Editable Distributed Hydrological Model

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Contents

The Document and the EDHM Package

The Document

This document is the use guide for EDHM and some other information about the hydrological models (**HM**) building.

EDHM

EDHM is a R package for hydrological models in order to simplify the models building, specially the distributed hydrological model. In the package contain many complete **MODEL** that can used directly, and many **MODULE** that can a new MODEL to building. All of the MODELs and MODULEs are build with matrix-arithmetic, that can good deal with the distributed situation. In the package there are many tools to calibrate the parameters or build a new MODEL or a new MODULE. The Package is only in GitHub published, for the first time use, please install the package EDHM and HMtools use the following code:

```
install.packages("devtools")
devtools::install_github("LuckyKanLei/HMtools")
devtools::install_github("LuckyKanLei/EDHM")
```

Chapter 1

Basic Concept

1.1 Hydrological Cycle

Process

1.2 Important Concept of EDHM

Process

Method

Module

Model

Run_Model

Evaluate

Calibrate

1.3 Data and Parameter

1.3.1 Variable naming

1.3.2 Data Structure

1.3.3 Data or Parameter

Chapter 2

Model Use and Develop

Choose a Model

virtue: convenience

shortage: poor adaptability

2.1 Model Structure or Concept

Design a Model

2.2 Use Model with a MODEL or Run_MODEL

2.2.1 Check the InData list

2.2.2 Data Preparation

2.2.3 Evaluate

2.2.4 Calibrate

2.3 Copuling a new Model with MODULE

2.3.1 Choose MODULE

2.3.2 Set the Data-FLow

2.3.3 Build the MODEL and Run_MODEL

2.4 Design a new MODULE

2.4.1 Method and Formula

2.4.2 Coding the Inhalt

2.4.3 Set In/OutData and Parameter

Here is a review of existing methods.

Chapter 3

Modules

3.1 ReferenceET

3.1.1 ReferenceET.Hargreaves

\begin{table}[!h]

\caption{(#tab:t_In_ReferenceET.Hargreaves)InData}

Group	Variable	Unit	Description
MetData	TAir	Cel	Average Air temperature in Timestep
	TMax	Cel	Maximal Air temperature in one day
	TMin	Cel	Minimul Air temperature in one day
GeoData	Latitude	deg	Latitude
TimeData	NDay	-	Day nummer in one year

\end{table}

\begin{table}[!h]

\caption{(#tab:t_P_ReferenceET.Hargreaves)Param}

Paramter	Min	Max
PeriodN	0	0
GridN	0	0

\end{table}

\begin{table}[!h]

\caption{(#tab:t_Out_ReferenceET.Hargreaves)OutData}

Group	Variable	Unit	Description
Evatrans	RET	mm	Reference evapotranspiration

\end{table}

3.1.2 ReferenceET.Linacre

\begin{table}[!h]

\caption{(#tab:t_In_ReferenceET.Linacre)InData}

Group	Variable	Unit	Description
MetData	TAir	Cel	Average Air temperature in Timestep
	Actual_vapor_press	mPa	Actual vapor press
GeoData	Latitude	deg	Latitude
	Elevation	m	Elevation
TimeData	NDay	-	Day nummer in one year

\end{table}

\begin{table}[!h]

\caption{(#tab:t_P_ReferenceET.Linacre)Param}

Paramter	Min	Max
PeriodN	0	0
GridN	0	0

\end{table}

\begin{table}[!h]

\caption{(#tab:t_Out_ReferenceET.Linacre)OutData}

Group	Variable	Unit	Description
Evatrans	RET	mm	Reference evapotranspiration

\end{table}

3.1.3 ReferenceET.PenMon

\begin{table}[!h]

\caption{(#tab:t_In_ReferenceET.PenMon)InData}

Group	Variable	Unit	Description
MetData	TAir	Cel	Average Air temperature in Timestep
	TMax	Cel	Maximal Air temperature in one day
	TMin	Cel	Minimul Air temperature in one day
	RelativeHumidity	%	Relative Humidity, not greater than 100
	WindSpeed	m/s	Average Wind Speed
	WindH	m	The hight to mess the WindSpeed
	SunHour	h	Sunshine duration in one day
GeoData	Latitude	deg	Latitude
	Elevation	m	Elevation
TimeData	NDay	-	Day nummer in one year

\end{table}

\begin{table}[!h]

