AR&R WORKSHOP

CATCHMENT MODELLING

Hydrologic Simulation

SURFACE RUNOFF MODELS

- Time-Area Approaches
- Unit Hydrograph Approaches
- Runoff Routing Approaches
- Kinematic Wave Approaches
- Diffusion Wave Approaches

Time-Area Approaches

- Cordery-Webb UH – triangular TAD
- LRRM – isochrones of travel time
- RAFTS
- RORB
- DRAINS
- Worked examples

Unit Hydrograph Approaches

- Calculating Flood Hydrographs
- Derivation from Rainfall & Streamflow data
- Synthetic UH
- Cordery-Webb Synthetic UH
- Worked examples

Kinematic Wave Approaches

- Theory
- Link to runoff routing models
- Estimation of hydrographs
- Time of concentration (eg Rational urban)
- Worked examples

Runoff Routing Models

- Lag & Route
- Clark (Cordery-Webb UH)
- Nash
- LRRM
- Stream Network Models

Stream Network Models

- RORB
- WBNM
- RAFTS
- URBS
- PLM/ RRR

Stream Network Models - Major Topics

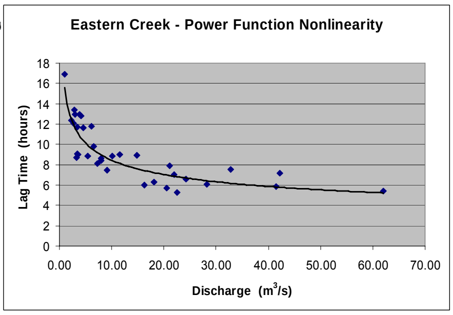
- Allocating Lag Times to Subareas
- Forms of Nonlinearity
- Modelling Nonlinearity
- Estimating Parameters for Ungauged Catchments

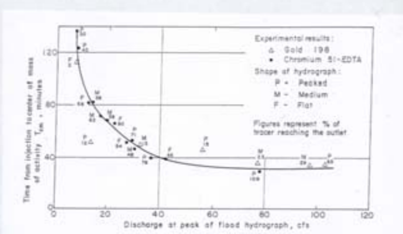
Allocating Lag Times to Subareas within the Catchment

- Flow velocity constant along the stream
- Lag time α travel distance L
- Lag time α area $A^{0.55}$
- Very little evidence slope has an effect
- RORB Lag α L
- WBNM Lag α $A^{0.57}$
- RAFTS Lag α $A^{0.52}S^{-0.50}$
- URBS Lag α $A^{0.50}$

Evidence for Nonlinearity

- Catchment Lag vs Discharge – power function $S=kQ^m$
- Travel time (radioactive tracing) – piecewise linear PLM
- Flood wave travel time – 2 power + transition
- At a station hydraulics – nonlinear, variable, to linear
- Storage-discharge from hydrographs – varying nonlinearity

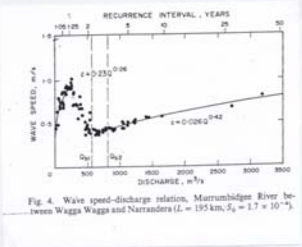




Relation of time to the center of mass of labeled water and peak discharge of the flood traced

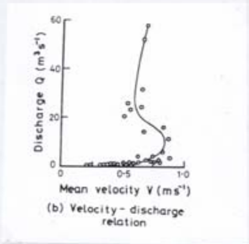
RADIOACTIVE TRACING (Pilgrim)

Piecewise Linear (PLM)



WAVE SPEED in RIVER REACHES (Wong & Laurenson)

2 Nonlinear relations



AT A STATION HYDRAULICS (Pilgrim)

Nonlinear, Varying

Nonlinearity - Summary

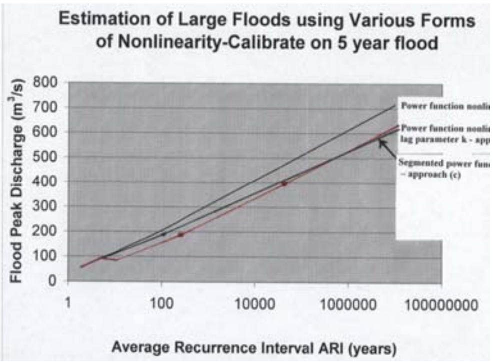
- As discharge Q increases:
- INBANK – Velocity increases & Lag decreases (PF)
- OVERBANK COMMENCING – Velocity decreases, Lag increases (transition, possibly linear)
- OVERBANK ESTABLISHED – Velocity re-commences to increase, Lag decreases (second PF)

