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Dynamic Ecosystems
Floodplain Model

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MSc Spatial Decision Support SystemsGeoinformation

Where are we going?

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- Objective
- Floodplain ecosystems
  - Importance
  - Modeled phenomena
  - Terms
- Model requirements
- Floodplain modeling procedure
  - Components overview
  - Concept & implementation
  - Software
  - Package
  - Outlook
- Floodplain modeling & SDSS

Objective

- Computer implementation of:
  - Simulation models (Two Models)
  - Generic for riparian ecosystem
  - Static, initial floodplain landscape model
  - Dynamic floodplain model:
    - Simulates landscape evolution
    - Vegetation response to variables determine by discharge & morphology

Importance of riparian ecosystems

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- Support of niche species
- Support food webs
- Support birds migration
- Biodiversity
- Cultural heritage
- Water quality
- Impacts wide spread
- International nature restoration-protection laws
  - Assessing tools


Villach


Monfalcone, Italy


Monfalcone, Italy


Boise, Idaho

Hoover Dam, Nevada

Sarajevo, Bosna Herzegovna


Praha, Czech Republic

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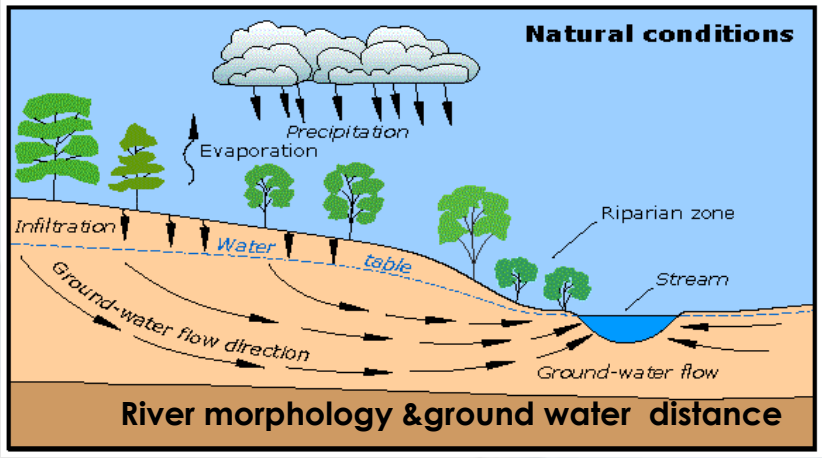
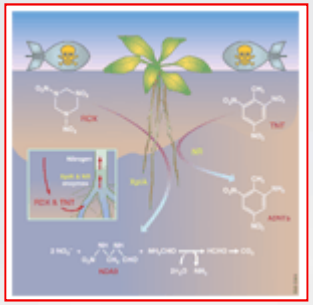
Floodplain ecosystems

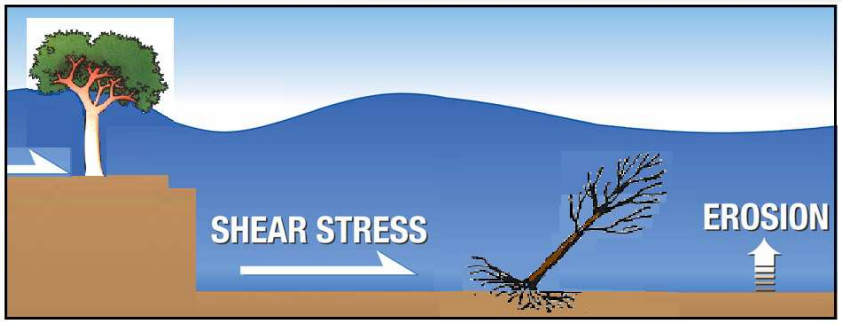
Considered phenomena

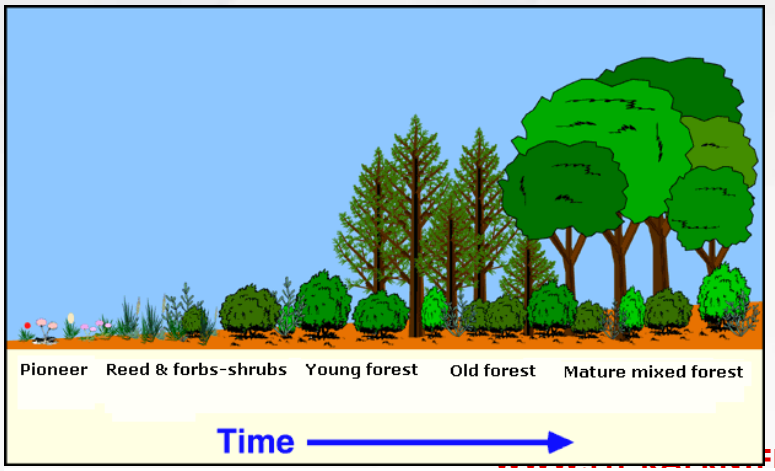
- Recruitment
  - Colonization sites
  - Groundwater level
  - Scour disturbance (flow by the shore)
- Shear stress
- Flood duration (physiological stress)
- Time



Open bar







http://www.physicalgeography.net/fundamentals/9i.html

Terms: succession series, cover types

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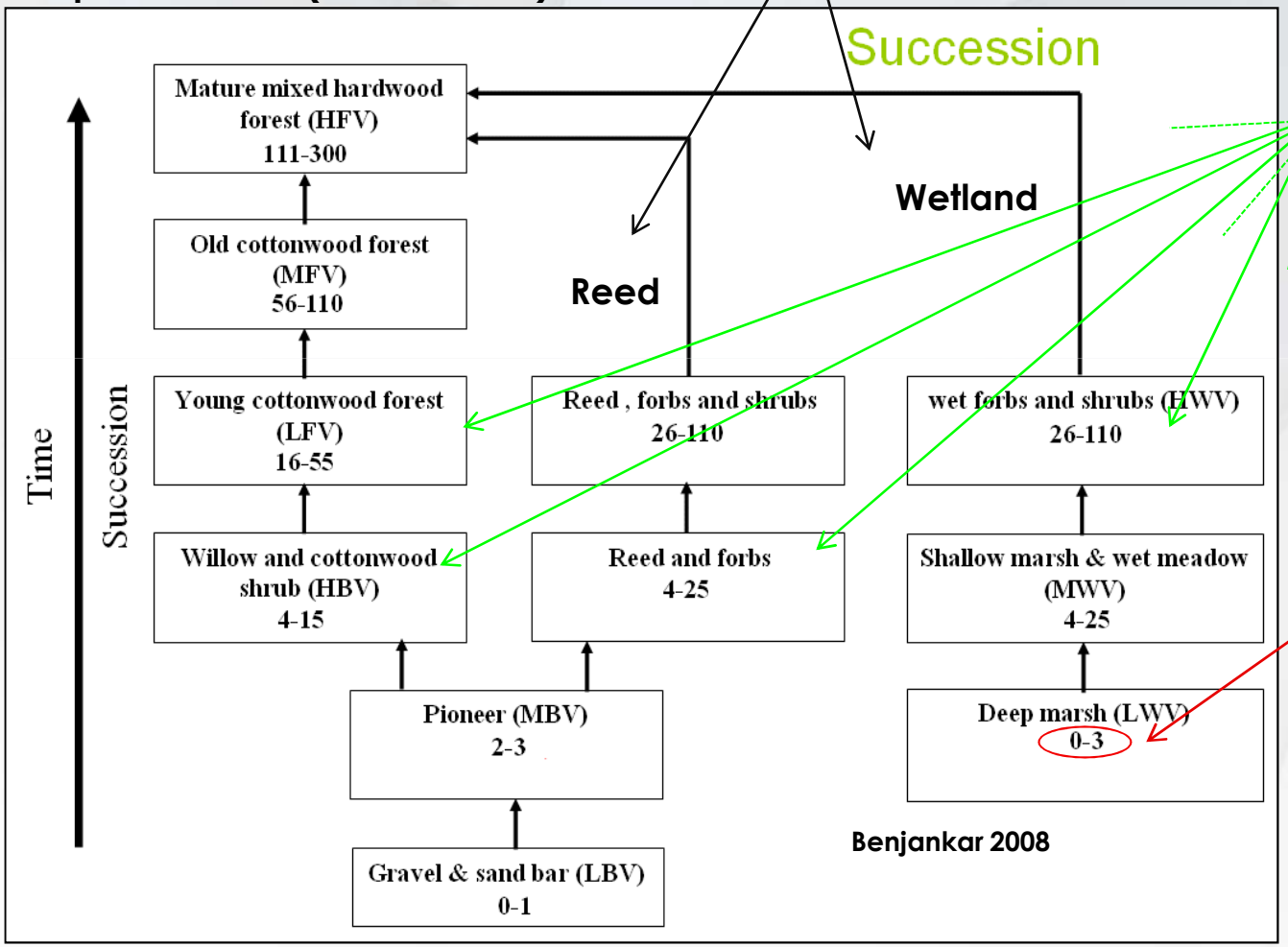
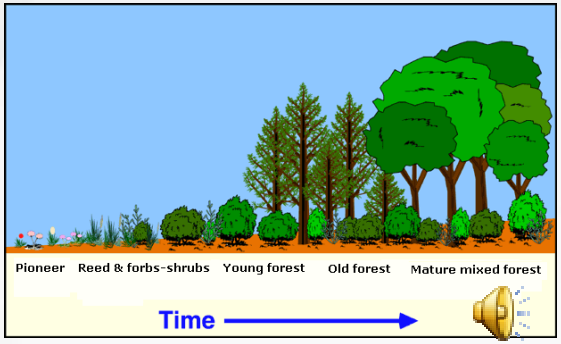
Succession Series (different vegetation kinds)