\caption{(#tab:t_P_ReferenceET.PenMon)Param}

Paramter	Min	Max
PeriodN	0	0
GridN	0	0

\end{table}

\begin{table}[!h]

\caption{(#tab:t_Out_ReferenceET.PenMon)OutData}

Group	Variable	Unit	Description
Evatrans	RET	mm	Reference evapotranspiration

\end{table}

3.2 ActualET

3.2.1 ActualET.Gr4j

\begin{table}[!h]

\caption{(#tab:t_In_ActualET.Gr4j)InData}

Group	Variable	Unit	Description
Evatrans	RET	mm	Reference evapotranspiration
Ground	MoistureVolume	mm	Moisture volume
Prec	Precipitation	mm	Precipitation, summe of rain and snow

\end{table}

\begin{table}[!h]

\caption{(#tab:t_P_ActualET.Gr4j)Param}

Paramter	Min	Max
Gr4j_X1	0	0

\end{table}

\begin{table}[!h]

\caption{(#tab:t_Out_ActualET.Gr4j)OutData}

Group	Variable	Unit	Description
Evatrans	AET	mm	Actual evapotranspiration
Prec	Precipitation	mm	Precipitation, summe of rain and snow

\end{table}

3.2.2 ActualET.Vic

\begin{table}[!h]

\caption{(#tab:t_In_ActualET.Vic)InData}

Group	Variable	Unit	Description
Aerodyna	AerodynaResist	s/m	Aerodyna Resist
	ArchitecturalResist	s/m	Architectural Resist
	StomatalResist	s/m	Stomatal Resist
Canopy	StorageCapacity	mm	Canopy Storage Capacity for Intercept and Evaporation f
Evatrans	RET	mm	Reference evapotranspiration
Ground	MoistureVolume	mm	Moisture volume
	MoistureCapacityMax	mm	Maximal Moisture Capacity
Intercept	Interception	mm	Interception in Canopy
Prec	Precipitation	mm	Precipitation, summe of rain and snow

\end{table}

\begin{table}[!h]

\caption{(#tab:t_P_ActualET.Vic)Param}

Paramter	Min	Max
SoilMoistureCapacityB	0	0

\end{table}

\begin{table}[!h]

\caption{(#tab:t_Out_ActualET.Vic)OutData}

Group	Variable	Unit	Description
Evatrans	EvaporationCanopy	mm	Evaporation from Canopy
	Transpiration	mm	Transpiration (water from Root layer of vegetation)
	EvaporationLand	mm	Evaporation from Landsurface (sometimes cotain the Evaporation from

\end{table}

3.3 SNOW

3.3.1 SNOW.17

\begin{table}[!h]

\caption{(#tab:t_In_SNOW.17)InData}

Group	Variable	Unit	Description
MetData	TAir	Cel	Average Air temperature in Timestep
Snow	Ice_Volume	mm	Soild Ice Volume, not depth
	Liquid_Volume	mm	Liquid Volume
	SN17_ATI	-	-
	SN17_HD	mm	-
Prec	SnowFall	mm	Snow
	RainFall	mm	Rain
GeoData	Elevation	m	Elevation
TimeData	NDay	-	Day nummer in one year

\end{table}

\begin{table}[!h]

\caption{(#tab:t_P_SNOW.17)Param}

Paramter	Min	Max
SN17_SCF	0	0
SN17_MFMAX	0	0
SN17_MFMIN	0	0
SN17_UADJ	0	0
SN17_NMF	0	0
SN17_TIPM	0	0
SN17_PXTEMP	0	0
SN17_MBASE	0	0
SN17_PLWHC	0	0
SN17_DAYGM	0	0
TimeStepSec	0	0

\end{table}

\begin{table}[!h]

\caption{(#tab:t_Out_SNOW.17)OutData}

Group	Variable	Unit	Description
Snow	Ice_Volume	mm	Soild Ice Volume, not depth
	Liquid_Volume	mm	Liquid Volume
	SN17_ATI	-	-
	SN17_HD	mm	-
Prec	Precipitation	mm	Precipitation, summe of rain and snow

\end{table}

3.3.2 SNOW.Ddf

\begin{table}[!h]

