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Channel Routing Model For Flood Zone Mapping

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ABSTRACT

The present study aims to develop a Channel routing model for mapping of zones for different discharges in river.

In Channel routing the change in the shape of a hydrograph as it travels down a channel is studied. By considering a channel reach and an input hydrograph at the upstream end, this form of routing aims to predict the Flood hydrograph at various sections of the reach. Information on the flood-peak attenuation and the duration of high-water levels obtained by channel routing ix of utmost importance in flood forecasting operations and flood-protection works.

Key word : Channel routing model, Flood zone mapping, Flood control

Introduction

Channel routing model is to predict the stages of river for particular discharge in the river. The damages caused by floods are very difficult to estimate and a figure of rupees 5 thousand corers as the annual flood damage in the country gives right order of magnitude. during 1953 -2000 the average number of human lives and cattle lost due to flood in the country where 1595 and 94000 respectively. On an average about 7.5 Mha. Land affected annually out of these about 3.5 Mha are land under crops similarly annually 3.345 lakes of people are affected and about 12.15 lakes houses damaged by floods .A national program of flood management was launched in 1954 .flood forecasting is handled by CWC according to national water policy while structural flood control measures will continue to be necessary the emphasis should be on non structural methods so as to reduce the recurring expenditure on flood relief.

Model Description

This model performs subcritical and/or supercritical dynamic routing of an input hydrograph through a channel-valley. This option is for routing a specified inflow hydrograph through the downstream valley, i.e., there is no upstream reservoir and associated outflow hydrograph as computed by the program. This model does not allow dams or bridges to be located along the downstream valley.The governing equations of the model are the complete one-dimensional St. Venant equations of unsteady flow which are coupled with internal boundary equations. The flow may be either subcritical or supercritical or a combination of each varying in space and time from one to the other; fluid properties may obey either the principles of Newtonian (water) flow flow.The hydrograph is specified as an input time series.

The equations of St. Venant, expressed in conservation form (Fread, 1974b), with additional terms for the effect of expansion/contractions (Fread, 1976), channel sinuosity (DeLong, 1986) and non-Newtonian flow (Fread, 1987b) consist of a conservation of mass equation, i.e.,

$$\frac{\partial}{\partial x}Q + \frac{\partial}{\partial t}s(A + A\text{o}) - \text{q} = 0 \qquad (1)$$

and a conservation of momentum equation, i.e.,

$$\frac{\partial}{\partial t}(sQ) + \frac{\partial}{\partial x}\left[\beta\,\frac{Q2}{A}\right] + gA\left[\frac{\partial h}{\partial x} + Sf + Se + Si\right] + L' = 0 \qquad (2)$$

where:

h = the water surface elevation

A = the active cross-sectional area of flow

Ao = the inactive (off-channel storage) cross-sectional area

s = a sinuosity factor after DeLong (1986) which varies with h

x = the longitudinal distance along the channel (valley)

t = the time

q = the lateral inflow or outflow per lineal distance along the channel (inflow is positive and outflow is negative in sign)

b = the momentum coefficient for velocity distribution

g = the acceleration due to gravity

Sf = the boundary friction slope

Se = the expansion-contraction slope

Si = the additional friction slope associated with internal viscous dissipation of non-

Newtonian fluids such as mud/debris flows

Eqs. 1 and 2 can be solved by either explicit or implicit finite-difference techniques (Liggett and Cunge, 1975).

Explicit methods, although simpler in application, are restricted by mathematical stability considerations to very small computational time steps. Such small time steps cause the explicit methods to be very inefficient in the use of computer time.Implicit finite-difference techniques (Preissmann, 1961; Amein and Fang, 1970;Strelkoff, 1970), however, have no restrictions on the size of the time step due to mathematical stability. However, convergence considerations may require its size to be limited (Fread, 1974a).

Softwares used for channel routing model:

- HECIDB - Modified Puls lane ware.
- USTFLO Explicit staggered grid.
- DAMBRK Four pointed weighted difference implict.
- MOC-LIF MOC Explict method.

Sample input parameters to model

Inflow hydrograph description

Table 1:

Time Elapsed TI(K) (hr)	Upstream Inflow QI(K) (cms)
0.00	1650.0
3.00	1650.0
6.00	50.0

Table 2: Cross-Section And Reach Summary

Cross Section Number	Cross Section Location (km)	Bottom Elevation (m MSL)	Reach Number	Reach Length (km)	Reach Slope (m/km)
1	0.00	555.000			
2	0.342	538.200	1	0.243	48.549
3	0.871	537.800	2	0.328	1.219
4	1.756	533.000	3	1.185	4.050
5	3.209	524.000	4	1.453	6.193
6	4.221	518.200	5	1.012	5.730
7	5.106	517.200	6	0.885	1.130
8	7.693	506.100	7	2.587	4.290
9	8.376	504.200	8	0.683	2.781
10	8.874	500.100	9	0.498	8.231
11	9.172	498.250	10	0.298	6.207
12	9.876	497.800	11	0.704	0.639
13	11.007	493.600	12	1.131	3.713
14	13.106	492.800	13	2.099	0.381
15	15.620	483.100	14	2.514	3.858