Riparian Forest (Cottonwood)



Cover Types (phases)

Age range (phase time span)



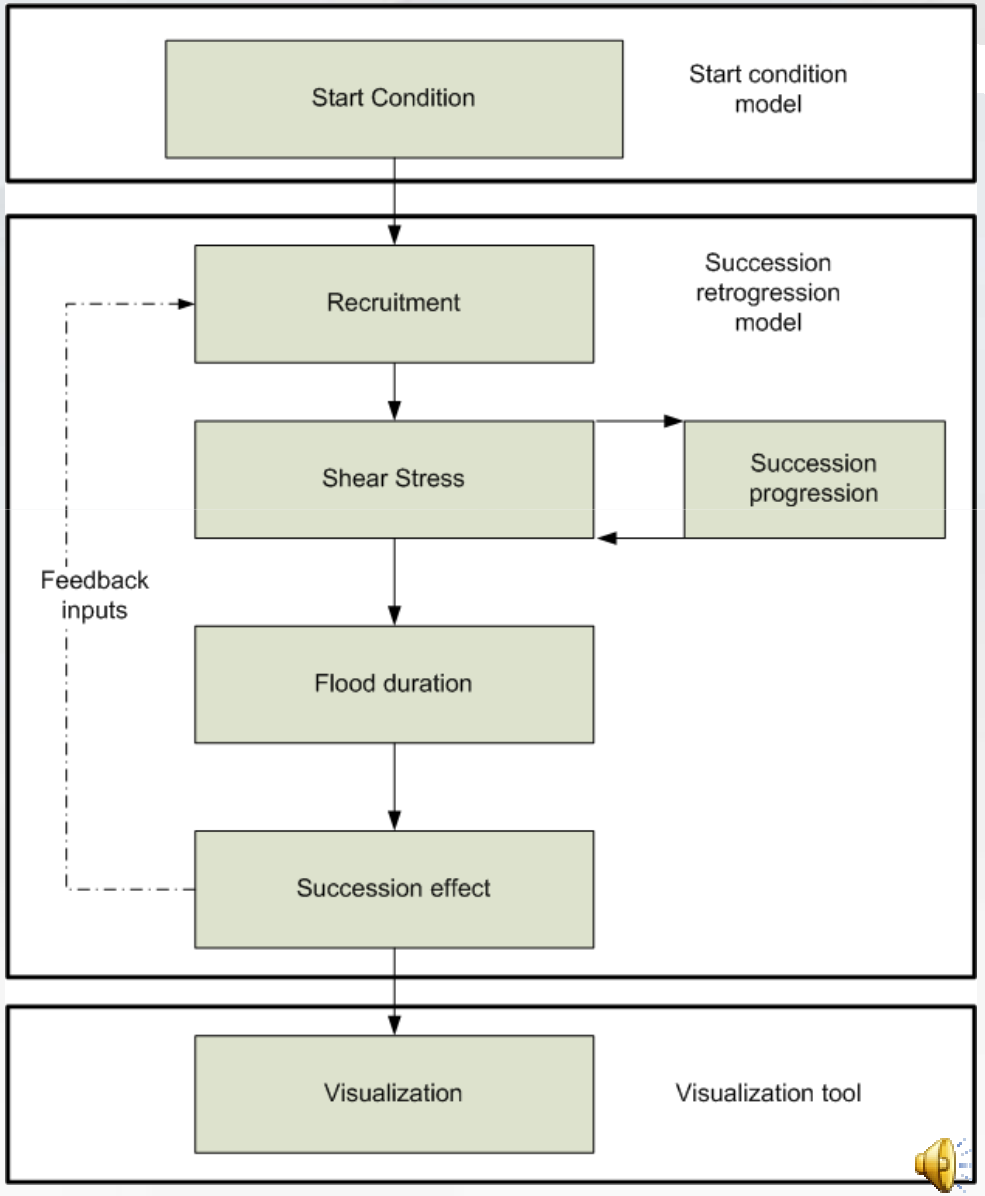
Requirements of the model

- Spatial referenced inputs-outputs (Maps)
- Model set on three succession series
- Record of cover types areas (additional , non spatial output)
- Well documented
- Results displayed with user defined color legend

Modeling procedure components

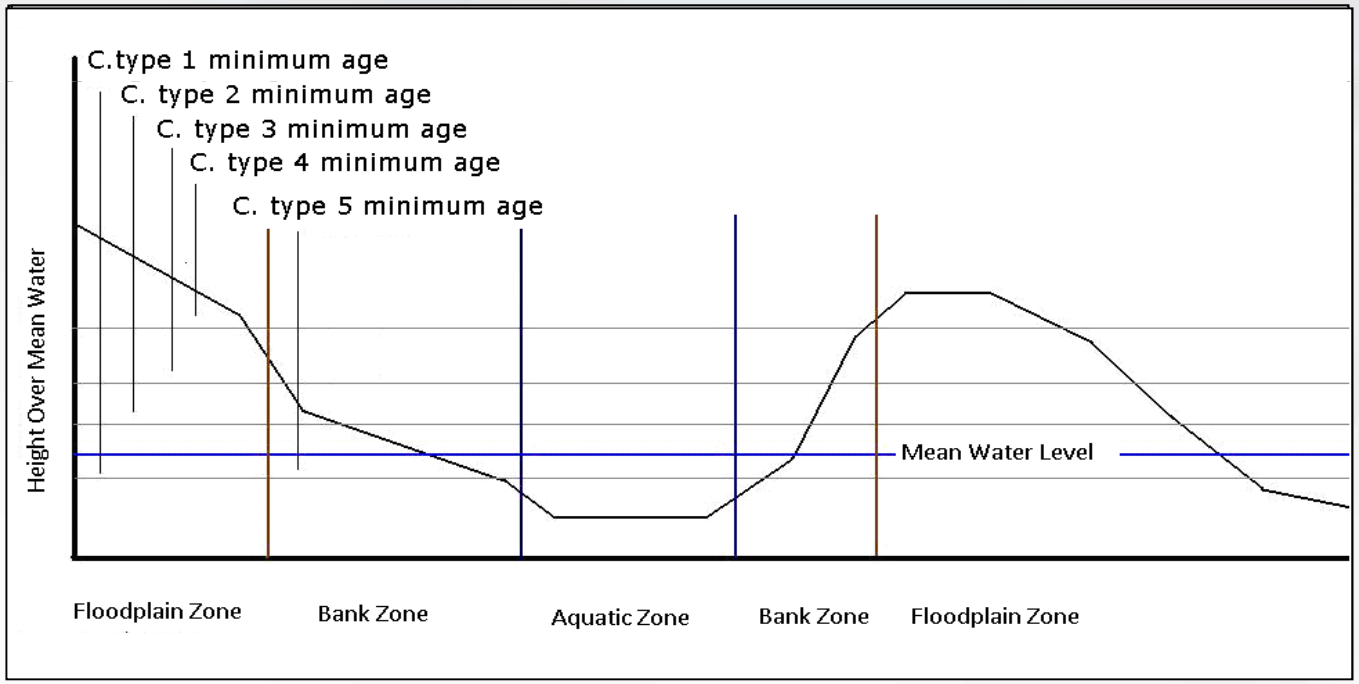
- Start condition model:
  - Defines extents of the starting succession stands
  - Assigns minimum ages * of the stands in the study area
- Succession retrogression model:
  - Dynamic
  - Evaluates evolution & spatial distribution of vegetation
  - Yearly inputs
  - Made by four submodels
- Visualization tool:
  - Re-displays succession retrogression outputs with a unified legend

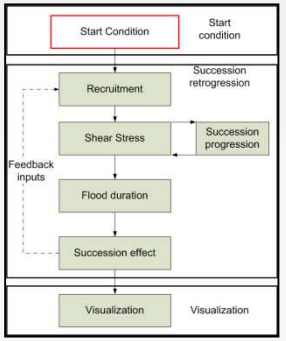
*minimum number of years that, in natural conditions, are necessary to reach that stand status (height, resistance, shape…)