\caption{(#tab:t_In_SNOW.Ddf)InData}

Group	Variable	Unit	Description
Ground	MoistureVolume	mm	Moisture volume
Snow	Volume	mm	Summe Volume of Ice and liquid water, not depth
Prec	SnowFall	mm	Snow
	RainFall	mm	Rain

\end{table}

\begin{table}[!h]

\caption{(#tab:t_P_SNOW.Ddf)Param}

Paramter	Min	Max
Factor_Day_degree	0	0

\end{table}

\begin{table}[!h]

\caption{(#tab:t_Out_SNOW.Ddf)OutData}

Group	Variable	Unit	Description
Snow	Volume	mm	Summe Volume of Ice and liquid water, not depth
Prec	Precipitation	mm	Precipitation, summe of rain and snow

\end{table}

3.4 BASEFLOW

3.4.1 BASEFLOW.ARNO

\begin{table}[!h]

\caption{(#tab:t_In_BASEFLOW.ARNO)InData}

Group	Variable	Unit	Description
Ground	MoistureVolume	mm	Moisture volume
	MoistureCapacityMax	mm	Maximal Moisture Capacity

\end{table}

\begin{table}[!h]

\caption{(#tab:t_P_BASEFLOW.ARNO)Param}

Paramter	Min	Max
ExponentARNOBase	0	0
ARNOBaseThresholdRadio	0	0
DrainageLossMax	0	0
DrainageLossMin	0	0

\end{table}

\begin{table}[!h]

\caption{(#tab:t_Out_BASEFLOW.ARNO)OutData}

Group	Variable	Unit	Description
Ground	BaseFlow	mm	Base Flow

\end{table}

3.5 INTERCEPTION

3.5.1 INTERCEPTION.Gash

\begin{table}[!h]

\caption{(#tab:t_In_INTERCEPTION.Gash)InData}

Group	Variable	Unit	Description
Canopy	StorageCapacity	mm	Canopy Storage Capacity for Intercept and Evaporation from Canopy
Evatrans	EvaporationCanopy	mm	Evaporation from Canopy
Intercept	Interception	mm	Interception in Canopy
Prec	Precipitation	mm	Precipitation, summe of rain and snow

\end{table}

\begin{table}[!h]

\caption{(#tab:t_P_INTERCEPTION.Gash)Param}

Paramter	Min	Max
CoefficientFreeThroughfall	0	0

\end{table}

\begin{table}[!h]

\caption{(#tab:t_Out_INTERCEPTION.Gash)OutData}

Group	Variable	Unit	Description
Intercept	Interception	mm	Interception in Canopy
Prec	Precipitation	mm	Precipitation, summe of rain and snow

\end{table}

3.6 InfiltratRat

3.6.1 InfiltratRat.GreenAmpt

\begin{table}[!h]

\caption{(#tab:t_In_InfiltratRat.GreenAmpt)InData}

Group	Variable	Unit	Description
Ground	MoistureVolume	mm	Moisture volume
	Depth	mm	Ground Depth
SoilData	Conductivity	m/s	Soil actual Conductivity
	WettingFrontSuction	m/s	Wetting Front Suction
	Porosity	100%	Soil Porosity, not greater than 1

\end{table}

\begin{table}[!h]

\caption{(#tab:t_P_InfiltratRat.GreenAmpt)Param}

Paramter	Min	Max
GridN	1	9999

\end{table}

\begin{table}[!h]

\caption{(#tab:t_Out_InfiltratRat.GreenAmpt)OutData}

Group	Variable	Unit	Description
Infilt	InfiltrationRat	mm	Infiltration Rate (for some INFITRATION Module)

\end{table}

3.7 Infiltration

3.7.1 Infiltration.OIER

\begin{table}[!h]

\caption{(#tab:t_In_Infiltration.OIER)InData}

Group	Variable	Unit	Description
Infilt	InfiltrationRat	mm	Infiltration Rate (for some INFITRATION Module)
Prec	Precipitation	mm	Precipitation, summe of rain and snow

\end{table}

\begin{table}[!h]

\caption{(#tab:t_P_Infiltration.OIER)Param}

Paramter	Min	Max
InfiltrationRateB	0	0

\end{table}

\begin{table}[!h]

\caption{(#tab:t_Out_Infiltration.OIER)OutData}

Group	Variable	Unit	Description
Infilt	Infiltration	mm	Infiltration

\end{table}

3.7.2 Infiltration.SER

\begin{table}[!h]

