

SWAT

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Chapter 1

SWAT

An updated SWAT 2012 revision 670 code

Objectives

- Standard indentation and translation to Fortran 90 by using `findent`. See the `translate-fortran90.pl` perl script file (:heavy_check_mark:)
- Exhaustive use of the "implicit none" directive to detect bad variable usage (:heavy_check_mark:)
- Generate a GNU `Make` makefile and compile with GNU `GFortran`. See the `generate-makefile.pl` perl script file (:heavy_check_mark:)
- Remove non-used variables and format labels (:heavy_check_mark:)
- Detect and solve all uninitialized variables (:heavy_check_mark: :construction:, some proposed solutions could be incorrect)
- Remove unneeded variable initializations (:heavy_check_mark:) as:

```
j=0 ! this line is not necessary  
j=ihru
```
- Remove redundant code (:heavy_check_mark:)
- Exhaustive use of the "parameter" directive on constants (:heavy_check_mark:)
- Generate a detailed list of issues detected in the original code (:heavy_check_mark:, see at the end of this README)
- Remove obsolete commented code (:x:)
- Update variable descriptions in comments (:construction:, a lot of work)
- Standardize comments by using Doxygen style in order to generate documentation. See at `latex/refman.pdf` (:construction:, a lot of work)

Required tools

- `GFortran` (to compile the source code)
- `Make` (to build the executable file)
- `Perl` (optional: to execute the perl scripts to update the makefile or to translate original files to Fortran 90)
- `Findent` (optional: to translate original files to Fortran 90 with a standard indentation)
- `Doxygen` (optional: to generate a reference programming manual from source code)
- `TeX Live` or `MiKTeX` (optional: to generate a reference programming manual from source code)
- On Microsoft Windows systems you have to install `MSYS2` and the required utilities (`GFortran` and `Make`). You can follow detailed instructions in `install-unix`

Instructions to generate Fortran 90 style code from original code

In order to generate Fortran 90 style code with standard indentation from original code you have to type on a UNIX type terminal (you need `Perl` and `Findent`):

```
$ perl translate-fortran90.pl
```

Instructions to generate an initial GNU make Makefile

Type on the UNIX type terminal, when translated the original code to Fortran 90 style (you need `Perl`):

```
$ perl generate-makefile.pl
```

Instructions to generate an executable to test

Type on the UNIX type terminal (you need `GFortran` and `Make`)

- In UNIX type operative systems:

```
$ make
```

- In a `MSYS2` terminal in Microsoft Windows:

```
$ EXE=".exe" LDFLAGS="-static" make
```

- Cross-compiling a 32 bits Microsoft Windows executable in a UNIX type operative system:

```
$ prefix="i686-w64-mingw32-" EXE=".exe" LDFLAGS="-static" make
```

- Cross-compiling a 64 bits Microsoft Windows executable in a UNIX type operative system:

```
$ prefix="x86_64-w64-mingw32-" EXE=".exe" LDFLAGS="-static" make
```

Instructions to generate an optimized executable file

Type on the UNIX type terminal (you need **GFortran** and **Make**)

- In UNIX type operative systems:

```
$ CFLAGS="-march=native -fno" LDFLAGS="-fno" make strip
```

- In a **MSYS2** terminal in Microsoft Windows:

```
$ EXE=".exe" CFLAGS="-fno" LDFLAGS="-fno -static" make strip
```

- Cross-compiling a 32 bits Microsoft Windows executable in a UNIX type operative system:

```
$ prefix="i686-w64-mingw32-" EXE=".exe" CFLAGS="-fno" LDFLAGS="-fno -static" make strip
```

- Cross-compiling a 64 bits Microsoft Windows executable in a UNIX type operative system:

```
$ prefix="x86_64-w64-mingw32-" EXE=".exe" CFLAGS="-fno" LDFLAGS="-fno -static" make strip
```

Instructions to generate a reference programming manual from source code

Type on the UNIX type terminal (you need **Doxygen** and **TeX Live** or **MiKTeX**):

```
$ doxygen
```

```
$ cd latex
```

```
$ make
```

The reference programming manual file latex/refman.pdf is generated from source code in PDF format

Issues in the original source code

This is a list of possible issues detected in the original source code. These issues have been mostly detected by the **GFortran** compiler warnings. Some of them could not arise because the logic of the variables is not possible.