Table 3: Slope Information For Cross-Section Reaches

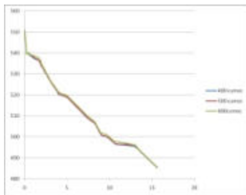
Reach Section Number	Water Surface Elevation	Hydraulic Depth (M)	Reach Bottom Slope (m/km)	Dynamic Slope (m/km)	Total Slope (m/km)	Critical Slope (m/km)	Manning n CMN
1	552.66	5.62	48.55	0.07	48.62	4.99	0.03
1	555.5	6.44	48.55	0.08	48.63	3.54	0.026
2	538	0.11	1.22	0.03	1.25	25	0.035
2	538.5	0.22	1.22	0.04	1.26	19.88	0.035
2	539.05	0.61	1.22	0.06	1.28	14.14	0.035
2	539.5	0.32	1.22	0.03	1.25	7.41	0.023
2	541.5	1.62	1.22	0.1	1.32	12.8	0.039
3	535.4	0.2	4.05	0.02	4.07	20.51	0.035
3	536.2	0.4	4.05	0.03	4.08	16.2	0.035
3	536.95	0.89	4.05	0.04	4.09	12	0.035
3	537.5	0.2	4.05	0.01	4.06	3.06	0.013

Sample output from model :

Table 4: Flood Crest Summary For 400 Cumec Discharge

Cross Section Location (km)	Maximum Stage Elevation (m MSL)	Maximum Flow (cms)	Time To Maximum Stage (hr)	Left Floodplan Max Flow Velocity (m/sec)	Channel Maximum Flow Velocity (m/sec)	Right Floodplan Max Flow Velocity (m/sec)	Flood Elevation (m MSL)
0	550.72	399	0	0	4.494	0	567.98
0.005	550.49	399	0	0	4.481	0	567.409
0.01	550.26	399	0	0	4.454	0	566.838
0.015	550.03	400	0	0	4.446	0	566.267
0.02	549.79	400	0	0	4.448	0	565.696
0.025	549.56	400	0	0	4.457	0	565.125
0.03	549.33	400	0	0	4.469	0	564.554
0.035	549.09	400	0	0	4.485	0	563.983
0.04	548.86	400	0	0	4.504	0	563.412
0.045	548.63	400	0	0	4.525	0	562.841
0.05	548.4	400	0	0	4.513	0	562.27
0.055	548.16	400	0	0	4.511	0	561.699
0.06	547.93	400	0	0	4.536	0	561.128
0.064	547.7	400	0	0	4.539	0	560.557
0.069	547.47	400	0	0	4.531	0	559.986
0.074	547.23	400	0	0	4.549	0	559.415
0.079	547	400	0	0	4.548	0	558.844
0.084	546.77	400	0	0	4.53	0	558.273
0.089	546.53	400	0	0	4.524	0	557.702
0.094	546.3	400	0	0	4.527	0	557.131
0.099	546.07	400	0	0	4.572	0	556.56
0.104	545.84	400	0	0	4.572	0	555.989
0.109	545.6	400	0	0	4.543	0	555.418
0.114	545.37	400	0	0	4.53	0	554.847
0.119	545.13	400	0	0	4.526	0	554.276
0.124	544.9	400	0	0	4.528	0	553.705
0.129	544.66	400	0	0	4.537	0	553.133
0.134	544.43	400	0	0	4.553	0	552.562
0.139	544.2	400	0	0	4.517	0	551.991
0.144	543.96	400	0	0	4.521	0	551.42
0.149	543.72	400	0	0	4.475	0	550.849

Figure 1: Graph for Different Cumec Discharge



Conclusions

Following conclusions were made from the study

When the river discharges are very high, it is to be expected that the river will overflow its banks and spills into flood plains. Flood plain management identify the Flood prone areas of' a river and regulates the land use to restrict the damage due to floods. The locations and extent of areas likely to be affected by Floods periods are identified and development plans of these areas are prepared in such a manner that the resulting damages due to floods are within acceptable limits of risk,

Figure :2 Conceptual Flood Zone Mapping

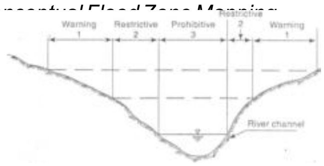


Figure shows a conceptual zoning of a flood prone area,

- Prohibitive zone :

  25 Years of return period flood

  = 1.5 X Capacity of River Channel, whichever is higher.
- Restrictive zone:

  Pass Design, out flow flood max design may be max out flow corresponding to design flood.
- Caution zone:

  Dam break flood.
- No Residential Construction will be allowed in prohibitive zone.
- No residential construction will be allowed in in the restrictive zone. The level of temples, parks shall be be kept higher to avoid flood damages.
- In a warning zone peoples are to be trained about flood situations advised to escape from the area as soon as get the flood warning.

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