- Q_{100} approx 2 X Q_5
- PMF approx 3-5 X Q_{100}

Modelling Nonlinearity

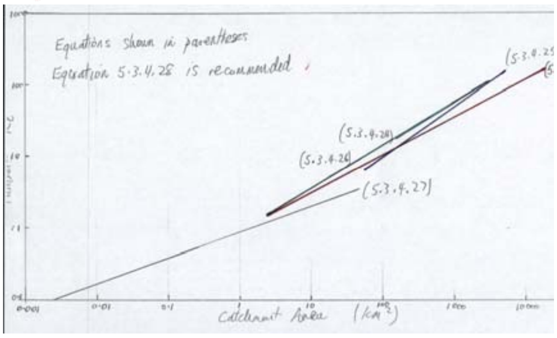
- Single nonlinear PF
- PLM
- Nonlinear PF with increased lag parameter for overbank flow

- Calibrate on 1 in 5 year AEP (bankfull discharge), predict floods up to PMF



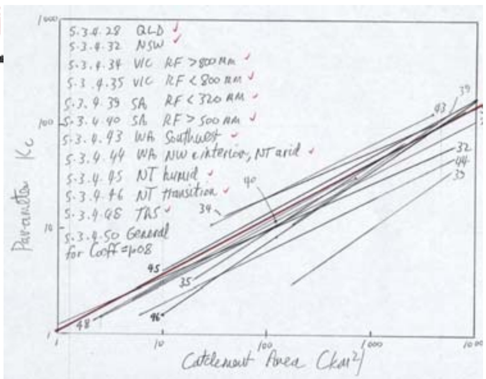
Estimating Parameters for Ungauged Catchments - RORB

- Qld, NSW, Vic, SA, WA, NT, Arid Central Australia, Tasmania
- For Queensland:
- $Kc=0.69A^{0.63}$
- $Kc=0.35A^{0.71}$
- $Kc=0.80A^{0.62}$
- $Kc=0.83A^{0.35}$
- $Kc=0.88A^{0.53}$



Area Standardised Lag Parameter - RORB

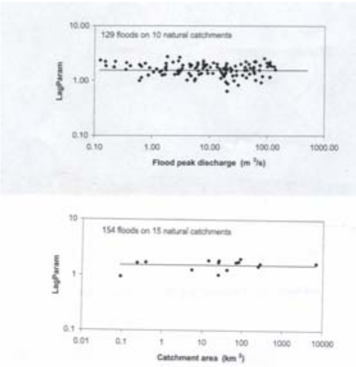
- Kc/d_{av} or $Kc/A^{0.55}$
- Similar to C, B and β in WBNM, RAFTS, URBS
- Same value applies to a wide range of catchments – (220 catchments) range 0.96 – 1.25 (average 1.1)
- Many of the regional relations can be reduced to a single relation



Estimating Parameters for Ungauged Catchments - WBNM

- Average values:
- Queensland C = 1.47 (17 catchments)
- NSW C = 1.74 (19 catchments)
- VIC C = 1.74 (6 catchments)
- SA C = 1.64 (8 catchments)

- Average for 50 catchments C = 1.60



WBNM Lag Parameter C

Relations between the Models – Nonlinearity parameter m

- General form: $S = k\,Q^m$
- $Lag = k\,Q^{m-1}$

- RORB m = 0.80 (can vary)
- WBNM m = 0.77
- RAFTS m = 0.715
- URBS m = 0.8 (can vary)

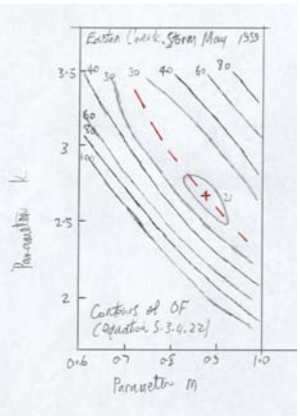
Relations between the Models – Lag magnitude k

- RORB: Lag = Kc Kr $Q^{-0.20}$=1.1d_{av}Kr $Q^{-0.2}$
  - Lag α $A^{0.55}$Kr $Q^{-0.20}$
- WBNM: Lag=C$A^{0.57}Q^{-0.23}$
- RAFTS: Lag=0.285$A^{0.52}S^{-0.50}Q^{-0.285}$
- URBS: Lag= β $A^{0.50}Q^{-0.20}$

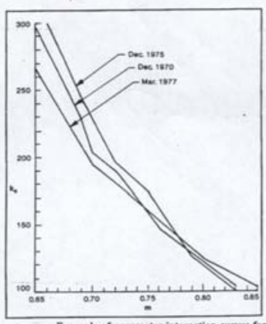
Relations between Lag Parameters – Lag magnitude k

- RORB:
- Lag α Kc $Q^{-0.20}$ α d_{av} $Q^{-0.20}$ α $A^{0.55}$ $Q^{-0.20}$
- WBNM: Lag α $A^{0.57}$ $Q^{-0.23}$
- RAFTS: Lag α $A^{0.52}$ $Q^{-0.22}$
- URBS: Lag α $A^{0.50}$ $Q^{-0.20}$
- Can show that WBNM C = 1.45 Kc/d_{av}

Parameter Derivation from Rainfall & Streamflow Data



Parameter Interaction



Example of parameter interaction curves for Dawson River (after Weeks, 1980)