**General Unit Hydrograph Model for River-tide Dynamics V1.0**

**Matlab Toolbox Tutorial**

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A General unit hydrograph model Matlab toolbox for water level and tidal range distributions in the Modaomen Estuary, China.

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How to use General Unit Hydrograph Model for River-tide Dynamics

**1. Download and install General Unit Hydrograph Model for River-tide Dynamics Matlab toolbox**

**Users can download the latest General Unit Hydrograph Model for River-tide Dynamics Matlab toolbox from Github:**

**https://github.com/Huayangcai/General-Unit-Hydrograph-Model-for-River-tide-Dynamics-V1.0-Matlab-Toolbox.git**

**2. General Unit Hydrograph Model for River-tide Dynamics Demo**

**2.1. Reproducing the water level and tidal range distributions**

First of all, you need to load the data provided by General Unit Hydrograph for River-tide Dynamics Matlab Toolbox (such as `Data\_Modaomen.mat`). The demo can be executed **using the main program labelled by `Example\_GUH\_Modaomen.m`.**

**The data file ‘Data\_Modaomen.mat’ contains 3 variables, including `stname`, `z` and `h`.**

`stname` denotes the name of gauging stations, including 6 columns (e.g., SZ, DLS, ZY, JM, GZ and MK, respectively).

For instance:

`SZ`

`DLS`

`JM`

`ZY`

`GZ`

`MK`

`z` and `h` denote monthly water level and tidal range data, respectively. The data between the 1st and the 6th column denote the water level and tidal range series observed in the stations mentioned above. For instance, there are 6 columns of water levels and tidal ranges in this variable, the 1st column represents the data in SZ, while the 6th column represents the data in MK.

**The syntax of the main subroutine is illustrated below:**

**[X,yy,yy\_gradient,Xdata2,yy2,yy2\_gradient,X1,X2,sigma]=f\_GUH\_waterlevel\_distributions(inputs);**

**or**

**[X,yy,yy\_gradient,Xdata2,yy2,yy2\_gradient,X1,X2,sigma]=f\_GUH\_tidalrange\_distributions(inputs);**

**Descriptions of the inputs:**

`inputs`: contains two columns, the first column is the distance, while the second column is the water level or tidal range at the six stations

**Descriptions of the outputs:**

`X`: linear regression coefficients for the GUH model, containing xp, mu and m

`yy`: the computed water levels and tidal ranges in the six stations

`yy\_gradient`: the computed water level and tidal range gradient in the six stations

`Xdata2`: used for reproducing water level and tidal range distributions along the channel, in this case, the channel length and interval is 150 km and 1 km, respectively

`yy2`: the computed water levels and tidal ranges along the channel axis

`yy2\_gradient`: the computed water level and tidal range along the channel axis

`X1`: the first inflection point

`X2`: the second inflection point

`sigma`: the deviation of the two inflection points to the xp

**The code is provided below for you to copy and execute. The instructions previously described are also included in the main program.**

clc,clear all

close all

%% data input

load Data\_Modaomen.mat

x=[0 21 40 75 96 144]; % distance

%% normalization of the dataset

Zmin=min(z(:,1));Zmax=max(z(:,end));

Zn=(z-Zmin)./(Zmax-Zmin);

Hmin=min(h(:,end));Hmax=max(h(:,1));

Hn=(h-Hmin)./(Hmax-Hmin);

%% Computation of water level distributions

for ii=1:length(Zn)

Xdata=x;

Ydata=Zn(ii,:);

inputs=[Xdata;Ydata]';

[X\_para\_z(ii,:),yy\_z(ii,:),yy\_gradient\_z(ii,:),...

Xdata2,yy2\_z(ii,:),yy2\_gradient\_z(ii,:),...

x1\_z(ii,:),x2\_z(ii,:),sigma\_z(ii,:)]=...

f\_GUH\_waterlevel\_distributions(inputs);

end

%% Computation of tidal range distributions

for ii=1:length(Hn)

Xdata=x;

Ydata=Hn(ii,:);

inputs=[Xdata;Ydata]';

[X\_para\_h(ii,:),yy\_h(ii,:),yy\_gradient\_h(ii,:),...