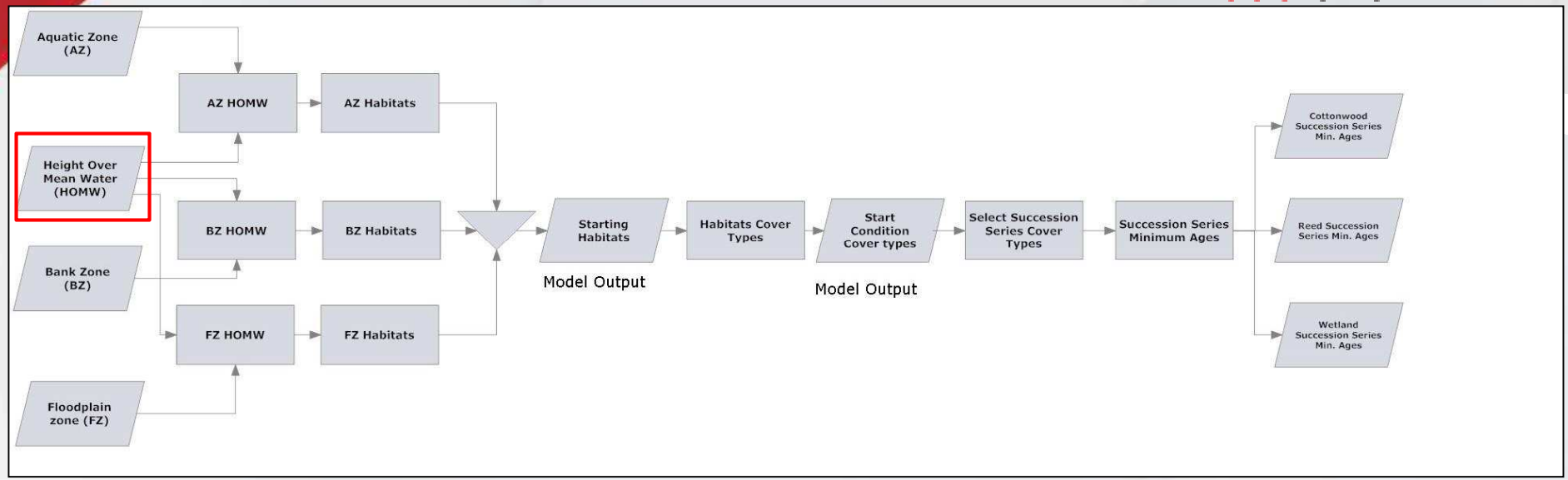
Start condition

- Defines initial habitat conditions and related landscape
  - Height over mean water level
  - Zone where heights are measured (aquatic , bank or floodplain zone)
- Tuple height-zone defines a unique habitat
- Each habitat has a unique cover type
- Each cover type has a minimum age

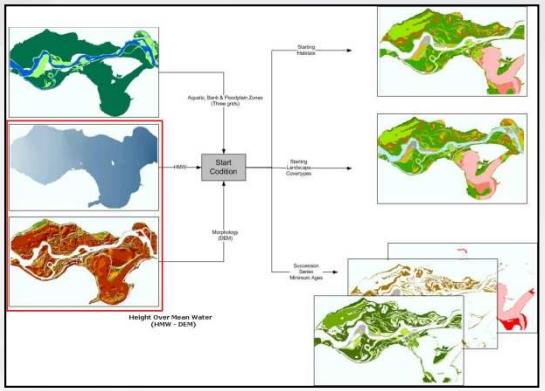


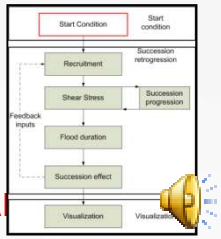


Start condition implementation



Input Grids	Parameters	Output Grids
• Height over mean water • Morphology (DEM) • Aquatic zone • Bank zone • Floodplain zone	• Heights over mean water of the bank zone habitats • Heights over mean water of the floodplain zone habitat • Reclassification from initial habitats to cover types • Cover types minimum age	• Start condition landscape • Initial habitats • succession minimum ages • Reed succession minimum age • Wetland succession minimum age





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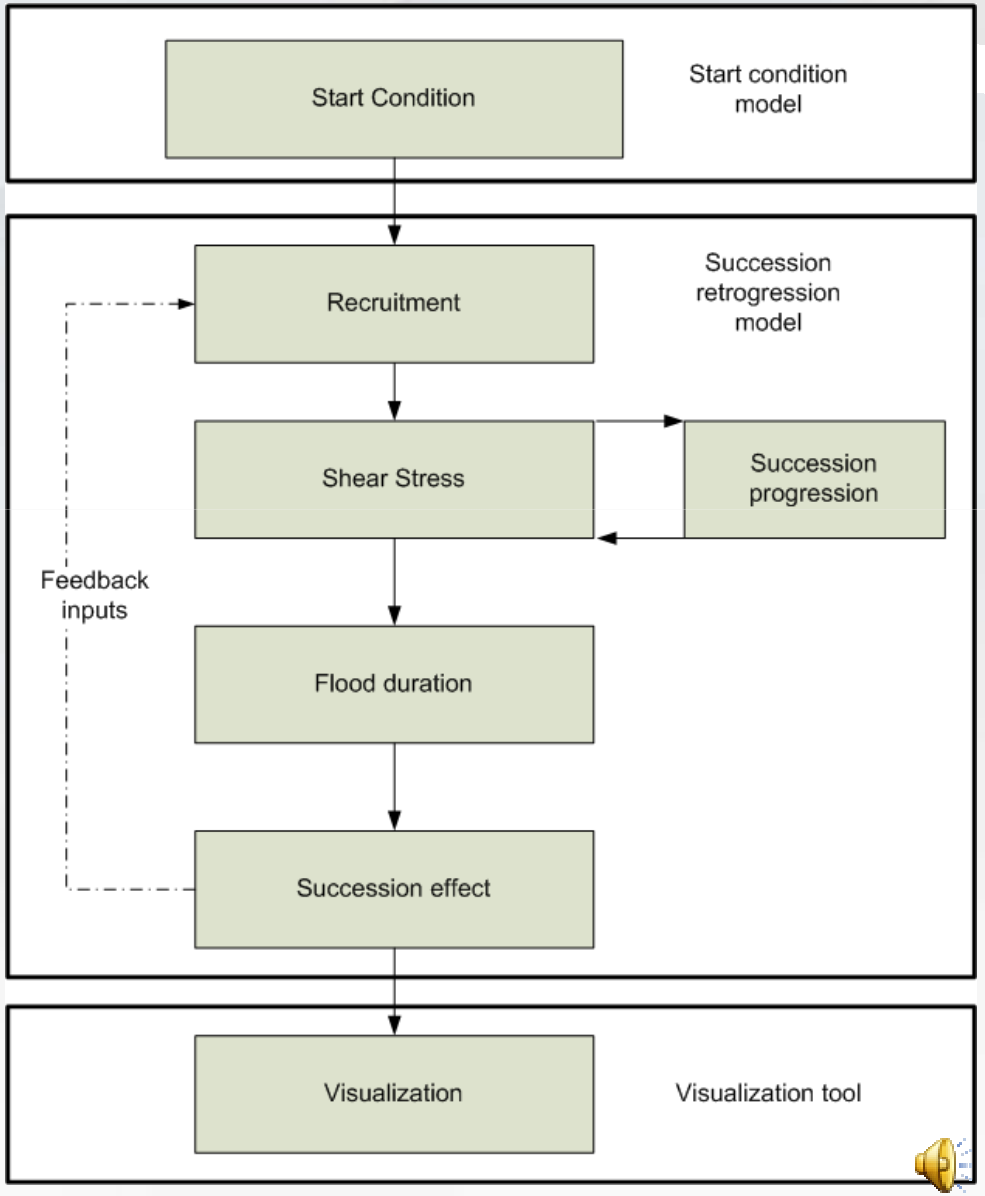
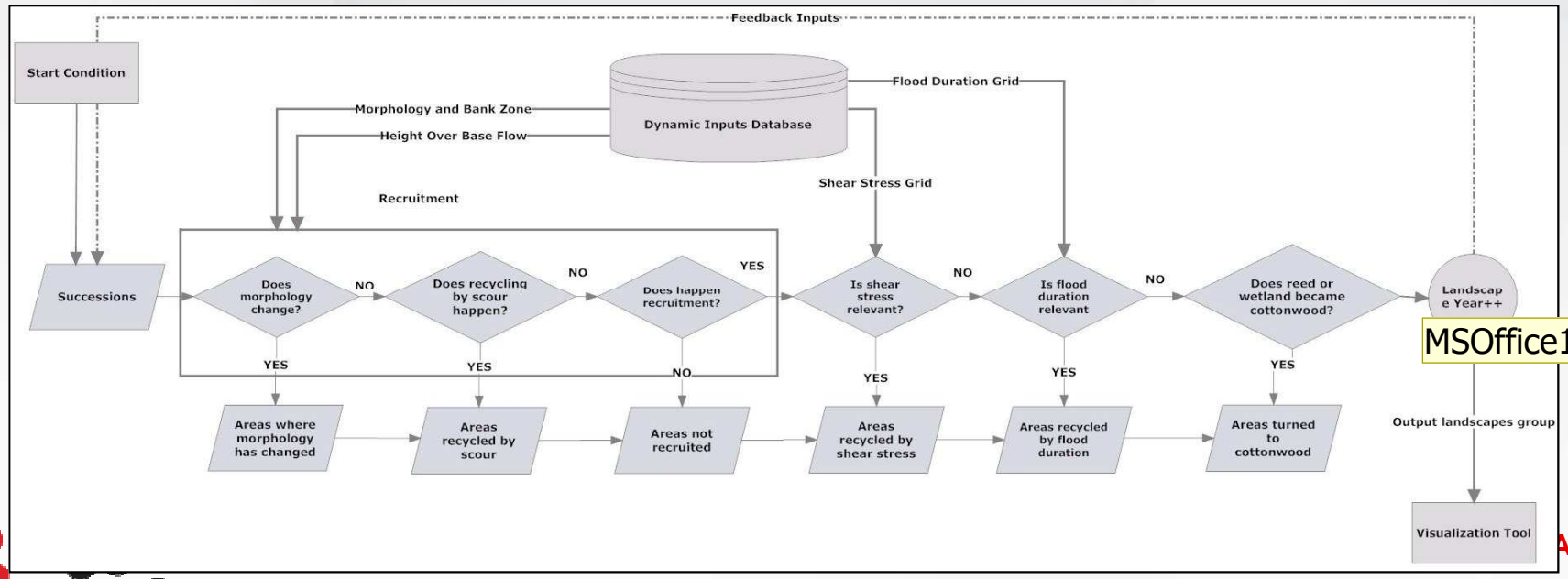


