The more things change...

the more they stay the same

Extreme Precipitation Symposium
June 2006
UC Davis

Forty-five years in hydrologic modeling

- As a hydrologic modeler I am a user of extreme precipitation data
  - Designer of storm drainage systems
  - Flood litigation
  - Hydrologic analyses
  - Role in technology transfer

What is extreme rainfall?

- 10-yr or less frequent
- Infrequent enough so people forget its magnitude
- 10-yr Sacramento County rainfall:
  - 1 hour 0.75 in.
  - 12 hours 2.25 in.
  - 24 hours 2.98 in.

Hydrologists use rainfall to calculate runoff

- Usually involves a hydrologic model
- Involves repetitive computations—need computers
- I would like to discuss how computational tools have evolved over the past several decades

The early days (1960s)

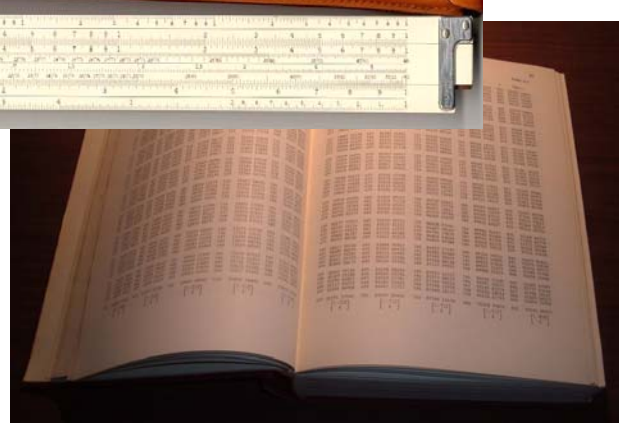
Computations were tedious

What we had to use:

- Pencil and paper
- Charts and graphs
- Slide rule
- Tables of logarithms

The 1960’s tools for computing

Slide rule and case

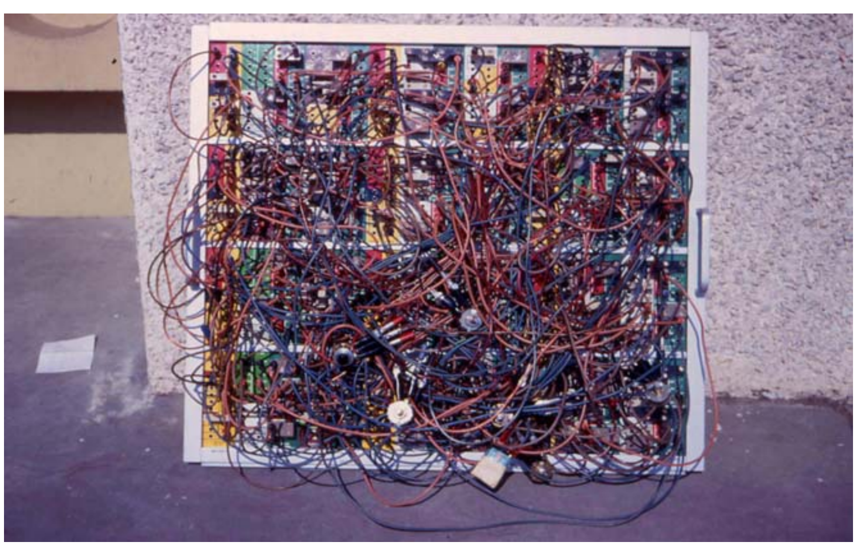


Tables

1960s

- Mathematical models –
  - Rational method model
  - Unit hydrographs
    - Slide rule used for calculations
- My first hydrologic project
  - 100 square miles of watershed
  - Rational method calculations
  - Storm drains: Double 10’ x 10’ boxes

