methodology

1. Development of simulation model to simulate reservoir operation using monthly available historical inflow. Month end storage and canal releases obtained from simulation. Month end storage overlaid over a simulation period. Ultimately, calculation of rule level and flood absorption volume for revised Ukai Dam reservoir operation.
2. Studying river behavior, tidal effect, historical flood impact, and rain fall contribution in flood. Calibration and validation of mathematical model by comparing observed flood water levels.
3. Preparation of river cross section with respect to caring capacity while river flow through Surat city.
4. Preparation of excel program for flood forecasting based on real time reservoir operation.
5. Determination of peak flood frequency probability using peak flood by California method.
6. Preparation of flood risk and flood hazard map for whole Surat city by using Cartosat data image and software (MicroDEM for Image Processing and DEM processing/Eshayal Smart for GIS Map Window 4.5 for Stereo Data Processing and Watershed Delineation).
7. Interpretation and compilation of all results of analysis for optimal solutions for minimization of Tapi River flood impacts – Surat.

In Chapter No. 2 – Literature Review:

In this chapter and attempt is made to overview work done by different persons in the field related to the Tapi river flood – Surat. Also, the similar kinds of work done and model's use for similar studies are reviewed. Literature reviewed from Abroad and India relevant to the same research study. In this chapter, literature review like research paper, books, web sites, journals, reports, power point presentation, news record, photographs and manuals are included.

Flood problem in India have been described dividing the country into regions, pointing out specific phenomena related to flood in the regions indicating the regional variability of the problem. Some special flood-problems, like dam break flow and flood in the Tal areas, have also been mentioned. Various measures for flood management in India have been presented including both structural and non-structural measures. Non-structural measures are found to be more effective for the flood management. Thus, a combined approach may be adopted considering structural as well as non-structural measures together. Short term as well as long term strategies is required to be evolved to combat the floods so as to minimize its detrimental effect on the society. The use of modern tools like remote sensing and GIS may be increased for

preparing the maps of flood hazard, flood risk and flood plain zones etc. There is a need for developing the decision support system to provide the knowledge and information about the areas to be submerged due to flood water in real time. It will helpful for the administrators in preparing the evacuation plans during the flood period to save the lives and properties of the people affected due to floods. There should be improvement require for the cooperation and coordination between the scientific communities and appropriate local government and civil agencies for developing the effective, workable response plains to flood disasters.

According to literature review research done up to the year 2000. So, Ukai reservoir operation policy decisions, decision models, are very old and may not applicable after severe Tapi River flood in the year 2006 at Surat city.

In Chapter No. 3 –Data Collection and Interpretation:

Data Collection:

In this chapter data collected from various Government agencies, offices are complied and listed. Topographic data i.e. Channel cross sections, layout & connectivity, configuration of weirs, hydrologic data i.e. inflow hydrographs for upstream & downstream boundary condition, bed roughness, deforestation and historical change data, sediment data i.e. size, properties, distributions, sediment inflow hydrographs by class, verification data i.e. discharge hydrographs, sediment transport rates by size class, observed changes in bed levels and composition, remote sensing image data from NRSC, distorted physical model data pilot project report, gate reservoir operation register data up to year 2008, long span monthly inflows data, irrigation-industrial-drinking water demand, reservoir elevation-storage relationship, reservoir elevation- area, penstock numbers and capacity, maximum drawdown level-full reservoir level-canal bed level, tidal wave data, drainage disposal and past flood data, rainfall data, river cross sections from Ukai to Hazira in auto cad format and Hydropower generation and demand data.

Interpretation:

The large data scrutinize for different calculation and its interpretation shown in this research study. Among some of the data like Ukai Dam technical features, irrigation demand, hydropower generation, inflow, outflow, daily reservoir water level, existing gate operation policy rule levels, historical flood data used for modification of rule level for Ukai reservoir. Conversion done from F.P.S. system to M.K.S. system before use for study Tapi river cross section used for determination of flood carrying capacity in Surat. Among this obtained data, interpretation for the same shown in form of Graphs.