Succession retrogression model

- **Dynamic: inputs-feedback variables**
- **Can be different for each simulated year**
- **File paths stored in a database**
- **Based on hard thresholds & Boolean evaluations**
- **Dynamic inputs:**
  - Morphology (DEM) & Bank zone
  - Height over base flow (approx. soil moisture and scour disturbance)
  - Mechanical disturbance (Shear stress)
  - Physiological flooding stress (Flood duration)

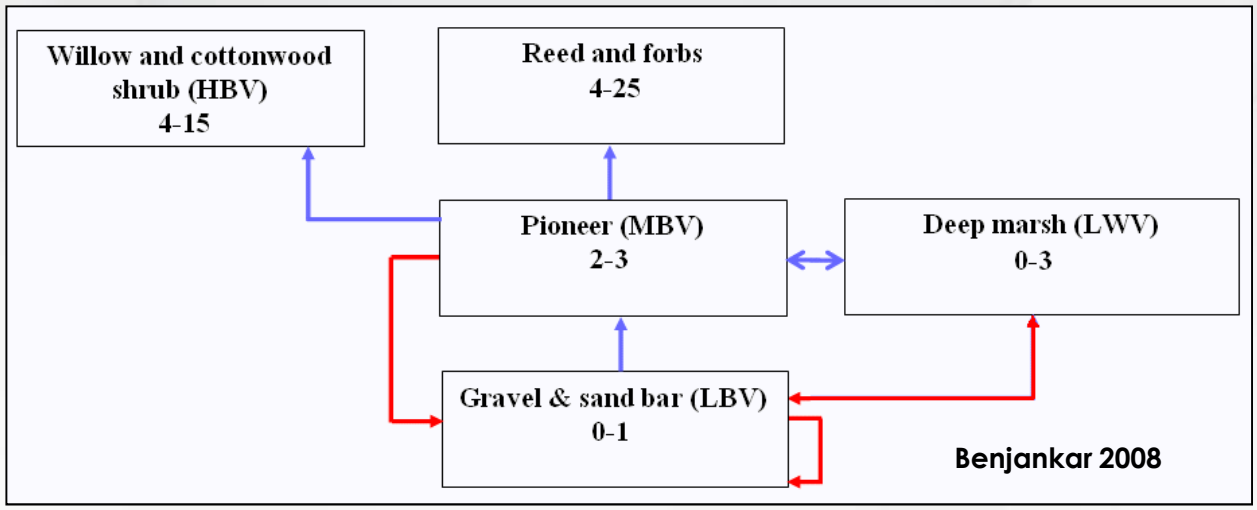


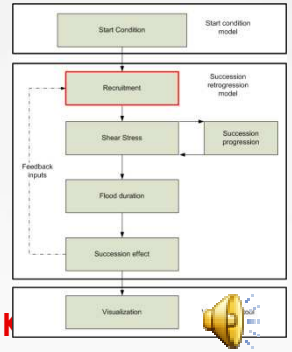
Slide 12

MSOffice10 how to classifiy this (morphology vs hydrology)?
, 9/16/2008

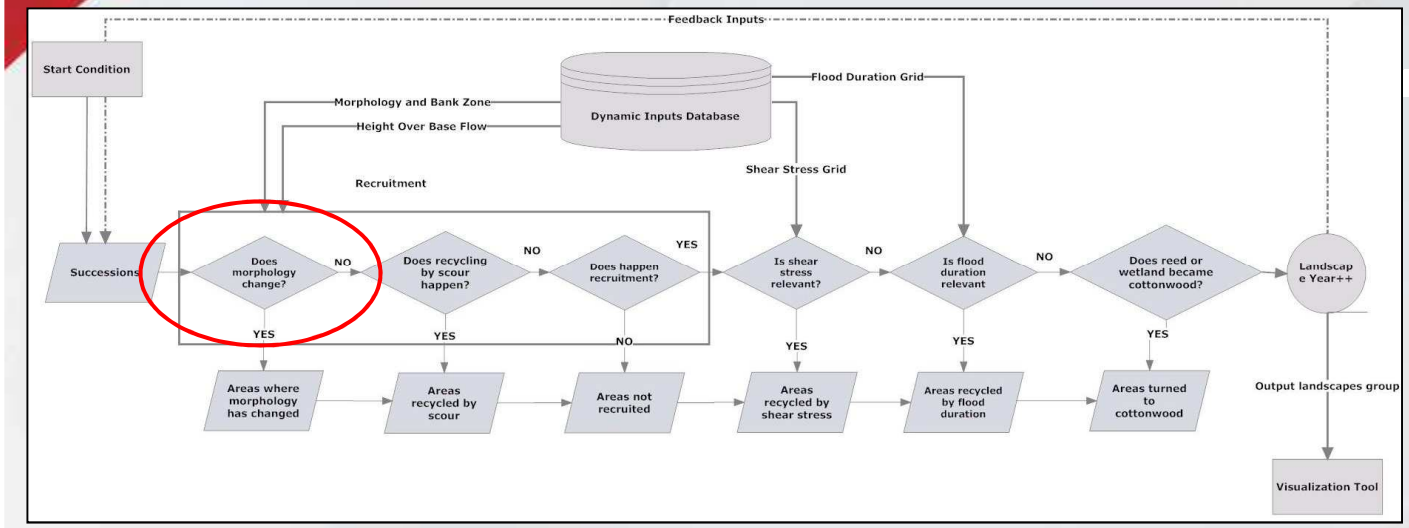
Recruitment submodel rules

- Verifies changes in morphology
- Vegetation renewal, scour disturbance:
  - Occur only on open bar
  - Height Over Base Flow (HBF), Bank Zone, Morphology
- Reed & cottonwood share pioneer phase
- Fate of shared pioneer depends by HBF at 3rd year

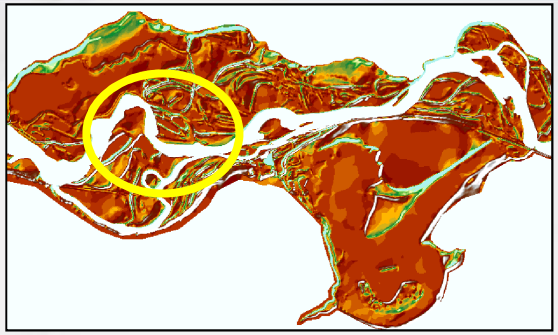




Succession retrogression evaluations

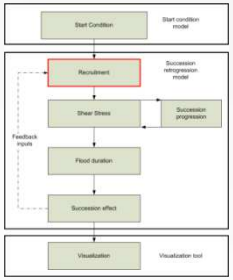


DEM Year n

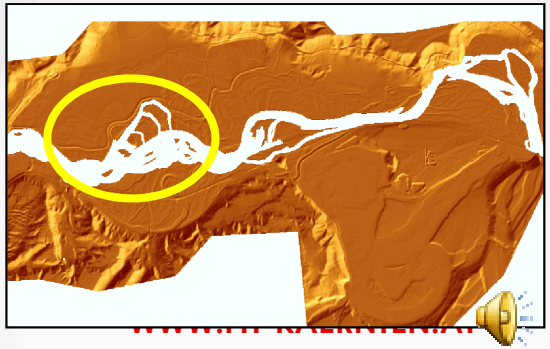


Recruitment Morphology Check:

- New land → potentially colonizable
- Land to water → loss of cover types



DEM Year n+1



Succession retrogression evaluations

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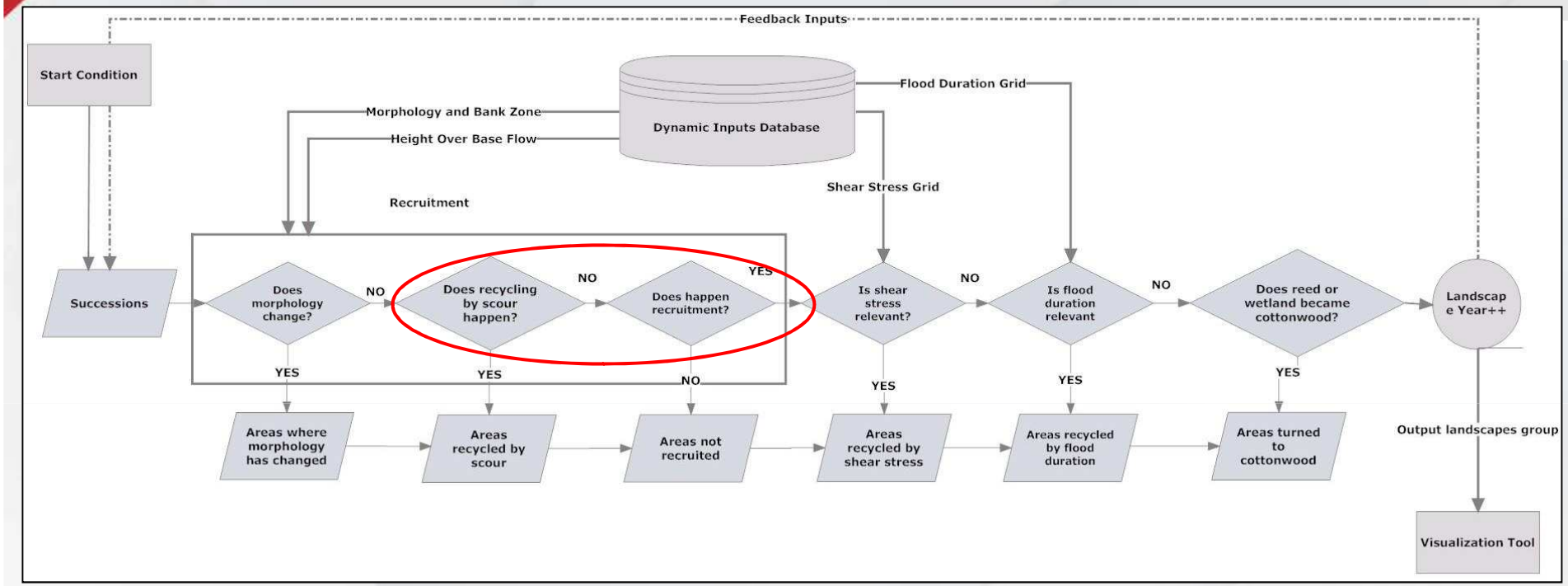
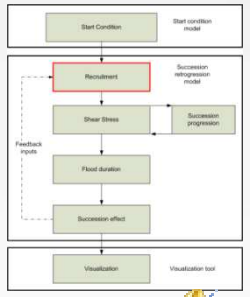


Recruitment: vegetation renewal, seedling disruption (scour)



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Recruitment rules II-Renewal, Disruption

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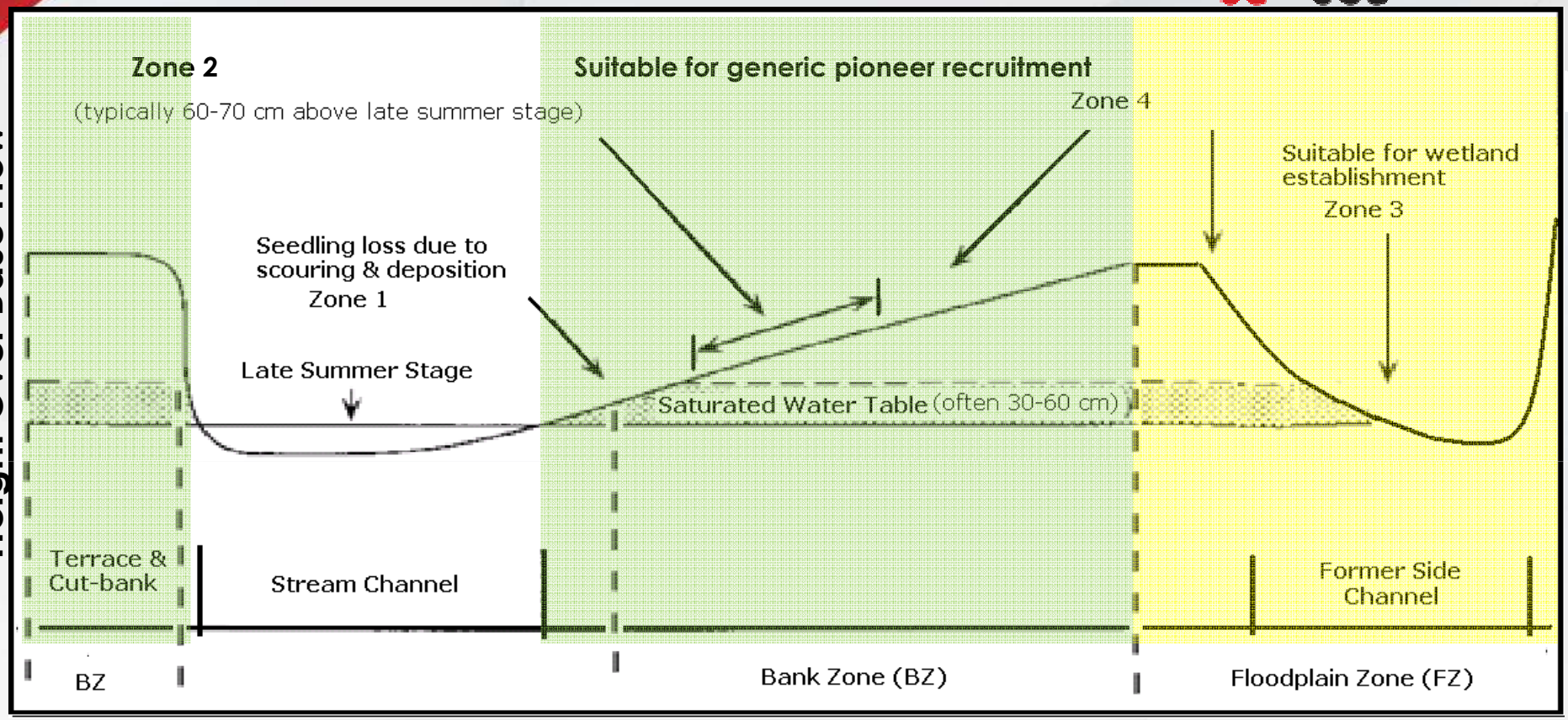
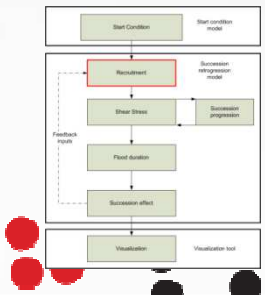


Adapted from Mahoney & Rood, 1998



Height Over Base Flow				
Bank Zone	Disruption			
			Cottonwood	
		Reed		Reed
Floodplain zone	Wetland	Reed		

After 3rd Year

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Recruitment submodel implementation

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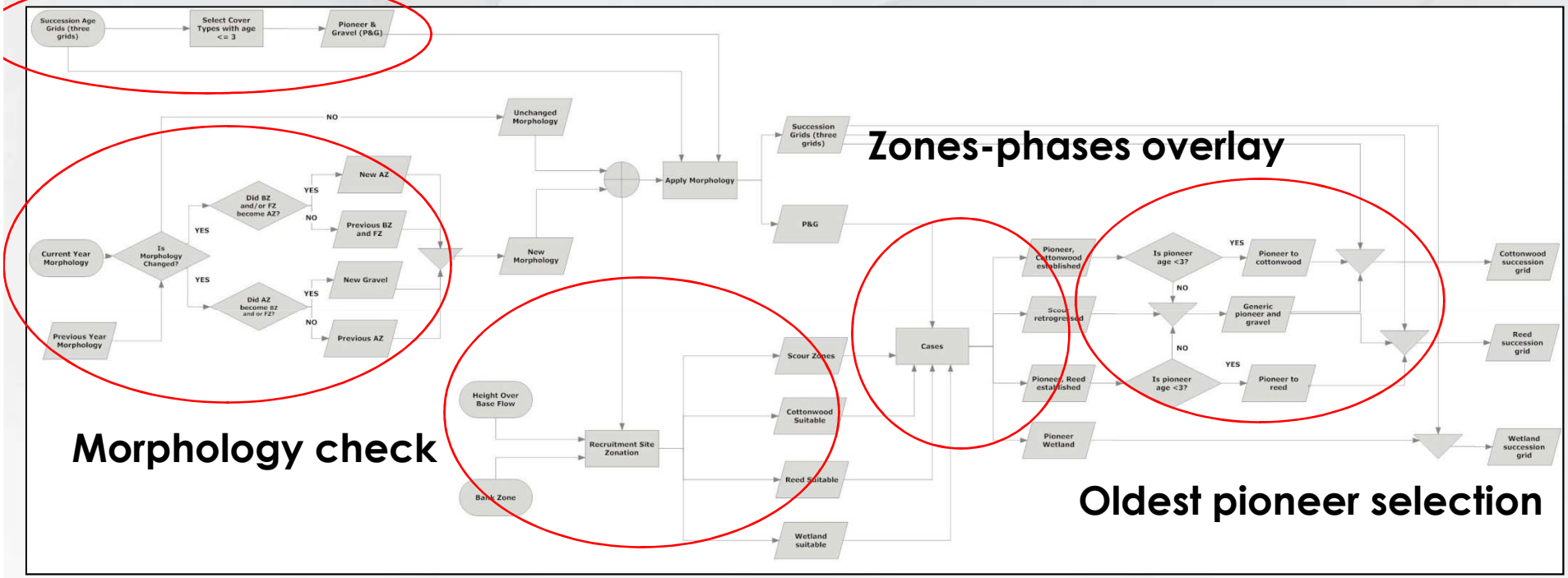
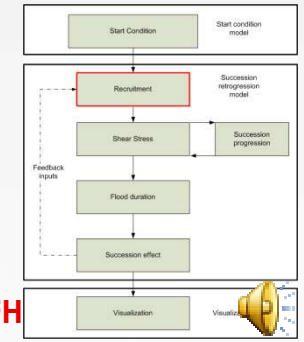
Pioneer phases selection