1960s Analog Computer



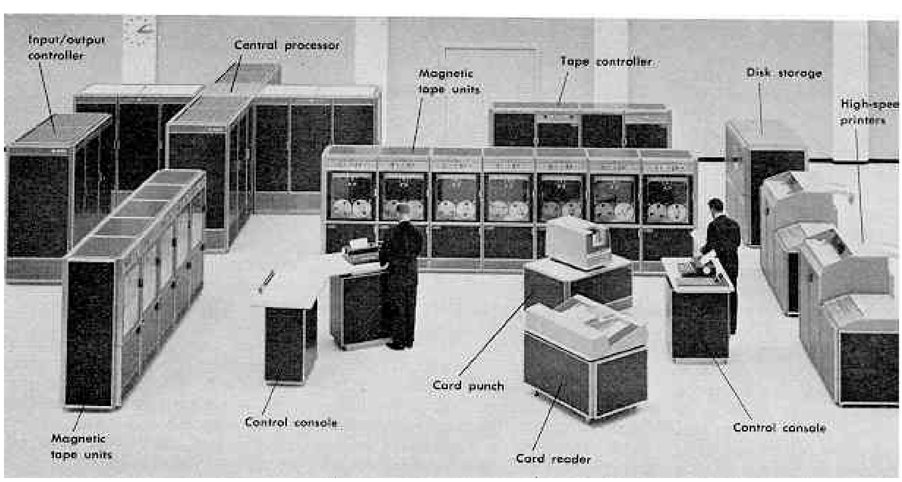
Graduate school – U. Michigan

- Computers just beginning to be used (1961)
  - Learned programming language
  - FORTRAN had not been developed yet
  - MAD (Michigan Algorithm Decoder)

Alfred E. Neuman
Fictional mascot of
“Mad” magazine

Computer operators had “What, me worry?” printed on every output.

Mainframe computers



1960's Hydrologic techniques

- Unit hydrograph by isolated storm
  - Slide rule computations
- Method – apply rainfall to catchment to produce runoff (just like we do today)
- Key features of Unit Hydrograph
  - Peaking parameter
  - Timing parameter

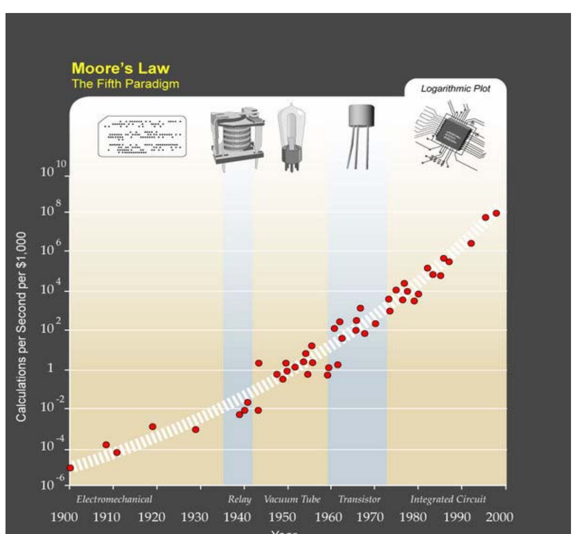
Early 1960's - DWR

Electric Marchant Calculator from the 1960s

Handheld calculator

- **Texas Instruments *TI-30*.**
- Display is 8 digits, red LED.
- Four function, memory, scientific functions.
- Integrated circuit
- Made in various countries including USA and Italy.
- Popular, low-cost calculator.

Moore's Law



Wikipedia -http://en.wikipedia.org/wiki/Moore's_law

The Five Generations of Computers

1. Vacuum tubes – early mainframes ($millions)
2. Transistors - still relied on punched cards for input and printouts for output (PDP1- $120K)
3. Integrated circuits - smaller and cheaper than earlier computers (1965 PDP8 - $20,000)
4. Microprocessors – allowed the development of the Internet, GUIs, the mouse and handheld devices (1981 IBM PC - $1595)
5. Artificial intelligence – in the future: Quantum computation and nanotechnology ???

My first computer

http://oldcomputers.net/index.html

Osborne 1

- **Introduced: April 1981**
- **Price: US $1,795**
- **Weight: 24.5 pounds**
- **CPU: Zilog Z80 @ 4.0 MHz**
- **RAM: 64K RAM**
- **Display: built-in 5" monitor 53 X 24 text**
- **Ports: parallel / IEEE-488 modem/serial port**
- **Storage: dual 5-1/4 inch, single density 91K drives**
- **Operating System: CP/M**

Life is better now-a-days

Computers certainly have improved over the years, but has software improved?

- Exponentially improved hardware does not necessarily imply exponentially improved software to go with it.
- “The productivity of software developers does not increase exponentially with the improvement in hardware, but by most measures has increased only slowly and fitfully over the decades.”

