Computer considerations
What does a model program do?

- Obligatory
  - Model equations
  - Time integration
  - Read input files
  - Output results
• Additional tasks
  – Parameter estimation
  – Decision rules
  – Evaluation
  – Optimization
  – Virtual experimentation
  – Sensitivity analysis
  – Assimilation of real-time data
  – Etc.
• Criteria for choosing modelling software
  – Limit programming
    • Obligatory tasks – some software has time motor.
    • Additional tasks – some software has estimation, optimization routines.
    • To reduce programming time and errors.
    • To provide well-tested code for parameter estimation, optimization, etc.
  – Provide possibility of exchange of components
    • E.g. use existing soil water dynamics model
  – Facilitate use by end-users
Several families of languages are available
• General purpose programming languages
  – The 12 most popular:
  – C, C++, C#, Java, JavaScript, Perl, PHP, Python, Ruby, Shell, SQL, and Visual Basic
  – You can program what you need.
  – No specific help for dynamic system models
  – Which is best? The one you know!
• Specialized languages
  – Matlab: algorithms, numerical analysis
  – **R/S+ statistics**
  – You can program anything
  – Lots of help with math, stat
  – R/S+ is slow (interpreted)
• Dynamic system software with graphical interface
  – ModelMaker
  – Stella
  – Vensim
  – FST (not graphic)
  – Very easy to learn and use
  – Limited to predefined features
    • e.g. can’t add estimation algorithms
Demonstration of ModelMaker

• Predator prey model
  – Two state variables
  – Prey: \( \frac{dA}{dt} = rA(1 - \frac{A}{K}) - aAL \)
  – Predator: \( \frac{dL}{dt} = bAL - mL \)
  – \( r = 0.25 \) \( K = 4000 \) \( a = 0.004 \) \( b = 0.0001 \) \( m = 0.03 \)
  – Initial values prey = 2000/m² predator = 2/m²
  – Discrete time calculation \( \Delta t = 1 \) day
  – Integrate over 1000 days
• Modelling platforms
  – DEVS Discrete Event System Specification
  – Two examples RECORD, MODCOM
  – You program the equations, platform handles time (integration, interaction between processes, input, output, discrete events)
  – Share components
  – Some added software
  – Difficult to extend language
• Specific models
  – Crop models
  – STICS
  – DSSAT
  – APSIM
  – Much associated software
  – Limited to specific models
• The special case of EXCEL
  – Good for users (everybody knows EXCEL. The data may already be in that format)
  – Each line is another day
  – Some graphs and parameter estimation included
  – Limitations on use of model
Demonstration of Excel

• Same predator prey model as Model Maker
Decision tree

Specific model?

- Use that model software
- Platform

Share components?

- Dynamic system software with graphical interface
- Numerical analysis or statistics is very important?

Relatively simple model and analysis?

- Specialized language
- Use a language that you know (or that users know)
THE END