湖泊水生态模型 WET

培训手册

中国科学院南京地理与湖泊研究所

2024 年 10 月 14~16 日

培训须知

2024 年 10 月 14-16 日，拟在中国科学院南京地理与湖泊研究所开设湖泊水生态模型 WET（Water Ecosystem Tool）的短期培训课程（workshop），授课人为丹麦科技大学的 Tobias K. Andersen 博士与南京地湖所的孔祥臻研究员，授课内容包括 WET 模型基本原理、案例上机操作、模型自动率定方法、WET 源代码编译等，主要内容为英文授课。本次培训不收取任何费用，交通与食宿费用自理。具体信息如下：

一、**培训时间**：2024 年 10 月 14 日-2024 年 10 月 16 日

二、**地点**：中国科学院南京地理与湖泊研究所麒麟新园区 A 楼 419 会议室

三、**食宿安排**

1. 住宿地点（**请参会人员自行预定酒店**）：

    1) 麒麟金帆万源酒店（南京市江宁区麒麟街道创研路 260 号），距离 1.7km，房费 288 元/晚（协议价），电话：18061712606（微信同号）

    2) 锦江都城酒店（麒麟门园博园店），距离 3km，房费 235 元/晚（参考价）

    3) 桔子水晶麒麟门地铁站酒店（南京市江宁区麒麟街道开城路 111 号），距离 2.5km，房费 372 元/晚（参考价）

2. 就餐地点（早中晚均有）：

    1) 中国科学院南京分院食堂（可使用微信/支付宝）

    2) 中国科学院南京地湖所食堂（需所内人员协助刷卡）

四、会议联系

薛雨霏 18935930320 <u>1538851281@qq.com</u>

严雨潇 15308337725 <u>yuxiao_26@163.com</u>

培训内容 Modelling lake ecosystems with WET

Purpose of the workshop

This workshop trains participants in the theory and practical application of the state-of-the-art lake ecosystem model Water Ecosystems Tool (WET). The workshop covers the theory behind as well as model development of the lake models WET (and PCLake+). Through combined lectures and hands-on exercises on participants own computers, participants will learn how to:

- Set-up a WET lake model via the QGIS interface QWET

- Manual calibration and scenario executions with WET models

- Auto-calibration and sensitivity analysis of WET models with parsac

- Compile GOTM-FABM-WET executable from source code

- Contribute to the development of WET modules

The software used has been developed for Windows computers, and participants therefore need a Windows computer to be able to follow the hands-on exercise.
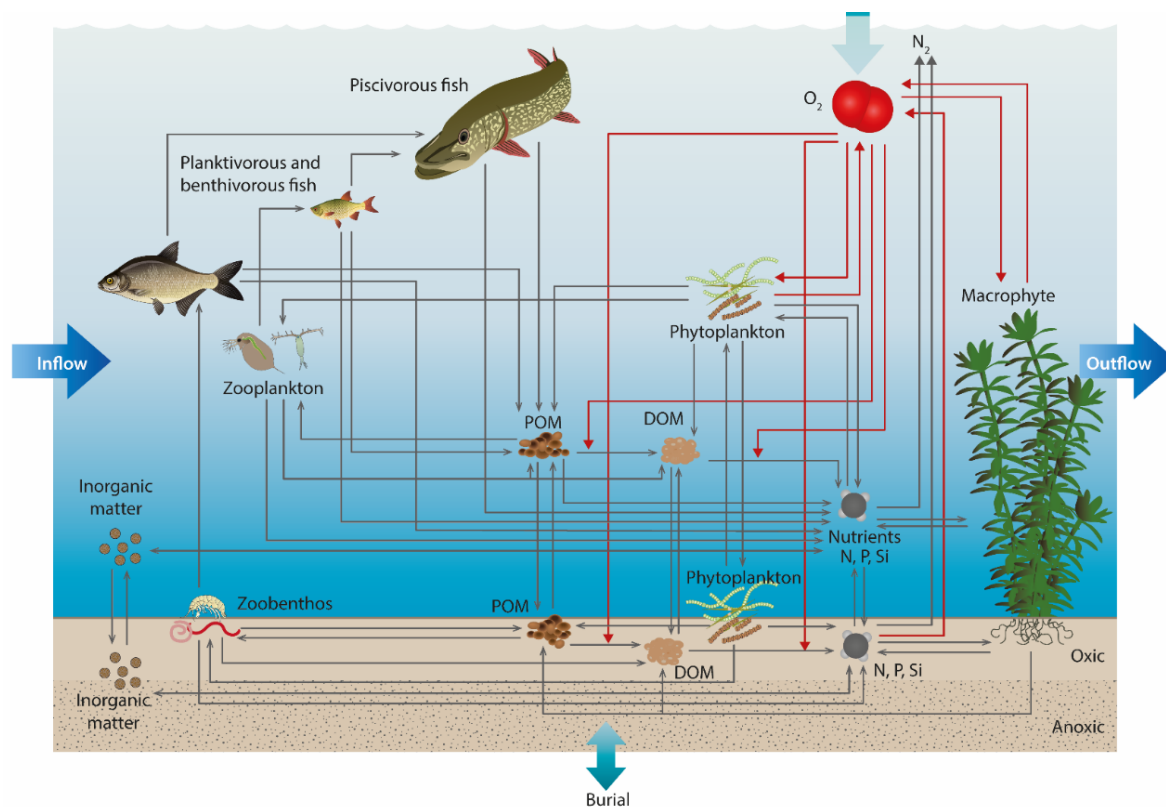