- In biofilm.f:

- "dcoef" is used but not initialized. dcoef=3 as in watqual.f? Then, I propose at beginning: `real*8, parameter :: dcoef = 3.`

- In bmp_ri_pond.f:

- "qseep" and "qet" could be used not initialized at lines 133 and 134. However the problem only arises for `nstep<1`

- In bmp_sand_filter.f:

- "sed_removed" at line 342 could be used not initialized if `sfstedstdev<=0`

- In bpm_sed_pond.f:

- `bmp_sed_pond` seems to be `bmp_sed_pond` at line 186

- In `bmp_wet_pond.f`:
 - `"hvol"` could be used not initialized in `"ext_dpth"` subroutine at line 267 in first bucle iteration
- In `clicon.f`:
 - `"tmxbsb"`, `"tmnbsb"`, `"rbsb"`, `"rstpbsb"`, `"rhdbbsb"`, `"rabsb"`, `"rmxbsb"`, `"daylbsb"`, `"fradbsb"` and `"u10bsb"` could be used not initialized at 186-207 lines
- In `conapply.f`:
 - `"k"` and `"kk"` could be used not initialized at 121-122 lines if `iday_pest(j) /= ipst_freq(j)` and `curyr > nyskip`
- In `confert.f`:
 - `"ifrt"` seems to be `"it"` at line 214
- In `curno.f`:
 - `"smxold"` could be used not initialized if `cn1(h) <= 1.e-6` and `curyr /= 0` at line 96
- In `drains.f`:
 - `"nlayer"` could be used not initialized at line 23. However, the problem only arises if it is not set in the previous bucle (`mlyr <= 1` or `sol_z(j1, j) <= 0`)
- In `etact.f`:
 - `"sev"` could be used not initialized at line 286 if `dep >= esd` and `ly == 2`
- In `filter.f`:
 - `"remove21"` seems to be `"remove2"` at line 316
- In `grass_wway.f`:
 - `"sf_depth"` and `"sf_sed"` could be used not initialized at lines 133 and 137 if `sf_area > 0` and `sf_area <= 1.e-6`
- In `hhnoqual.f`:
 - `"algon"` seems to be `"algcon"` at line 190
- In `hhwatqual.f`
 - `"orgnpin"` seems to be `"orgpin"` at line 278
 - `thour = 1.0` at line 377 overwrites previous `"thour"` calculation. It is wrong
- In `hmeas.f`:
 - `"rhdbbsb"` could be used not initialized at line 84
- In `killop.f`:
 - `"ff1"` and `"ff2"` are used but not initialized at lines 167 and 267. They are set in `harvkillop.f` file (lines 257-258). They have to be included in `modparm.f` to share `harvkillop.f` values? or they have to be redefined as in `harvkillop.f`?
- In `NCsed_leach.f90`:
 - `"perc_clyr"` could be used not initialized at line 221 if `sol_nly(j) < 2`
- In `nrain.f`:
 - `"no2pcp"` seems to be `"no3pcp"` at line 72
- In `pmeas.f`:

- "rbsb" could be used not initialized at line 143
- "flag" could be used not initialized if 'a==' at line 210
- "rainsb" could be used not initialized, however only if nstep<=0`
- In pminrl2.f:
 - at line 95 a comma is necessary between "base" and "vara"
 - "ssp" could be used not initialized at line 196 if $xx \leq 1.e-6$
- In pothole.f:
 - "solp_tileo" could be used not initialized at line 593 if $pot_vol(j) \leq 1.e-6$ or $potvol_tile \leq 1.e-6$
- In potholehr.f:
 - "potflow" seems to be "potflwo" at line 447
- In readatmodep.f:
 - momax=12*nbyr is defined at line 65 but not used. It has to be "mo_max"? but then, it overwrites the file read
- In readops.f:
 - year = 0. seems to be iyear = 0 at line 98
 - "mg13" seems to be "mgt13" at line 206
- In readpnd.f:
 - "vselsetlpnd" seems to be "velsetlpnd" at line 279
- In readru.f:
 - "tck" is used but not initialized at line 79
- In readsepticbz.f:
 - at line 135 4. e-8 seems to be 4.e-8
- In rewind_init.f:
 - "orig_tnylida" is used but not initialized at line 174
- In routels.f:
 - "dstor" is used but not initialized at line 134. It has to be calculated as in watbal.f? or as in the commented line 109?
 - "latqout" and "gwqout" could be used not initialized at lines 142-143
- In rtbact.f:
 - "netwtr" could be used not initialized at line 124, however only if nstep<1
- In rthpest.f:
 - thour=1.0 at line 183 overwrites previous "thour" calculation. It is wrong
 - "frsol" and "frsrb" could be used not initialized at lines 289-290 if $hrtwtr(ii) > 0.001$ and $hrtwtr(ii) / (idt*60) \leq 0.01$
- In rtpest.f:
 - tday=1.0 at line 180 overwrites previous "tday" calculation. It is wrong
- In sched_mgt.f:
 - < = seems to be <= at 202 line

