HYDRAULIC STUDY OF A NON-STEADY HORIZONTAL SUB-SURFACE FLOW CONSTRUCTED WETLAND DURING START-UP

MATLAB Code Description and User Guide

The code was created in MATLAB R2016b and adjusted to run in previous versions (back to MATLAB R2015a)

DESCRIPTION

The sections of code described here were written to accept the data output from a fluorometer (.mv file) and perform the following operations:

- read the data
- calibrate the data
- make minor adjustments
    - filtering and removing far outlying data
    - performing an exponential tail fit to data for which the flow test was terminated early or and the tail was completed manually
- extract the relevant data from the experimental window bounded by the time of tracer injection and the time of fluorometer shut down at the end of the flow test
- calculate the RTD and various hydraulic parameters using two methods:
    - standard RTD theory (textbooks by Fogler, Levenspiel etc.)
    - modified RTD theory for non-steady flow systems (Werner and Kadled, 1996)
- make various plots of the hydraulic output

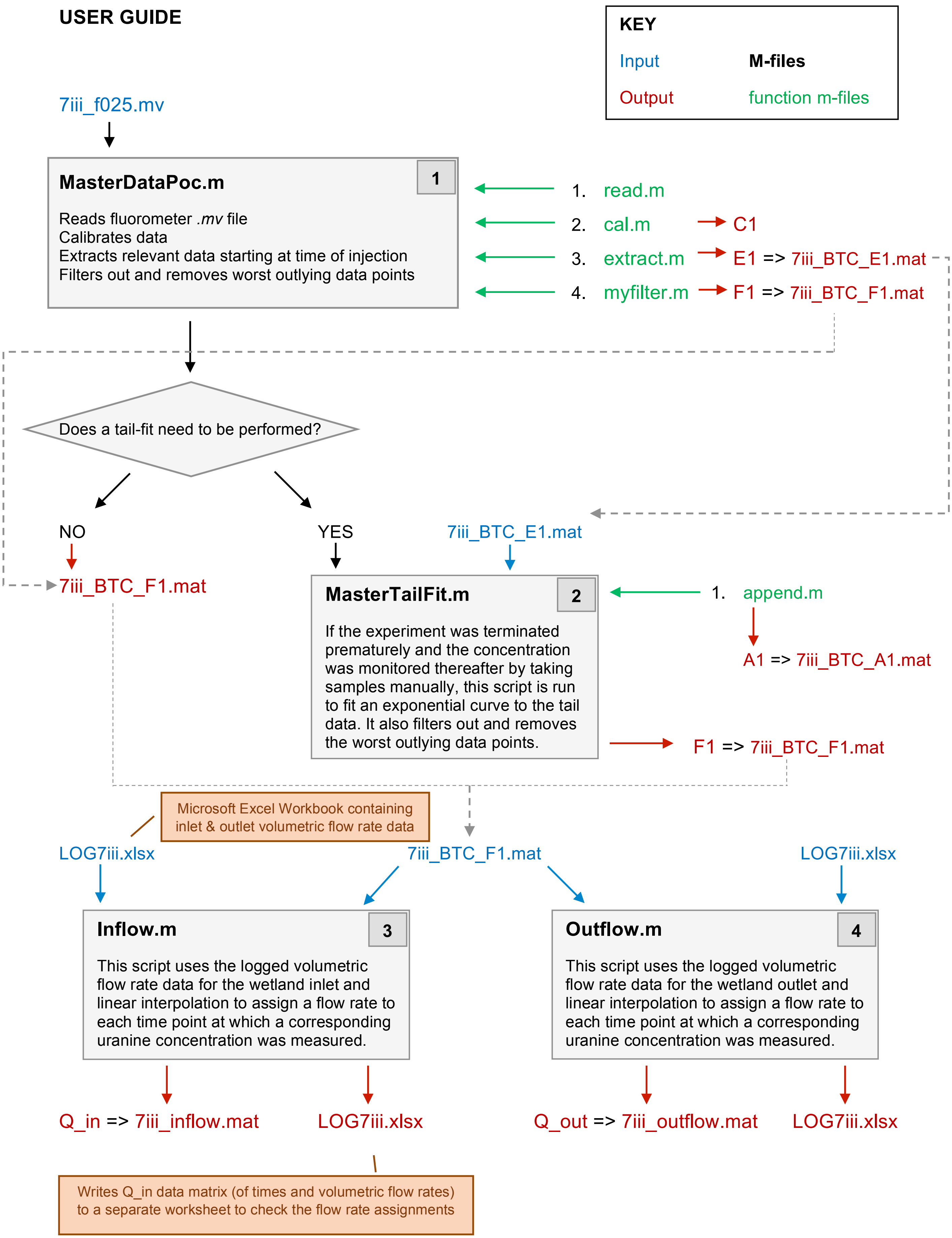
The following document details the content and order of execution of the various scripts (.m files and supporting function .m files)