\caption{(#tab:t_In_Infiltration.SER)InData}

Group	Variable	Unit	Description
Ground	MoistureCapacityMax	mm	Maximal Moisture Capacity
	MoistureCapacity	mm	Moisture Capacity
Prec	Precipitation	mm	Precipitation, summe of rain and snow

\end{table}

\begin{table}[!h]

\caption{(#tab:t_P_Infiltration.SER)Param}

Paramter	Min	Max
SoilMoistureCapacityB	0	0

\end{table}

\begin{table}[!h]

\caption{(#tab:t_Out_Infiltration.SER)OutData}

Group	Variable	Unit	Description
Infilt	Infiltration	mm	Infiltration

\end{table}

3.8 RUNOFF

3.8.1 RUNOFF.Gr4j

\begin{table}[!h]

\caption{(#tab:t_In_RUNOFF.Gr4j)InData}

Group	Variable	Unit	Description
Ground	MoistureVolume	mm	Moisture volume
Evatrans	AET	mm	Actual evapotranspiration
Prec	Precipitation	mm	Precipitation, summe of rain and snow

\end{table}

\begin{table}[!h]

\caption{(#tab:t_P_RUNOFF.Gr4j)Param}

Paramter	Min	Max
Gr4j_X1	0	0

\end{table}

\begin{table}[!h]

\caption{(#tab:t_Out_RUNOFF.Gr4j)OutData}

Group	Variable	Unit	Description
Ground	Runoff	mm	Runoff, it will be more wert, when the Runoff is in different form divided
	MoistureVolume	mm	Moisture volume

\end{table}

3.8.2 RUNOFF.OIER

\begin{table}[!h]

\caption{(#tab:t_In_RUNOFF.OIER)InData}

Group	Variable	Unit	Description
Infilt	InfiltrationRateMax	mm	Maximal Infiltration Rate (for some INFITRATION Module)
Prec	Precipitation	mm	Precipitation, summe of rain and snow

\end{table}

\begin{table}[!h]

\caption{(#tab:t_P_RUNOFF.OIER)Param}

Paramter	Min	Max
InfiltrationRateB	0	0

\end{table}

\begin{table}[!h]

\caption{(#tab:t_Out_RUNOFF.OIER)OutData}

Group	Variable	Unit	Description
Ground	Runoff	mm	Runoff, it will be more wert, when the Runoff is in different form divided
Infilt	Infiltration	mm	Infiltration

\end{table}

3.8.3 RUNOFF.SER

\begin{table}[!h]

\caption{(#tab:t_In_RUNOFF.SER)InData}

Group	Variable	Unit	Description
Ground	MoistureCapacityMax	mm	Maximal Moisture Capacity
	MoistureVolume	mm	Moisture volume
Prec	Precipitation	mm	Precipitation, summe of rain and snow

\end{table}

\begin{table}[!h]

\caption{(#tab:t_P_RUNOFF.SER)Param}

Paramter	Min	Max
SoilMoistureCapacityB	0	0

\end{table}

\begin{table}[!h]

\caption{(#tab:t_Out_RUNOFF.SER)OutData}

Group	Variable	Unit	Description
Ground	Runoff	mm	Runoff, it will be more wert, when the Runoff is in different form divid
Infilt	Infiltration	mm	Infiltration

\end{table}

3.8.4 RUNOFF.Vic

\begin{table}[!h]

\caption{(#tab:t_In_RUNOFF.Vic)InData}

Group	Variable	Unit	Description
Ground	MoistureCapacityMax	mm	Maximal Moisture Capacity
	MoistureVolume	mm	Moisture volume
Infilt	InfiltrationRat	mm	Infiltration Rate (for some INFITRATION Module)
Prec	Precipitation	mm	Precipitation, summe of rain and snow

\end{table}

\begin{table}[!h]

\caption{(#tab:t_P_RUNOFF.Vic)Param}

Paramter	Min	Max
SoilMoistureCapacityB	0	0
InfiltrationRateB	0	0

\end{table}

\begin{table}[!h]

\caption{(#tab:t_Out_RUNOFF.Vic)OutData}

Group	Variable	Unit	Description
Ground	Runoff	mm	Runoff, it will be more wert, when the Runoff is in different form divided
Infilt	Infiltration	mm	Infiltration

\end{table}

3.8.5 RUNOFF.VM

\begin{table}[!h]