Zones division



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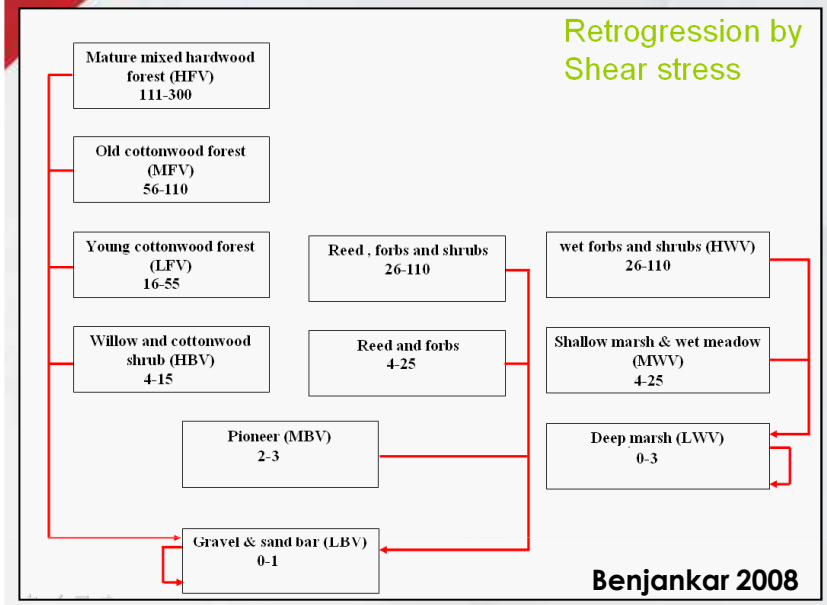
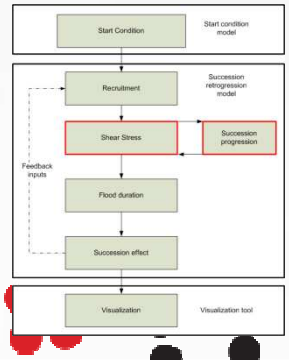
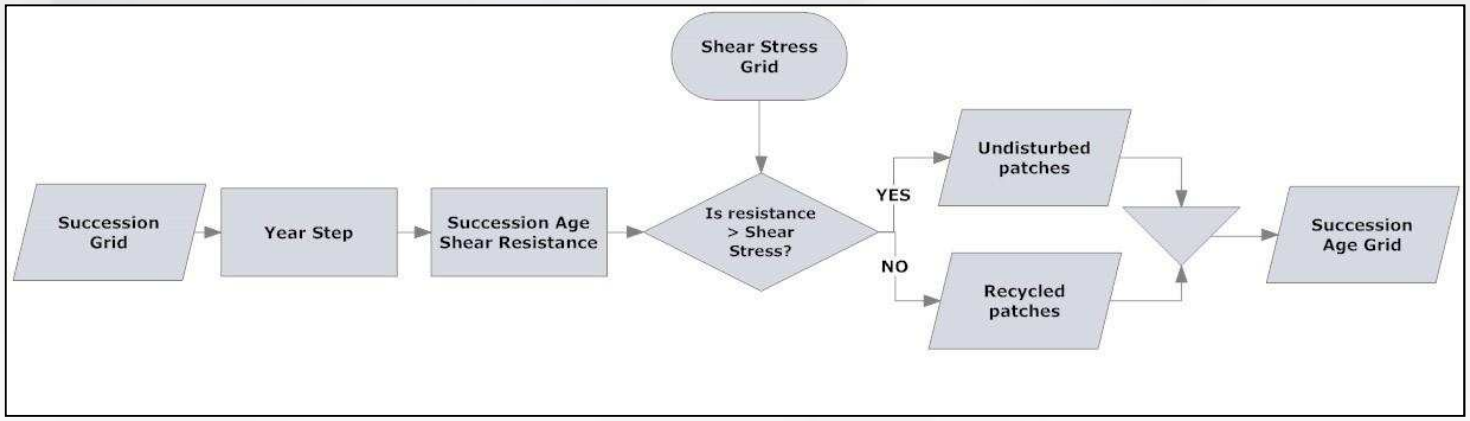
Shear stress submodel

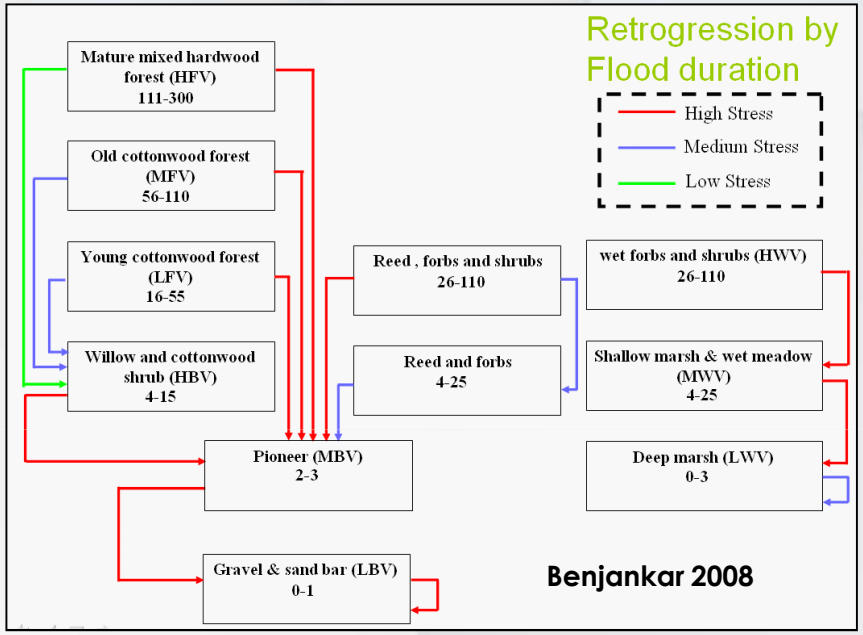


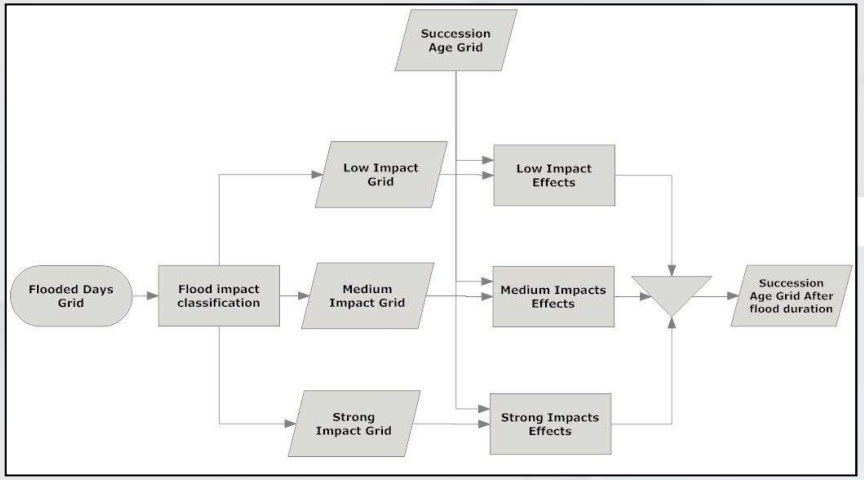
- Causes total recycling
- Add one (year) to succession ages
- Reclass ages to mechanical resistance
- Resistance VS. shear grid of the year





