Geoecology and population dynamic modeling

2003-2009
Geoecology-studies at the TU Braunschweig, Germany
Focus on: Ecology, hydrology, agroecology, soil sciences

Since 2009 in Braunschweig

- Diploma thesis: Parameterization of population dynamic models for aquatic shredder species with lab, mesocosm and field experiments*
- Current project: Temperature-dependent population dynamics of aquatic shredders and life-cycle strategies to cope with climate change

* S. Moenickes, A.K. Schneider, L. Mühle, L. Rohe, O. Richter, F. Suhling (2011): From population-level effects to individual response: modelling temperature dependence in *Gammarus pulex*. Journal of Experimental Biology 214: 3678-3687.





Adaptive behavior of earthworms…

Since November 2009 in Potsdam

Member of the working group Environmental Modelling at Potsdam University

[funded by the Leibniz Center for Agricultural Landscape Research ZALF Müncheberg]

Planned PhD thesis

Adaptive behavior of earthworms and their effects on soil hydraulic properties

- Investigation of feedbacks: Field work in Weiherbach catchment (S-Germany)
- Simulation of feedbacks: Coupling of population dynamic model with soil hydrological model

At the moment: preparing a review paper on earthworm dynamic modeling and perspectives and challenges for modeling feedbacks between earthworms and abiotics





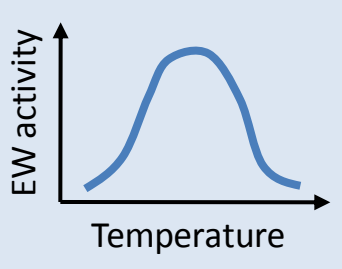
Aims

Feedbacks between earthworms and their habitat

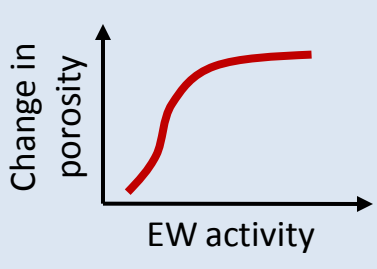
1. Development of an individual-based earthworm model and of an interface to couple this model with a soil physics model, HYDRUS or SWAP

2. Upscaling via deviation of transfer functions

Response (Example)



Effect (Example)



Small spatial scale

Upscaling

3. Coupling of transfer functions with slope scale soil hydrological model, e.g. CATFLOW (Zehe & Flühler 2001) to investigate effects of earthworms on soil hydrologicla processes

