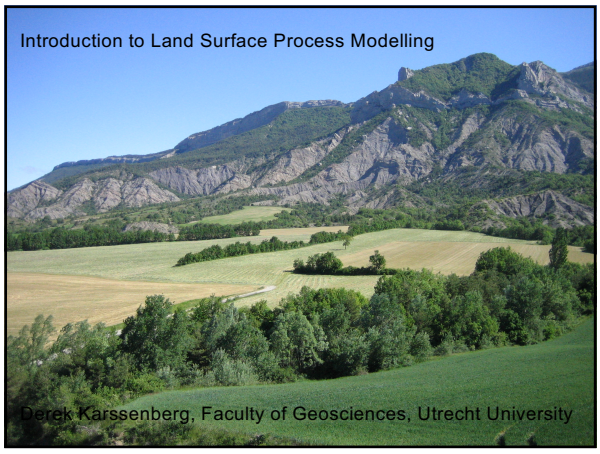

1

Lecturers

Derek Karssenberg (PhD)
- Computational Geography, http://www.computationalgeography.org
- Hydrology, geomorphology, energy science, geography & health
- http://karssenberg.geo.uu.nl

Kor de Jong (MSc)
- Computer science
- High Performance Computation

Oliver Schmitz (PhD)
- Computer science & environmental modelling
- Hydrology, pollution geography

Jessica Ruijsch (MSc student)
- Python & modelling
- Hydrology

2

Topics

- Process-based modelling
- Models as mediators between theory and observations
- Models as tools for ..
- Model development
- The course

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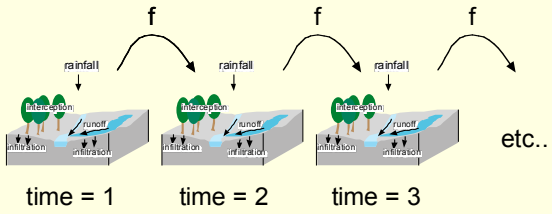
Process-based model



4

Statistical modelling v.s. process-based modelling

Statistical	Process-based
Derived from observations	Derived from theory (regarding processes) and observations
Not necessarily run forward in time	Run forward in time
Statistical software	Simulation software

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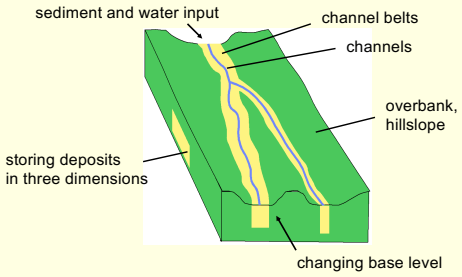
One example: process-based alluvial architecture modelling

- processes of erosion and deposition
- channel bifurcation and avulsion



6

Exercise (1)

- Create group (3 groups)

Exercise:
- Define the goal of the study (precise)
- Define the process-based model required to reach goal
- Describe how you can reach the goal of the study

- One / two persons present(s) results

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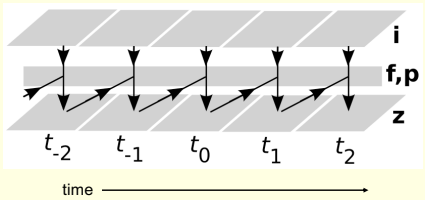
Process-based spatio-temporal modelling



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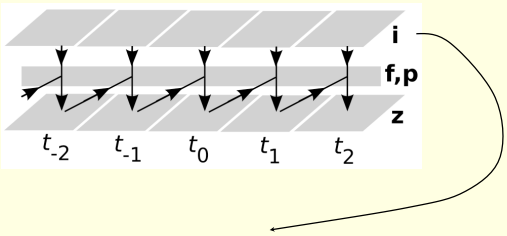
Process-based spatio-temporal modelling



Model input variables, e.g.
- Rainfall for each minute
- Evapotranspiration for each day

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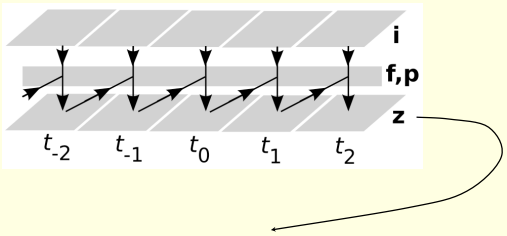
Process-based spatio-temporal modelling