Wikipedia -http://en.wikipedia.org/wiki/Moore's_law

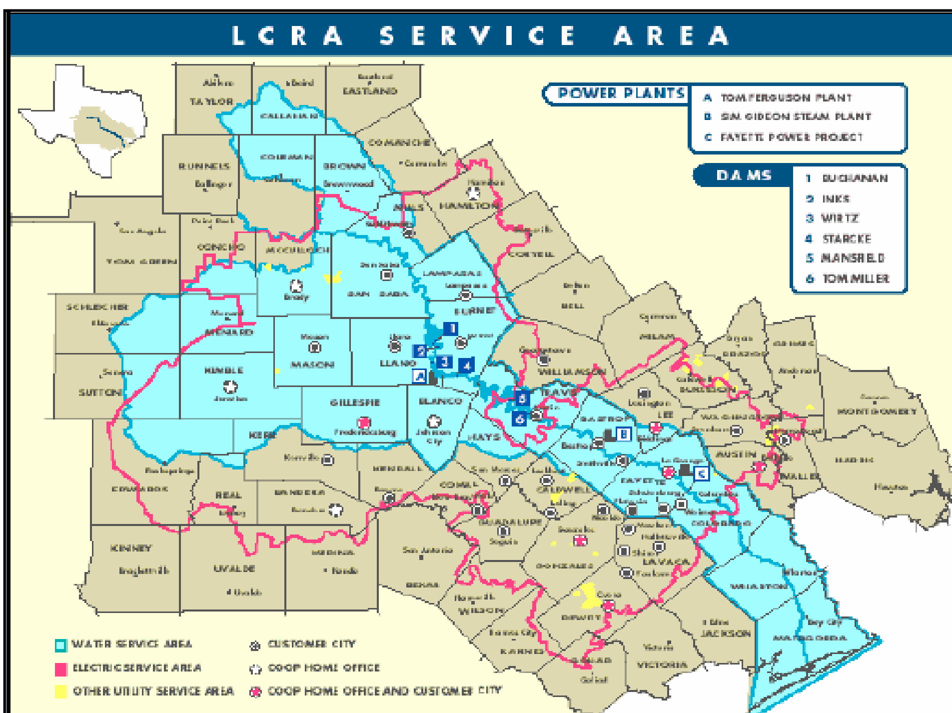
Software gets slower?

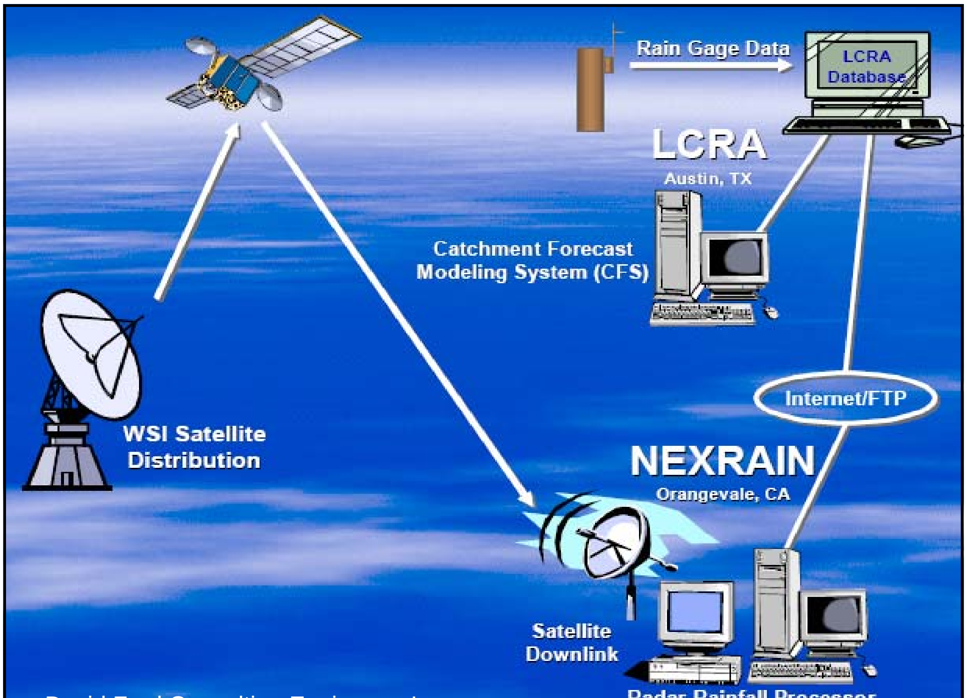
- Software tends to get larger and more complicated over time
- Wirth's law even states that "Software gets slower faster than hardware gets faster".

Wikipedia -http://en.wikipedia.org/wiki/Moore's_law

Current examples of computing in hydrology

- Lower Colorado River Authority –Texas
- Hydrologic forecasting
- Real-time inundation mapping
- Complex hydraulic and hydraulic system modeling
- Great graphical user interfaces