Figure 1. Overview of the structure of WET model

Workshop instructors

Your workshop instructors will be **Dr Tobias K Andersen** (tkan@aqua.dtu.dk) and **Dr Xiangzhen Kong** (xzkong@niglas.ac.cn). They both have great experience with model development and application for multiple lakes and reservoirs.

Workshop requirements

Please bring your personal computer to attend this workshop.

Workshop materials

To participate in the hands-on part of the workshop, you will need to have a working version of QGIS and the graphical user interface QWET. If you are a Mac user, we highly recommend you apply a windows-partition on your system, as the QWET installer is only available in windows format.

- *QGIS*

To run QWET you need to install QGIS3 64 bit version 3.16 or newer (available here: www.qgis.org). We recommend you install QGIS3 64 bit version 3.22 (QWET is currently tested up to version 3.36).

- *QWET*

QWET is an open source QGIS plugin for application and user adaptation of the Water Ecosystems Tool (WET). The QWET installer and the QWET source code is available through Gitlab:
https://u.pcloud.link/publink/show?code=XZsQLp0ZqyoHMg7pCvmO3pbUgJnRFYG LNhN7.

We recommend you install QWET version 3.5.1. Please read the download instructions and watch the associated video tutorial on how to download the software: https://projects.au.dk/wet/resources

- *Case study data for Shahe Reservoir*

For our case study, we will work with the Chinese Shahe reservoir. Signed-up participants will get access to the case study folder including files to configure a GOTM-WET model to Shahe Reservoir with QWET with lake specific hypsography and inflow and weather forcing as well as in-lake observations and files with calibrated parameters.

- *PyNCView*

To visualize model output with contour plots, we recommend using the software PyNCView. You can download an installer (for Windows) at this page (pyncview-0.99.9.msi): https://github.com/BoldingBruggeman/pyncview/releases (under Assets).

You can also download PyNCView in Python via "pip install pyncview".

- **PARSAC**

PARSAC is a Python-based tool for sensitivity analysis and auto-calibration in parallel developed by Bolding&Bruggeman. It is designed for analysis of models that take significant time to run. To download parsac, you will need a Python working environment and can install via Python pip: "pip install parsac –user". Parsac requires the Python package Parallel Python to parallelize the auto-calibration process. For more details on parsac and its installation, we recommend to check out its Github page: https://github.com/BoldingBruggeman/parsac.

[If you have problems installing the required software or downloading the case study, you are welcome to contact us.]

More resources

- **Water Ecosystems Tool (WET)**

WET is a further development of FABM-PCLake by Hu et al., at Aarhus University, Denmark. Key features originate from the PCLake aquatic ecosystem model by Janse and van Liere (1995), but key features and inspiration from CAEDYM and Ecopath/Ecosim has also been implemented. WET can describe interactions between multiple trophic levels and abiotic nutrient dynamics in both the water column and the sediment. The model accounts for the dynamics of dry weight, nitrogen, phosphorous, silica and oxygen, and features bottom-shear-dependent resuspension, as well as two different light-limitation functions for phytoplankton. WET is also implemented within the FABM framework, allowing the model to be coupled to various physical driver models, e.g. GOTM (1D, Burchard et al., 1999) or GETM (3D, e.g. Stips et al., 2004), without changing any of the model code.