Model output variables, e.g.
- River discharge

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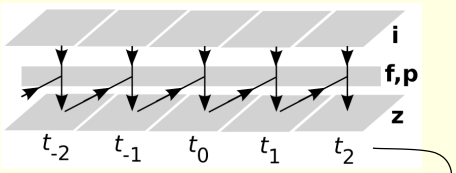
Process-based spatio-temporal modelling



Time steps:
- seconds
- years
- decennia

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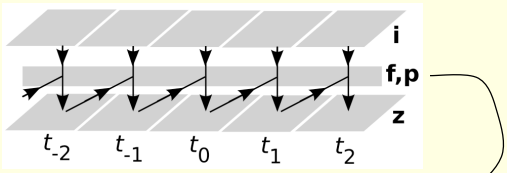
Process-based spatio-temporal modelling



Transition function (f) with parameters (p), e.g.
- Infiltration equation

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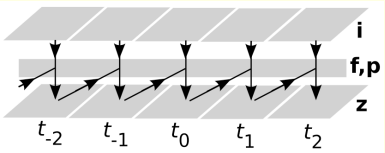
Exercise (2)

- Same groups

Exercise
- Define **i**, **z**, **f**, **p**
- Explain why these are needed in the model in relation to the goal of the study
- Present results



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Why are process-based models so useful in the geosciences?

Because of (at least) three properties.

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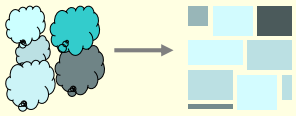
Properties (1): Formalization of process knowledge



theory

Often qualitative 'knowledge' about processes

model

Mathematical equations

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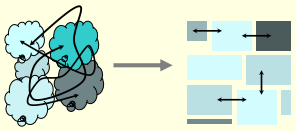
Properties (2): Coupling of processes



theory

Links often unclear Qualitative 'understanding'

model

Links defined in quantitative terms

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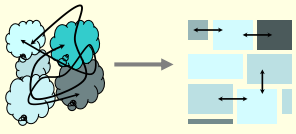
Properties (2): Coupling of processes



theory

Links often unclear Qualitative 'understanding'

model

Links defined in quantitative terms

Example: Landscape evolution

- Rainfall
- Infiltration, runoff
- Vegetation growth
- Erosion
- Sediment transport
- Soil compaction
- Crop management
- Land use change
- …

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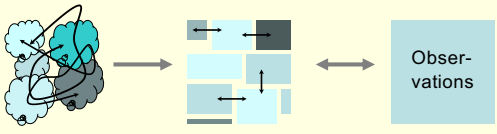
Properties (3): Integration of data



theory

model

Integrate observations (measurements) with the model:
- model inputs
- calibration and evaluation
- data assimilation

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The model mediates between the theory and the data

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Purposes of modelling

- Improving understanding of systems
- Prediction, backcasting, nowcasting

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Improving understanding

Objectives
- To study the land surface as a system of interacting components
- To understand processes of individual components
- To understand behaviour of the system as a whole

Relevance
- Scientific understanding
- Better management and policy making (in the end)

Challenges
- Understand how components work
- Understand how they interact

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Prediction, backcasting, and nowcasting

Objectives
- Describe (quantify) the state of the system
- Future situation: forecasting
- Current situation: nowcasting
- Past situation: backcasting

Relevance
- Avoiding hazards
- Managing land surface systems

Challenges
- Minimize estimation error

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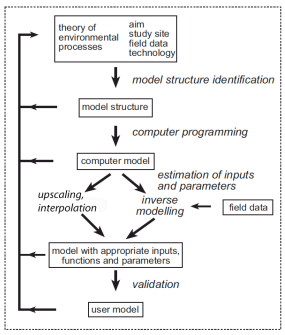
Model development cycle



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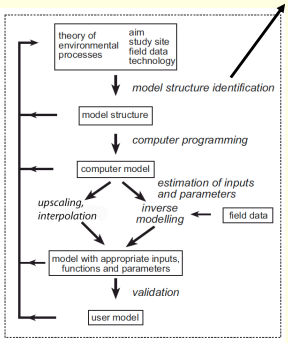
Model development cycle