In Chapter No. 4 – Modeling of Water Surface Profile Using ARIIMA Model and Critical Analysis of Short Term and Long Term Measures to Mitigate Tapi River floods:

One dimensional (1D) Auto Regression Integrated Mathematical Analysis (ARIMA) prepared to determine Tapi river flood water surface profiles under different flood frequency i.e. outflow ranging from 2 lacs Cusec to 8 lacs Cusec. This model is 1-D mathematical model for numerical simulation of unsteady water and sediment movement in multiply connected network of mobile bed channels. This model is capable of handling unsteady water and sediment flows in multiply connected channels highly non uniform sediment and grain sorting and armoring process. The model can simulate processes such as; sediment sorting, bed armoring, flow dependent friction factor and alternate drying and flooding of perched channels. The flow over the weir can also be handled. Continuity and Momentum equations are the Governing Equations for water flow. Model uses widely applied Pressiman 4 point weighted implicit finite difference scheme. For solution of governing equations terms in the equation are discredited in x-t plane and system of linearised simultaneous difference between equations is obtained i.e. Coefficient matrix is a banded matrix. ARIMA model uses Double sweep algorithm. The entire network of channel is schematized into links (Channel) and Nodes (junctions or any bifurcation points or end or beginning of channels) so that each link has one node at each end and each node has at least one link (Channel) starting from it or ending at it. Each link there are grid points where the cross sectional data given. The nodes could of internal and boundary nodes. In this chapter, input data requirement, solution of water flow equation, model assumptions, ARIMA model equations, flow chart for programming, development of water surface profiles of Tapi River at fixed different locations across Surat City and model limitations are discussed.

In Chapter No. 5 – Study of Early Flood Warning System in the Tapi River Basin:

Ukai multipurpose dam is major control point for Tapi river flood to save downstream Surat city. Addition to that, contribution for increasing large amount of flood inflows from upstream dams located in Upper Tapi Basin which accumulated ultimately at Ukai dam reservoir studied by graphical techniques. From this graphical technique remaining necessary rain gauge stations identified and located to collect right information for flood routing. The methodology adopted is as per the CWC manual on flood forecasting for both level and inflow forecasts. Graphical techniques are mainly used for most of the sites. For this purpose, various correlation diagrams depicting the effect of basin parameters have been prepared and tested for accuracy. These curves are updated every year. Flood level forecasts and inflow forecasts are issued as per the criteria fixed by State Government in consultation in CWC. Inflow forecasts for Hathnur and Ukai

Dams are worked out by discharge integration method. Flood routing techniques also discussed in this chapter by using mass curve method along with computer model.

In Chapter No. 6 – Development of Reservoir Simulation Model and Flood Risk Assessment Model Using GIS:

In this chapter, the time period for simulation is considered as a month. Month as a unit of time is most appropriate because reservoir water level to be maintained at the end of the month will be determined and the data regarding inflows, evaporation and water demand to be satisfied by multipurpose dam project is given per month. The reservoir simulation is carried out for 34 years. Revised rule levels calculated by using 34 years historical flood data used for Ukai dam gate reservoir operation. (Existing data available for 34 years as Ukai dam II^{nd} valley project implemented on Tapi River in the year 1973 i.e. 1974 to 2008.)

Flood risk and flood hazard map for whole Surat city developed by using NRSA image along with GIS software.

Real time gate operations at Ukai dam also discussed in this chapter in critical flood conditions.

In Chapter No.7 – Probable Solutions for Minimization of Impacts of Tapi River Flood:

Solutions to reduce Tapi river flood impacts, feasibility of best solutions, probable/optimal solutions, reasons for probable solutions, limitations of proposed model covered in this chapter.

In Chapter No.8 – Results, Conclusions and Recommendations are undertaken:

Results of analysis and calculated rule levels are plotted as shown and compared with existing rule level policy for Ukai dam. This comparison clearly indicates that rule level kept very high for July month as per existing reservoir operation policy even though all demand satisfied, while in suggested rule level on monthly basis shows space for flood absorption quantum in Mm^3. In this revised reservoir operation has minimize the deficiency of Irrigation and maximizing the hydro power generation without flooding downstream in existing condition. Calculated revised rule level compared with existing rule level and flood absorption volume determined.

Research Contribution:

Usefulness of Research:

Scope of further study:

References:

Total 45 references referred and listed alphabetically. All references are divided in three parts as listed below.

(i) Journal research papers-33

(ii) Books and Reports-9

(iii) Webography -2