A REALTIME FLOOD FORECAST MODEL FOR A TIDE-AFFECTED RIVER BASIN

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A continuous effort to develop and implement an effective, comprehensive, realtime flood-forecast model system, with specific applications to the Tamsui River basin, was undertaken by the NTU Hydroinformatic R&D Group. The Tamsui River system is a life artery of the Greater Metropolitan Taipei area, which has been repeatedly afflicted with floods of extraordinary magnitudes, suffering in life casualties and in property damages. As the first line of all flood control measures, as well as an expediency before completion of all protective construction works, establishment of a reliable and efficient flood forecast system appears to be of utmost importance and urgency.

First, a deterministic, basin-wide unsteady river flow model that simulates and outputs diverse flow variables was successfully devised and built. In addition to the elements of building a general numerical simulation model, the work also included aspects: of realtime/forecast simulation; of more automatic model treatment, e.g., the setting of four (a few more added later) boundary stations that would provide continuous time-dependent stage data --- three (five now) upstream boundaries, one each for the major tributaries, and one river-mouth boundary; of enhancing modeling scope and capability; and of upgrading model refinement, e.g., elaborating flow-resistance coefficient calibration, and effecting over-bank flow evaluation.

The present model affords fairly reasonable and dependable stage prediction for several forecast hours, with decreasing accuracy beyond that time. To extend the length of forecast time, a few special techniques, mostly, but not all, of stochastic nature, was developed to first extend the forecast of the boundary stage data, from which to further compute other variables and output data of the channel flow. For the upstream boundaries, a rainfall-stage model, which is a hydrologic model for obtaining boundary stage data from upland rainfall data, has been developed. The upper end of this model can be linked to another such model, named typhoon-rainfall model, for yet another extension, to as much as 24 hour flood forecasting. For the river-mouth boundary, a physics-based model has been devised, which gives highly accurate prediction of the astronomical tides plus the storm surge (stochastic for this part) when this effect would become significant. The above-listed hydrologic models, admittedly less powerful in their predictive ability, are still quite helpful in extending the forecast time to a substantial length.

The present flood-forecast model system was enhanced by addition of a GIS-based flood-inundation zone estimation model. When the flood stage in the river channel exceeds the bank height and the water begins overflowing into the surrounding region, the unsteady channel flow model automatically keeps track of the "lateral outflow" and evaluates its total volume, which is then converted to the inundated area on the GIS map by the inundation-estimation model. With this combination of the river channel flood-stage forecast model and the flood-inundation zone estimation model, the model system is believed to be able to offer the policy makers, and other concerned flood-protection authorities, a set of reliable and dynamic tools by which they can accurately predict oncoming floods and issue the appropriate warning.

After all component models of the system are properly developed, they have to be integrated, and the system so integrated needs to be examined, tested, and made practically usable, readily operable, and easily maintainable, the process normally termed as "implementation." For effective implementation, the model system should be designed to have quite friendly I/O interface, so that the user could input, manipulate, output, and interpret I/O data easily and properly. Also, to ensure operational simplicity and reliability, a hydrological data base has been designed and set up. The data related to flood forecast and inundation forewarning, some transmitted directly from the field, can then be entered to the base. Such data can be put to the following uses: addenda and collation, realtime and forecast simulation, access by multiple users for operation and inquiry.

Finally, this article is concluded by the listing of special features of the model: (i) a comprehensive and multipurpose unsteady flow simulation system; (ii) applicable to a whole river basin having dendritic and network reach configuration; (iii) capable of simultaneously treating three basic types of unsteady flow: tidal, flood, and nature/human caused rapidly-varied flow; (iv) designed for hindcast, realtime, and forecast simulation; (v) operable for large flood, high tide, and routine river-flow simulation; combined and continuous use of these flow types will be particularly effective; (vi) consisting of two distinct modules, one for sophisticated unsteady channel-flow simulation and the other for a GIS assisted flood inundation zone estimation modeling; (vii) linked to a good data base to which field collected data or computer generated results can be stored and from which collated data or processed outputs can be retrieved for basic computer executions or advanced problem applications; (viii) attached with an effective, user-friendly interface that makes variousy users' options appear attractive; (ix) accompanied by computer animation of water-surface profile (or flood stage) movements (realtime); and (x) illustrated by yet another computer animation of up-to-minute discharge/stage hydrographs of several points in the basin.