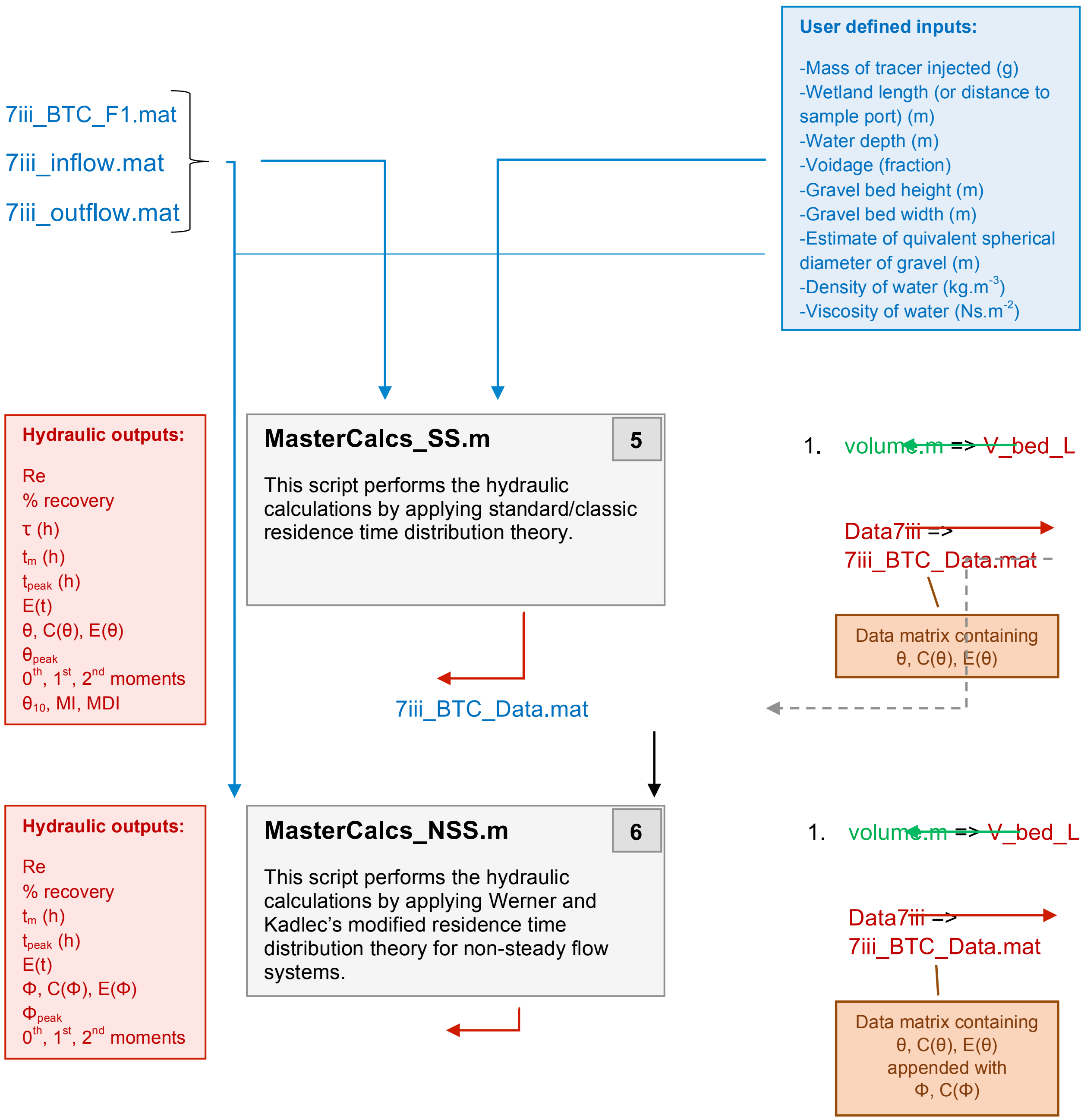
NOMENCLATURE

The following section summarizes the naming conventions, content and main function of the files provided as examples:

File Name	File Name Description	Explanation of content and function

USER GUIDE


KEY
Input
M-files
Output
function m-files
7iii_f025.mv
MasterDataPoc.m
1
Reads fluorometer .mv file
Calibrates data
Extracts relevant data starting at time of injection
Filters out and removes worst outlying data points
1. read.m
2. cal.m
C1
3. extract.m
E1 => 7iii_BTC_E1.mat
4. myfilter.m
F1 => 7iii_BTC_F1.mat
Does a tail-fit need to be performed?
NO
YES
7iii_BTC_E1.mat
7iii_BTC_F1.mat
MasterTailFit.m
2
If the experiment was terminated prematurely and the concentration was monitored thereafter by taking samples manually, this script is run to fit an exponential curve to the tail data. It also filters out and removes the worst outlying data points.
1. append.m
A1 => 7iii_BTC_A1.mat
F1 => 7iii_BTC_F1.mat
Microsoft Excel Workbook containing inlet & outlet volumetric flow rate data
LOG7iii.xlsx
7iii_BTC_F1.mat
LOG7iii.xlsx
Inflow.m
3
This script uses the logged volumetric flow rate data for the wetland inlet and linear interpolation to assign a flow rate to each time point at which a corresponding uranine concentration was measured.
Outflow.m
4