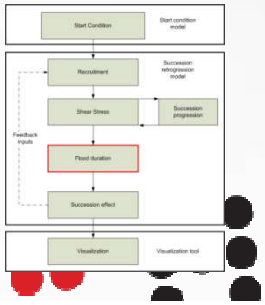
Flood duration submodel





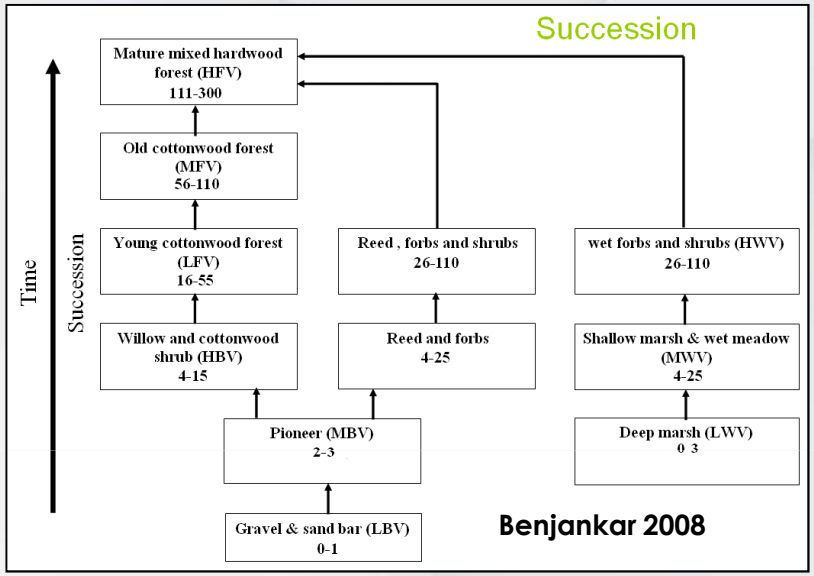
- Total or partial recycling
- Reclass flood grid to impacts
- Check where succession overlays impact grid
- Reclass accordingly

Range of flooded days	Impact severity
90 - 119	Low stress
120 - 150	Medium stress
150 - 366	High stress

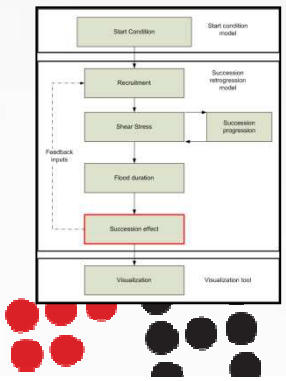


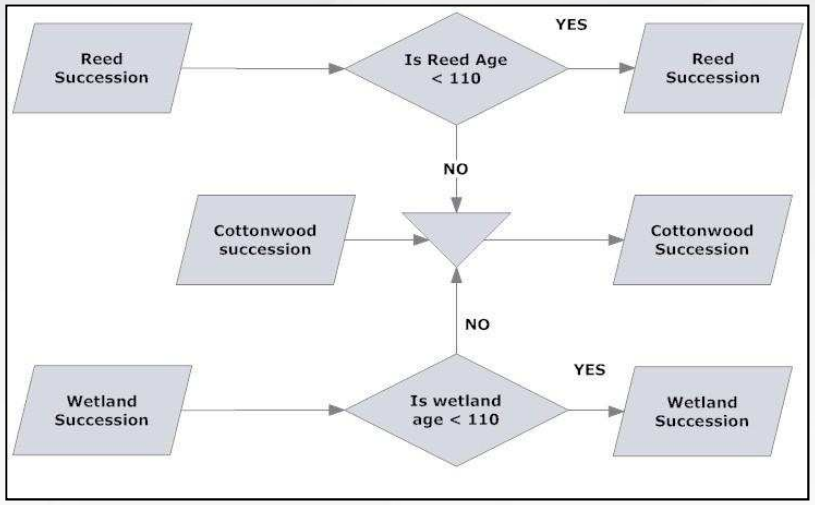
Example of impact intensity classification

Succession progression effect



- Perform age check on reed & wetland
- If old enough become cottonwood (forest series)





Succession-retrogression, elements

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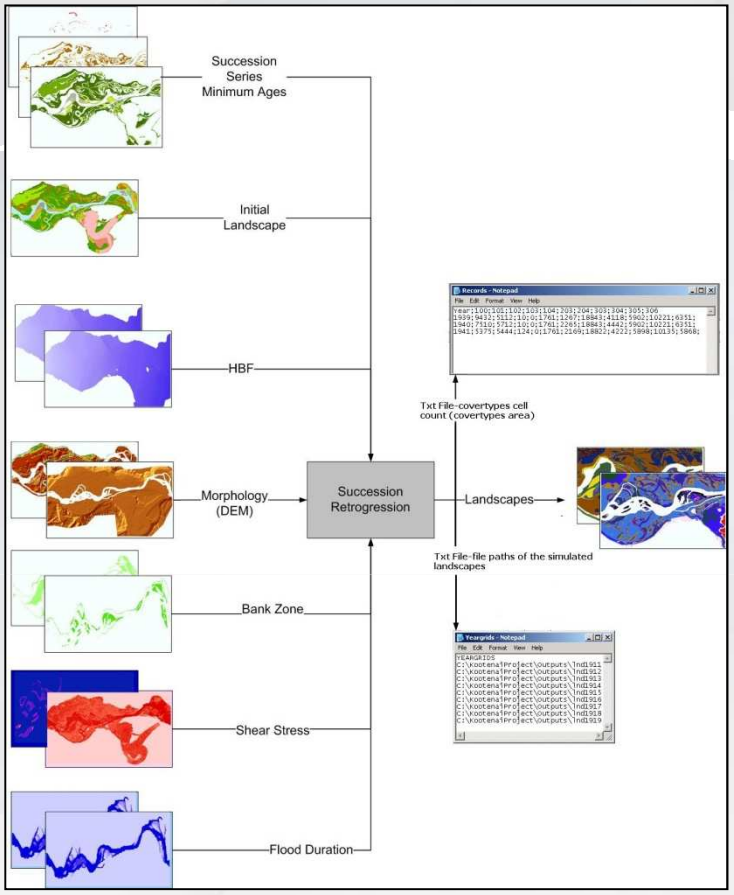
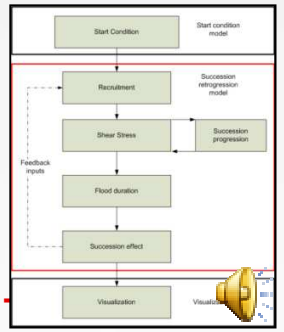
Inputs	Parameters	Outputs
• succession minimum ages • Reed succession minimum ages • Wetland succession minimum ages • Start condition landscape • Height over base flow • Bank zone • Morphology • Shear stress • Flood duration	• Heights over mean water range for the scour disturbance • Heights over mean water within the range suitable for establishment of cottonwood succession from generic pioneer phase • Heights over mean water within the range suitable for wetland recruitment • Successions age classes shear stress resistance (three parameters set)	• Landscape of the study site for each simulated year • File storing the number of cells for each grid code of each simulated landscape • File storing the file path of the simulated year output





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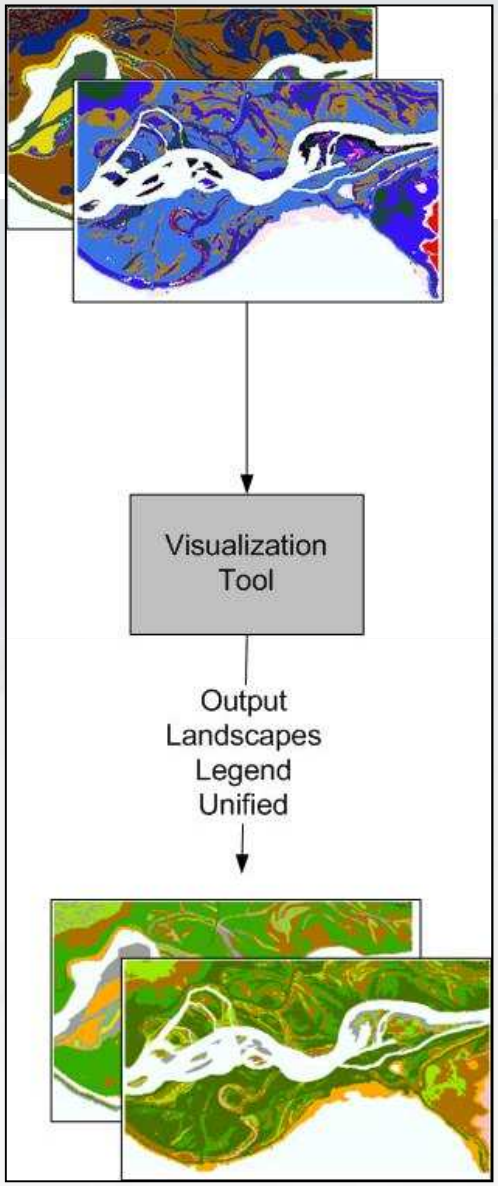
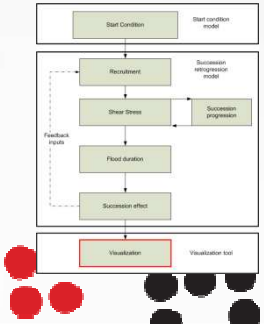
Visualization tool

- Re-display results of succession retrogression
- Requires some manual operations

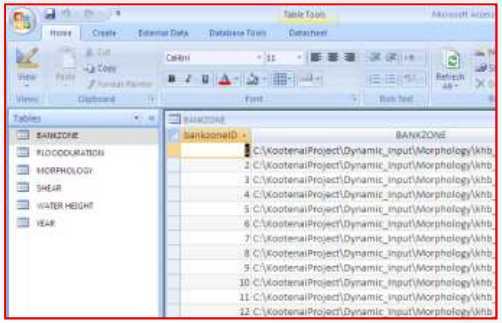




Software

- ArcGis 9.2
  - Model builder
  - Spatial analyst extension
  - Geoprocessing sequencing
  - Provides interface