Large spatial scale





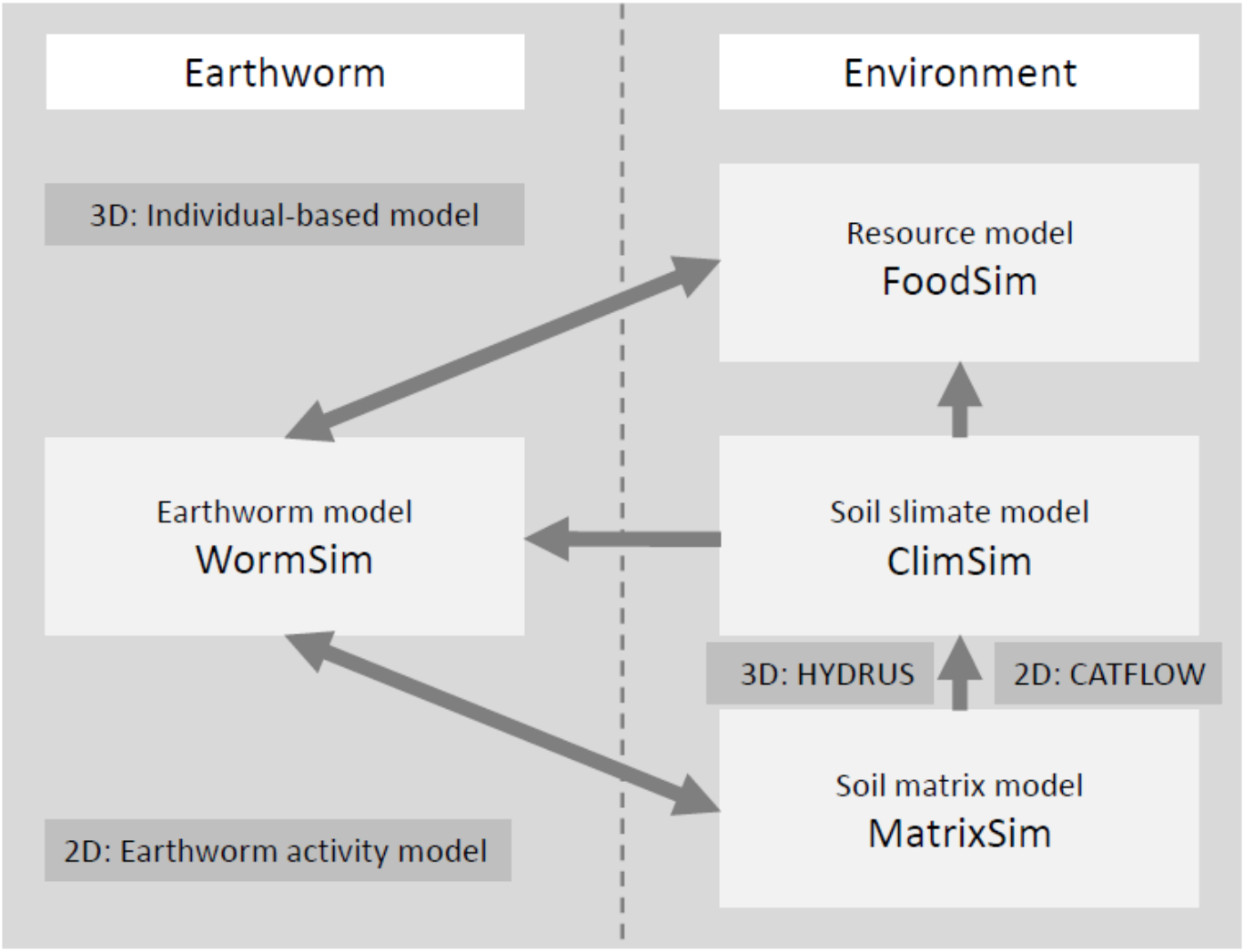
Hypotheses

1) Fitness-oriented behaviour explains spatiotemporal distribution patterns of anecic and endogeic earthworms on small spatial scale depending on abiotic and biotic factors.

2) Under undisturbed conditions, we assume coexistence of anecic and endogeic earthworms. However, we hypothesize tillage events to affect the strength of competition of both functional types.

3) Earthworm activity causes seasonally varying runoff processes at slope scale.

Conceptual model



3D	extent (area * depth): 100 m^2 * 5 m	grain: 1,000 cm^3
2D	extent (length * depth): 30 m * 2 m	grain: 0.25 m^3

AdaptiveWorm-3D

Model output

- Population structure
- State of soil hydraulic properties

Upscaling

Deviation of

- Spatiotemporal Earthworm activity
- Transfer function: porosity changes in dependency of earthworm activity

AdaptiveWorm-2D

Model output

Effects of earthworms on slope scale runoff processes

Field work and data analysis

Weiherbach Catchment (S-Germany)

Methods

Vier Testplots (4 m²) zu vier Zeitpunkten in 2012:

- Stechzylinderprobenahme: bodenhydraulische Eigenschaften
- Regenwurmsampling mit Senflösung: Populationsstruktur und Bestimmung mindestens der funktionellen Gruppe (Whalen & Costa 2003).
- Horizontalprofile für Porentiefenverteilung (Shipitalo & Le Bayon 2004, Zehe & Flühler 2001)

Data analysis

H_0: Es gibt keinen Effekt von Regenwürmern auf bodenhydraulische Eigenschaften.

H_A: Es gibt einen Effekt von Regenwürmern auf bodenhydraulische Eigenschaften.

Im Weiherbach Einzugsgebiet (Foto: J. Palm)

Regenwurmsampling (Foto: J. Palm)

Modellevaluation

Muster-orientierter Validierungsansatz nach Grimm & Railsback (2005).

Beispiele für emergierende Muster, die wir erwarten:

- Populationsdynamik (Ergebnisse aus BIOPORE-Projekt)
- Begrenzte Porentiefe von anezischen Regenwürmern (im Durchschnitt bis 2 m, Edwards & Bohlen 1996)
- Räumliche Verteilung von anezischen und endogäischen Regenwürmern (Ergebnisse aus BIOPORE-Projekt)

Szenarien - Die Wirkung von Störungen (*events*)

1) Konventionelle versus ökologische Bodenbearbeitung: als numerische Experiment, in dem bodenhydraulische Eigenschaften im Oberboden verändert werden
2) Starkregenereignis: die obere Randbedingung für die Berechnung des Wassertransports wird verändert
3) Trockenperiode: o. R.

Untersuchung der Wirkung von Frequenz und Intensität der Ereignisse auf das Verhalten der Regenwürmer