Xdata2,yy2\_h(ii,:),yy2\_gradient\_h(ii,:),...

x1\_h(ii,:),x2\_h(ii,:),sigma\_h(ii,:)]=...

f\_GUH\_tidalrange\_distributions(inputs);

end

%% reverse of the computed data

yy\_z=yy\_z\*(Zmax-Zmin)+Zmin;

yy\_h=yy\_h\*(Hmax-Hmin)+Hmin;

yy\_gradient\_z=yy\_gradient\_z\*(Zmax-Zmin)./1000; % convert the distance to meter

yy\_gradient\_h=yy\_gradient\_h\*(Hmax-Hmin)./1000;

yy2\_z=yy2\_z\*(Zmax-Zmin)+Zmin;

yy2\_h=yy2\_h\*(Hmax-Hmin)+Hmin;

yy2\_gradient\_z=yy2\_gradient\_z\*(Zmax-Zmin)./1000;

yy2\_gradient\_h=yy2\_gradient\_h\*(Hmax-Hmin)./1000;

%% Model Calibration

figure;

subplot 121

plot(z,yy\_z,'ob');hold on

plot([-0.5 4],[-0.5 4],'--k')

xlim([-0.5 4])

ylim([-0.5 4])

xlabel('Observed \itZ \rm(m)');

ylabel('Computed \itZ \rm(m)');

title('(a) Water level calibration')

subplot 122

h1=plot(h,yy\_h,'ob');hold on

h2=plot([0 1.3],[0 1.3],'--k')

xlim([0 1.3])

ylim([0 1.3])

xlabel('Observed \itH \rm(m)');

ylabel('Computed \itH \rm(m)');

title('(b) Tidal range calibration')

legend([h1(1) h2],'Observation','Best fitted','location','best')

%% Comparison between observations and computations

% figure for water level

figure;

for ii=1:length(Zn)

subplot (4,3,ii)

yyaxis left

set(gca,'Ycolor','b');

h1=plot(x,z(ii,:),'ob');hold on

h2=plot(Xdata2,yy2\_z(ii,:),'-b');hold on

if rem(ii,3)==1

ylabel('\itZ \rm(m)')

end

yyaxis right

set(gca,'Ycolor','r');

h3=plot(Xdata2,yy2\_gradient\_z(ii,:)\*10^5,'-r');hold on

if rem(ii,3)==0

ylabel('d\itZ\rm/d\itx \rm(10^{-5})')

end

if ii>9

xlabel('\itx \rm(m)')

end

title(['Case ' num2str(ii) ': Water level'])

end

legend([h1 h2 h3],'Observations','Best fitted','d\itZ\rm/d\itx','box','off','orientation','horizontal','Position',[0.58 0.66 0.2 0.6])

% figure for tidal range

figure;

for ii=1:length(Hn)

subplot (4,3,ii)

yyaxis left

set(gca,'Ycolor','b');

h1=plot(x,h(ii,:),'ob');hold on

h2=plot(Xdata2,yy2\_h(ii,:),'-b');hold on

if rem(ii,3)==1

ylabel('\itH \rm(m)')

end

yyaxis right

set(gca,'Ycolor','r');

h3=plot(Xdata2,yy2\_gradient\_h(ii,:)\*10^5,'-r');hold on

if rem(ii,3)==0

ylabel('d\itH\rm/d\itx \rm(10^{-5})')

end

if ii>9

xlabel('\itx \rm(m)')

end

title(['Case ' num2str(ii) ': Tidal range'])

end

legend([h1 h2 h3],'Observations','Best fitted','d\itH\rm/d\itx','box','off','orientation','horizontal','Position',[0.58 0.66 0.2 0.6])

The observations and the fitted curves derived from the GUH model for water level and tidal range distributions are presented in Figure 1 and Figure 2, respectively.



Figure 1 Water level distributions fitted by GUH model for the 12 cases in the example.



Figure 2 Tidal range distributions fitted by GUH model for the 12 cases in the example.

The model regression coefficients (*xp*, *μ* and *m*) for the 12 cases in the example are shown in Table 1.

Table 1 The regression coefficients of the model for the 12 cases in the example.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Cases | Water level | | | Tidal range | | |
| *xp* | *μ* | *m* | *xp* | *μ* | *m* |
| 1 | 19.86 | 1.62 | 96.49 | 0.90 | 0.15 | 17.88 |
| 2 | 40.11 | 1.96 | 59.35 | 14.66 | 2.14 | 14.26 |
| 3 | 57.97 | 2.84 | 31.63 | 14.26 | 2.08 | 11.30 |
| 4 | 29.56 | 2.86 | 54.78 | 3.21 | 1.29 | 31.41 |
| 5 | 75.90 | 3.16 | 9.27 | 5.56 | 1.27 | 14.46 |
| 6 | 52.42 | 3.46 | 21.93 | 0.48 | 0.14 | 21.71 |
| 7 | 79.20 | 3.45 | 5.77 | 0.26 | 0.13 | 29.34 |
| 8 | 85.91 | 3.18 | 3.80 | 2.05 | 1.70 | 40.05 |
| 9 | 89.33 | 2.49 | 0.05 | 0.57 | 1.08 | 87.33 |
| 10 | 22.48 | 0.73 | 21.80 | 4.68 | 4.67 | 99.87 |
| 11 | 39.37 | 1.87 | 29.81 | 1.12 | 0.62 | 47.27 |
| 12 | 48.79 | 1.89 | 52.09 | 0.81 | 0.12 | 13.82 |