- Python 2.4
  - PythonWin ext.
  - Dynamic data passing
  - Naming and records
  - Custom geoprocessing



- MS Access
- Dynamic inputs storage
- Popular

Model Package
Interfaces & toolboxes

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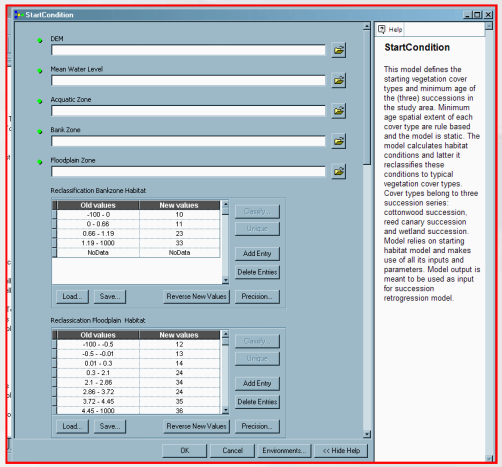
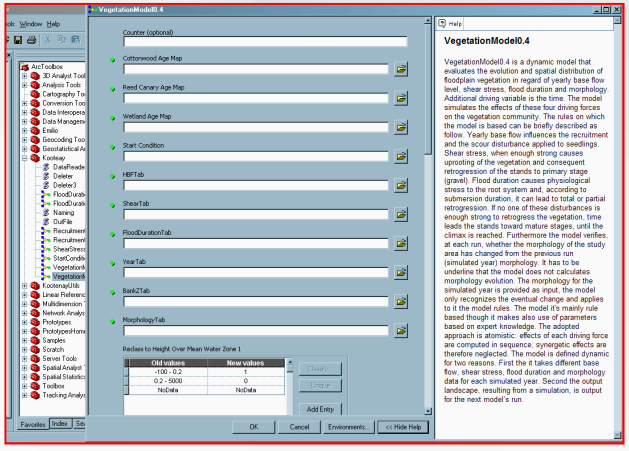
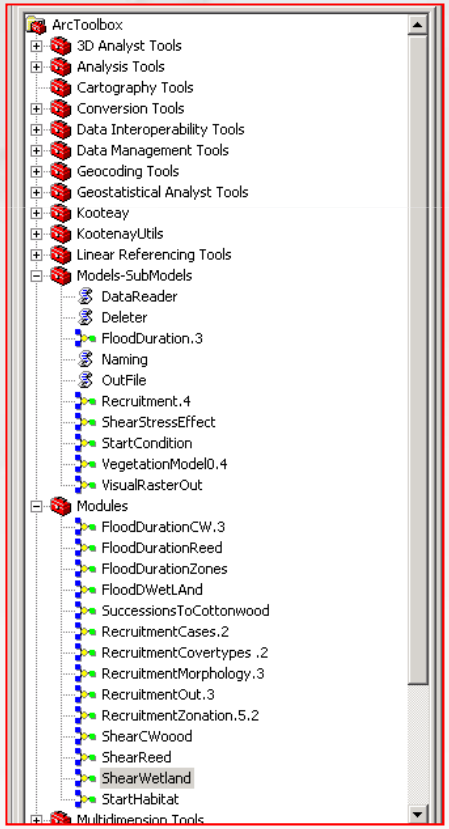


Start Condition

- Accessible from custom tbx.
- Select input grids
- Select output storage location
- Set parameters value
- Set number of iterations
- Aid user



Succession retrogression



Custom toolboxes

Model Package
Documentation & Help files

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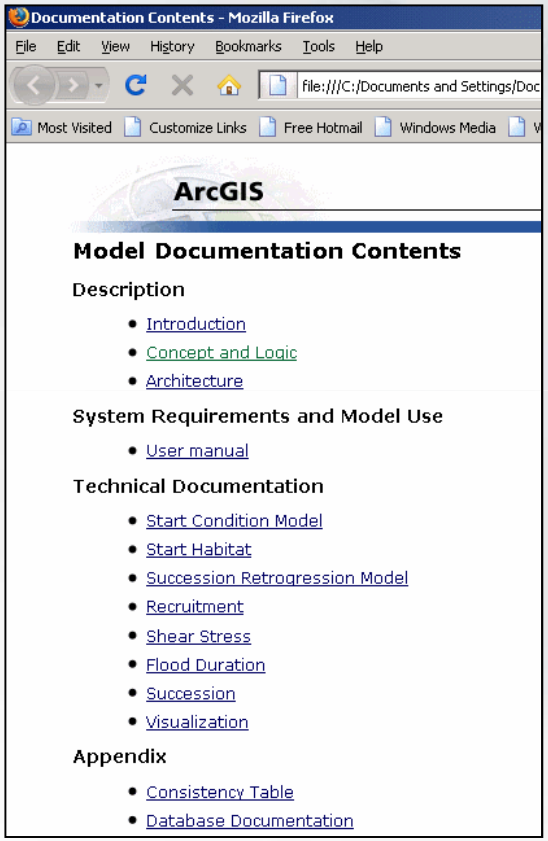
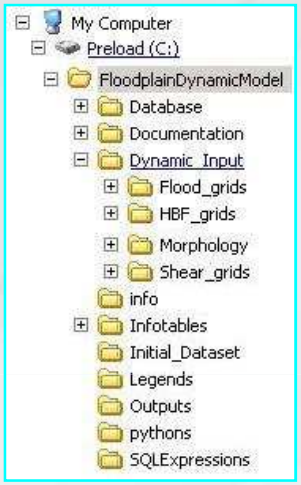
Documentation htm



chm Help file

Folder system



- Models-submodels-modules description
- Data types
- Parameters value range-consistency
- Model use
- Folder system contents
- Database model

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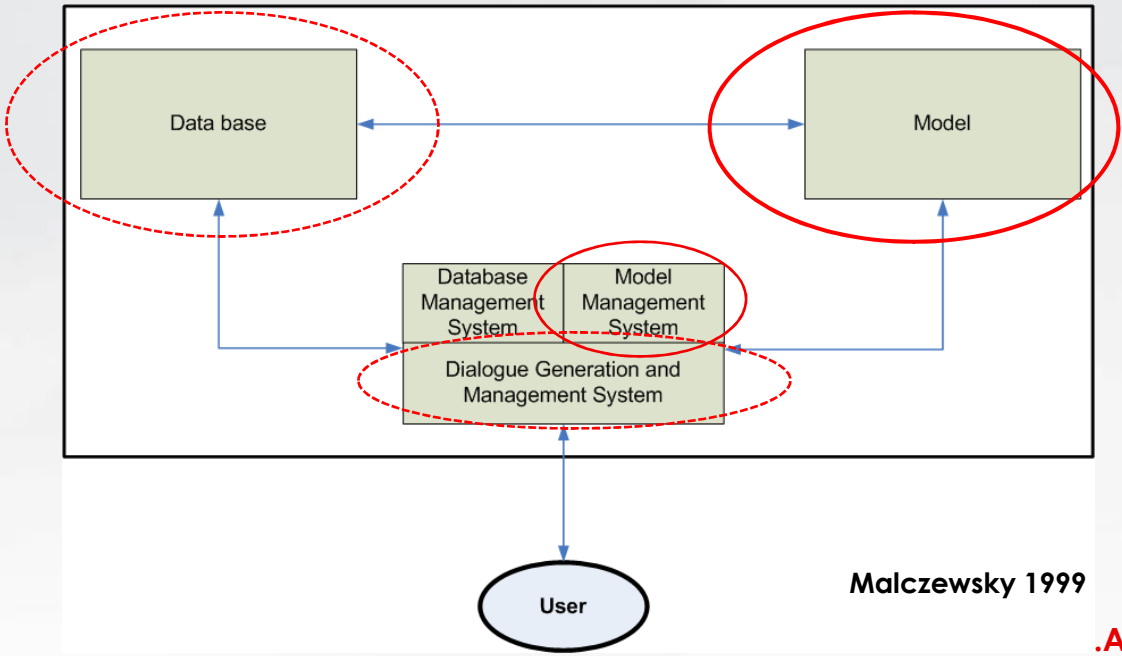
What can be better done

- Better DBMS (RDB compliant, manage scenarios)
- Integration with hydraulic software
- Mutually excluding solutions
- Increase decision space exploration capabilities
- Shorter the time required to assess different discharges

…what about SDSS?

- Database, model, GUI, User
- Support for (spatial) semistructured problems
  - Explore solution space (alternatives)
  - Support different decision making styles (decision maker preferences)



Malczewsky 1999

FACHHOCHSCHULE KÄRNTEN

Where have we been?

- Ecological & cultural river ecosystem importance
- Development of dynamic, general, spatial, process based Model
- Fulfill objectives & requirements
- Maybe not a full SDSS…

…BUT:

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Dynamic Ecosystems Floodplain Model

- Brand new in floodplain modeling
- Valuable assessing tool
- Room for improvements

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QUESTIONS?

Thank you, have a nice day ☺