This script uses the logged volumetric flow rate data for the wetland outlet and linear interpolation to assign a flow rate to each time point at which a corresponding uranine concentration was measured.
Q_in => 7iii_inflow.mat
LOG7iii.xlsx
Q_out => 7iii_outflow.mat
LOG7iii.xlsx
Writes Q_in data matrix (of times and volumetric flow rates) to a separate worksheet to check the flow rate assignments


7iii_BTC_F1.mat
7iii_inflow.mat
7iii_outflow.mat
User defined inputs:
-Mass of tracer injected (g)
-Wetland length (or distance to sample port) (m)
-Water depth (m)
-Voidage (fraction)
-Gravel bed height (m)
-Gravel bed width (m)
-Estimate of quivalent spherical diameter of gravel (m)
-Density of water (kg.m-3)
-Viscosity of water (Ns.m-2)
Hydraulic outputs:
Re
% recovery
τ (h)
tm (h)
tpeak (h)
E(t)
θ, C(θ), E(θ)
θpeak
0th, 1st, 2nd moments
θ10, MI, MDI
MasterCalcs_SS.m
5
This script performs the hydraulic calculations by applying standard/classic residence time distribution theory.
1. volume.m => V_bed_L
Data7iii =>
7iii_BTC_Data.mat
Data matrix containing θ, C(θ), E(θ)
7iii_BTC_Data.mat
Hydraulic outputs:
Re
% recovery
tm (h)
tpeak (h)
E(t)
Φ, C(Φ), E(Φ)
Φpeak
0th, 1st, 2nd moments
MasterCalcs_NSS.m
6
This script performs the hydraulic calculations by applying Werner and Kadlec's modified residence time distribution theory for non-steady flow systems.
1. volume.m => V_bed_L
Data7iii =>
7iii_BTC_Data.mat
Data matrix containing θ, C(θ), E(θ) appended with Φ, C(Φ)