Define conceptual model:
- graphical description
- description in words
- tables, equations

Choose type of model:
- Differential equations
- Cellular automata
- Probabilistic
- Rule-based

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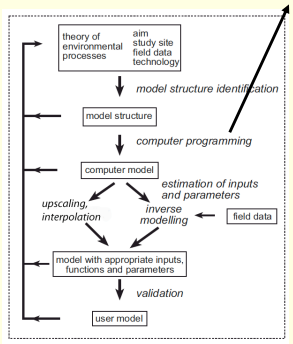
Model development cycle



Program the model

Use appropriate tool:
- Spreadsheet
- Modelling toolbox
- Generic programming language

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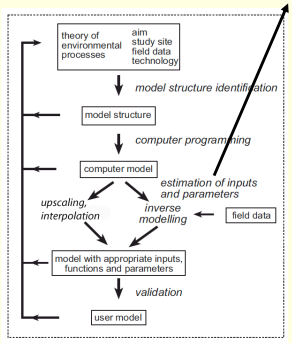
Model development cycle



Either (or both):
- Direct estimation
- Calibration

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Contents of the course: 1. Model Theory

Topics:

- Modelling real-world processes: approaches
  - Differential equations
  - Cellular automata
  - Probabilistic models
  - Agent-based models (or individual based models)
- Combining observations and data
  - Error propagation modelling
  - Model calibration (historical data)

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Contents of the course: 1. Model Theory

Study material:

- Reader
  - Study material for exam
  - Background reading material for tasks
- Powerpoint sheets

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Contents of the course: 1. Model Theory

Form:

- Lectures
  - Introduction lecture
  - Local (point) models
  - Guest lectures
- Weblectures

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Contents of the course: 1. Model Theory

Form:

- Working group on neighborhood interaction

Preparation for working group meeting:
- Listen to the web lecture (online/downloadable)
- Study related literature (reader, additional material if needed)
- Prepare a short presentation related to the material (topics will be provided), one presentation per 2 students

During working group meeting:
- Presentations by students (couples)
- Discussion related to presentation
- Questions related to theory

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Contents of the course: 1. Model Theory

Form:

- Question-based lecture

Preparation for question-based lecture:
- – Listen to the web lecture (online/downloadable)
- – Study related literature (reader, additional material if needed)
- – E-mail Derek questions at least one day before the question-based lecture

During question-based lecture:
- – Answer and discuss questions

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Contents of the course: 1. Model Theory

Form:

- Short paper assignments
  - Two short papers
  - Topics / questions provided
  - Related to one or more articles in reader
  - 1000 words

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Contents of the course: 2. Geoinformatics

Topics:

- Python programming
- Static modelling: Map Algebra with PCRaster Python
- Temporal (dynamic) modelling with PCRaster Python
- Stochastic modelling

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Contents of the course: 2. Geoinformatics

Study material:

- Think Python book, 2nd edition
- Powerpoint slides
- Computer practicals

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Contents of the course: 2. Geoinformatics

Form:

- Weblectures

- Computer practical
  - Available in Blackboard (click on 'Communities')
  - Fill in questions in Blackboard
  - Scheduled
  - Self study (computer lab or at home)

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Contents of the course: 3. Project

(Small) case study

Modelling work or literature study

Topics: see website http://karssenberg.geo.uu.nl/lspm

Write short report

Form:
- Prepare 1-page research proposal before you start, discuss this with supervisors (!)
- Self study
- Scheduled hours in computer lab (see course schedule), tutor support

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Land surface process modelling: course outline									
week in year									
6	7	8	9	10	11	12	13	14	15
week in course									
1	2	3	4	5	6	7	8	9	10
Model Theory									
Intr. to land surface process model.	Local (point) models		Spatial Models	Stochastic Models	Agent-based models	Calibration			
							Personal Project	Personal Project	Personal Project
Geoinformatics (mainly lab work)									
Python Program.	Python Program.	Python Program.	Dynamic Modelling	Dynamic Modelling	Stochastic modelling	Stochastic modelling			
Short paper assignments									
	Intro. case		Spatial models						
Exams									
							Exam (all material)		
Final report on personal project									
									Final report

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Marks

Final mark is weighted average of:

- Assignments (2)
- Written exam (1)
- Report on case study project (1)

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