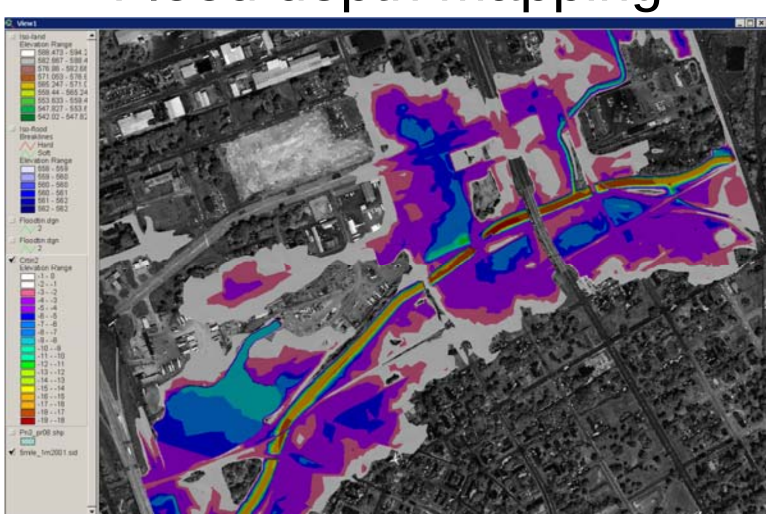
Evaluation and notification

- Evaluation
  - Formal threat recognition system and rules
- Forecasting
  - Conceptual forecasting with CFS
  - Water levels computed with Corps' HEC-RAS or with EPA's SWMM
- Notification
  - Automated paging

Real-time inundation mapping

David Ford Consulting Engineers, Inc.

Flood depth mapping



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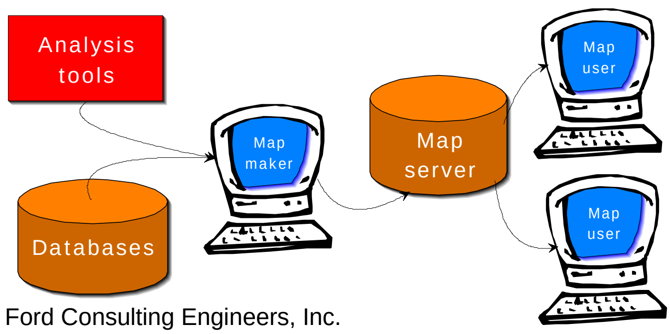
How maps are made available

- Maps produced by floodplain / hydrology staff and “published” to server
- Maps viewed by emergency managers with simpler GIS browser application



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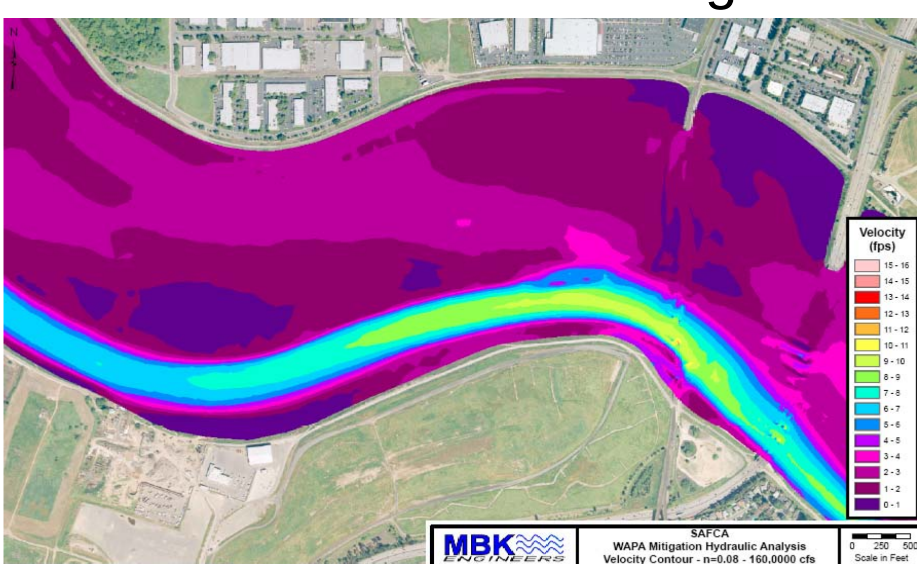
Two-D river modeling



What has changed?

- Powerful computational tools allow very complex models to be used
- Data transmission facilities allow rapid sharing of data
- Analysts can evaluate many alternatives and do detailed sensitivity analyses
- GIS procedures allow topographic data to be easily incorporated into models
- Graphical output features make understanding results much easier

What has stayed the same?

- We still don’t have very much data for comparing our models to the “real world”
  - Example: American River basin - less data is being collected now than in the 70s and 80s
- Models have a lot of uncertainty
  - Meteorologic and hydrologic systems are very complex
  - They are hard to characterize (we don’t have all the data we need)
  - Simple models are often the best (this is an argument for using unit hydrograph models)

Needs

- Improved data collection
  - Need more rain gages
  - Need more stream gages
- Provide more opportunity for comparison of model results with observed data
- Don't add complexity unnecessarily

Any questions?