\caption{(#tab:t_In_RUNOFF.VM)InData}

Group	Variable	Unit	Description
Ground	MoistureCapacity	mm	Moisture Capacity
	MoistureCapacityMax	mm	Maximal Moisture Capacity
Infilt	InfiltrationRateMax	mm	Maximal Infiltration Rate (for some INFITRATION Module)
Prec	Precipitation	mm	Precipitation, summe of rain and snow

\end{table}

\begin{table}[!h]

\caption{(#tab:t_P_RUNOFF.VM)Param}

Paramter	Min	Max
SoilMoistureCapacityB	0	0
InfiltrationRateB	0	0

\end{table}

\begin{table}[!h]

\caption{(#tab:t_Out_RUNOFF.VM)OutData}

Group	Variable	Unit	Description
Ground	Runoff	mm	Runoff, it will be more wert, when the Runoff is in different form divided
Infilt	Infiltration	mm	Infiltration

\end{table}

3.9 GROUNDWATER

3.9.1 GROUNDWATER.Vic

\begin{table}[!h]

\caption{(#tab:t_In_GROUNDWATER.Vic)InData}

Group	Variable	Unit	Description
Ground	ZoneMoistureVolume	mm	Moisture volume, when the Ground is in more than one
	ZoneDepth	mm	Ground Depth, , when the Ground is in more than one L
	BaseFlow	mm	Base Flow
Infilt	Infiltration	mm	Infiltration
Intercept	Interception	mm	Interception in Canopy
SoilData	Porosity	100%	Soil Porosity, not greater than 1
	SaturatedConductivity	m/s	Soil Saturated Conductivity

\end{table}

\begin{table}[!h]

\caption{(#tab:t_P_GROUNDWATER.Vic)Param}

Paramter	Min	Max
GridN	1	9999

\end{table}

\begin{table}[!h]

\caption{(#tab:t_Out_GROUNDWATER.Vic)OutData}

Group	Variable	Unit	Description
Ground	Overflow	mm	Overflow, when the caculated water volume greater than Ca
	ZoneMoistureVolume	mm	Moisture volume, when the Ground is in more than one Lay

\end{table}

3.10 ROUTE

3.10.1 ROUTE.G2RES

\begin{table}[!h]

\caption{(#tab:t_In_ROUTE.G2RES)InData}

Group	Variable	Unit	Description
Route	WaterSource	mm	Water Source for Routing, sometimes the same Data with the Runoff
	UHAll	-	All the UH data for all of the Grids for Routr with IUH
	TypeGridID	-	The grids type for Routr with IUH
	TransAll	-	All of the transform Matrix for all of the Grids for Routr with IUH

\end{table}

\begin{table}[!h]

\caption{(#tab:t_P_ROUTE.G2RES)Param}

Paramter	Min	Max
Gr4j_X2	0	0
Gr4j_X3	0	0
Gr4j_X4	0	0
time_step_i	0	0

\end{table}

\begin{table}[!h]

\caption{(#tab:t_Out_ROUTE.G2RES)OutData}

Group	Variable	Unit	Description
Route	StaFlow	m3/s	Station Flow in the seted grid

\end{table}

3.10.2 ROUTE.Gr4j

\begin{table}[!h]

\caption{(#tab:t_In_ROUTE.Gr4j)InData}

Group	Variable	Unit	Description
Route	WaterSource	mm	Water Source for Routing, sometimes the same Data with the Runoff
	Store	mm	Store in the Route (for some Module)
	Gr4j_UH1	-	UH form 1 only for Module ROUTE.Gr4j, made by the function
	Gr4j_UH2	-	UH form 1 only for Module ROUTE.Gr4j

\end{table}

\begin{table}[!h]

\caption{(#tab:t_P_ROUTE.Gr4j)Param}

Paramter	Min	Max
Gr4j_X2	0	0
Gr4j_X3	0	0
Gr4j_X4	0	0
time_step_i	0	0

\end{table}

\begin{table}[!h]

\caption{(#tab:t_Out_ROUTE.Gr4j)OutData}

Group	Variable	Unit	Description
Route	StaFlow	m3/s	Station Flow in the seted grid
	Store	mm	Store in the Route (for some Module)

\end{table}

Chapter 4

Model

4.1 Classical VIC

4.2 GR4J

Chapter 5

Final Words

We have finished a nice book.