For introduction to WET, we refer you to the scientific article:
https://doi.org/10.5194/gmd-15-3861-2022

- **General Ocean Turbulence Model (GOTM)**

Most commonly WET is coupled to the lake branch of 1D hydrodynamic model GOTM (source code available at https://gitlab.com/wateritech-public/waterecosystemstool/gotm). For details on lake branch GOTM, see the models Gitlab page. For more information on GOTM in general, check out https://gotm.net/portfolio/.

- **Framework of Aquatic Biogeochemical Models (FABM)**

The Framework for Aquatic Biogeochemical Models (FABM, developed by Bolding & Bruggeman) allows coupling a biogeochemical model to a wide variety of hydrodynamic models in 0D, 1D, 2D or 3D, without changing any model code, and encourages and supports modularization of ecosystem models. For more details, we refer you to FABMS wiki page https://github.com/fabm-model/fabm/wiki

Tentative agenda for the workshop

Datetime	Content	Note
Day 1: October 14, 2024		
9:00-9:20	Introduction to the workshop and instructors	
9:20-9:45	Short round-table introduction of participants – what is your background, and what do you hope to take with you from this course?	
9:45-10:00	Break	
10:00-12:00	**Lecture:** Theory on lake ecosystem modelling with focus on PCLake and WET	* for WET part
12:00-13:30	Break	
13:30-17:30	**Hands-on exercise:** Basic set-up of WET with QGIS and the DaShahe example	* Require installing QGIS 64 bit version 3.22 on personal computers. Breaks are taking by participants when needed
17:30-19:00	Break	
19:00-21:00	**Free work session** People add a topic or challenge on a list, and instructors can provide advises on how to use the WET model for their research, each 15-30min depending on the number of request.	
Day 2: October 15, 2024		
9:00-9:45	**Lecture:** Calibrating lake ecosystems: Recommendations for WET users	^ Require to install Python on personal computers
9:45-10:00	Break	
10:00-10:30	**Tutorial:** Introduction to parsac and auto-calibration	^
10:30-12:00	**Hands-on exercise:** Auto-calibration of your WET model	*
12:00-13:30	Break	
13:30-14:15	**Tutorial:** Introduction to parsac and sensitivity analysis (SA)	*
14:15-15:00	**Hands-on exercise:** Perform a SA of your WET model	^

15:00-15:30	**Lecture:** Why all modelers should do sensitivity analysis	*
15:30-15:45	Break	
15:45-16:30	**Lecture and group discussion:** WET modularization and the link to FABM	^ (can maybe borrow from Jorn and Nicolas material?) Possibility to brainstorm new module developments and more informal chat on potential research projects
16:30-17:30	**Lecture and group discussion:** New WET developments: Optimal fish feeding behavior, organic matter modularization and green house gas modelling	* Possibility to brainstorm new module developments
17:30-19:00	Break	
19:00-21:00	**Free work session** People add their wish on a list, and we both can provide advises on how to use the WET model for their research, each 15-30min depending on the number of request.	
Day 3: October 16, 2024		
9:00-9:30	**Catch-up on the previous days**	
9:30-11:30	**Tutorial and hands-on exercises:** WET code compilation and development	^ Require to install VStudio on personal computers. Also basic skills of Git will be needed. Break in between exercises
11:30-12:00	Closing remarks of the workshop	
13:30-17:30	A tour of the new campus of NIGLAS and UCAS-Nanjing	May take this time for networking
17:30	Leave	

* indicates material only needs to be updated specifically for this workshop
^ indicates new material should be developed

WET 中文小组微信群组
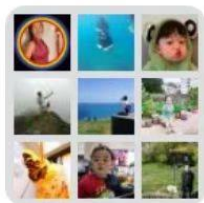
群聊：WET 中文小组

该二维码7天内(9月21日前)有效，重新进入将更新