- "husc" and "igrow" at lines 264-265 are used but not initialized. "husc" has to be `phu_op(iop, ihru)` has in `readmgt.f`? "igrow" has to be `igro(ihru)` has in `readmgt.f`?
- In `smeas.f`:
 - "rabsb" could be used not initialized at line 86
- In `sweep.f`:
 - "fr_curb" is used but not initialized at line 56. It has to be added to `modparm.f` to share result with `sched_mgt.f`? or it has to be `mgt5op(nop(ihru), ihru)` as in `sched_mgt.f`?
- In `tmeas.f`:
 - "tmxbsb" and "tmnbsb" could be used not initialized at lines 109-110
- In `transfer.f`:
 - "ratio", "xx" and "ratio1" could be used not initialized at lines 236, 239 and 241 if `ihout==2`
- In `wmeas.f`:
 - "u10bsb" could be used not initialized at line 85
- In `zero0.f`:
 - "sol_sumn03" seems to be "sol_sumno3" at line 508
- In `zero_urban.f`:
 - "stp_stagdis" seems to be "dtp_stagdis" at line 84
 - "subdr_kg" seems to be "subdr_km" at line 149
 - "spl_eros" is not defined at line 21, it could be "eros_spl"?

Chapter 2

Modules Index

2.1 Modules List

Here is a list of all documented modules with brief descriptions:

parm	Main module contatining the global variables	13
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Chapter 3

Data Type Index

3.1 Data Types List

Here are the data types with brief descriptions:

parm::ascrv	65
parm::atri	65
parm::aunif	65
parm::dstn1	66
parm::ee	66
parm::expo	66
parm::fcgd	66
parm::HQDAV	67
parm::layersplit	67
parm::ndenit	67
parm::qman	67
parm::regres	68
parm::rsedaa	68
parm::tair	68
parm::theta	68
parm::vbl	68

Chapter 4

File Index

4.1 File List

Here is a list of all documented files with brief descriptions:

allocate_parms.f90	This subroutine allocates array sizes	69
ascrv.f90	This subroutine computes shape parameters x5 and x6 for the S curve equation	69
aunif.f90	This function generates random numbers ranging from 0.0 to 1.0	70
caps.f90	This subroutine reads the input and output names given in file.cio and converts all capital letters to lowercase letters	70
gcycl.f90	This subroutine initializes the random number seeds. If the user desires a different set of random numbers for each simulation run, the random number generator is used to reset the values of the seeds	71
getallo.f90	This subroutine calculates the number of HRUs, subbasins, etc. in the simulation. These values are used to allocate array sizes	71
main.f90	This is the main program that reads input, calls the main simulation model, and writes output . .	72
readbsn.f90	This subroutine reads data from the basin input file (.bsn). This file contains information related to processes modeled or defined at the watershed level	72
readfcst.f90	This subroutine reads the HRU forecast weather generator parameters from the .cst file	73
readfile.f90	This subroutine opens the main input and output files and reads watershed information from the file.cio	73
readwwq.f90	This subroutine reads the watershed stream water quality input data (.wwq file) and initializes the QUAL2E variables which apply to the entire watershed	73
simulate.f90	This subroutine contains the loops governing the modeling of processes in the watershed . . .	74

Chapter 5

Module Documentation

5.1 parm Module Reference

main module containing the global variables

Data Types

- interface [ascrv](#)
- interface [atri](#)
- interface [aunif](#)
- interface [dstn1](#)
- interface [ee](#)
- interface [expo](#)
- interface [fcgd](#)
- interface [HQDAV](#)
- interface [layersplit](#)
- interface [ndenit](#)
- interface [qman](#)
- interface [regres](#)
- interface [rsedaa](#)
- interface [tair](#)
- interface [theta](#)
- interface [vbl](#)

Variables

- integer, parameter [mvaro](#) = 33
max number of variables routed through the reach
- integer, parameter [mhruo](#) = 79
max number of variables in output.hru
- integer, parameter [mrcho](#) = 62
max number of variables in reach file
- integer, parameter [msub0](#) = 24
max number of variables in output.sub
- integer, parameter [mstdo](#) = 113

- max number of variables summarized in output.std*
- integer, parameter **motot** = 600
- integer **icalen**
- real *8 **prf_bsn**
 - Basinwide peak rate adjustment factor for sediment routing in the channel. Allows impact of peak flow rate on sediment routing and channel reshaping to be taken into account.*
- real *8 **co2_x2**
- real *8 **co2_x**
- real *8, dimension(:), allocatable **alph_e**
- real *8, dimension(:), allocatable **cdn**
 - denitrification exponential rate coefficient*
- real *8, dimension(:), allocatable **nperco**
 - nitrate percolation coefficient (0-1)*
 - 0:concentration of nitrate in surface runoff is zero*
 - 1:percolate has same concentration of nitrate as surface runoff*
- real *8, dimension(:), allocatable **surlag**
 - Surface runoff lag time. This parameter is needed in subbasins where the time of concentration is greater than 1 day. SURLAG is used to create a "storage" for surface runoff to allow the runoff to take longer than 1 day to reach the subbasin outlet (days)*
- real *8, dimension(:), allocatable **co_p**
- real *8, dimension(:), allocatable **cmn**
 - rate factor for humus mineralization on active organic N*
- real *8, dimension(:), allocatable **phoskd**
 - Phosphorus soil partitioning coefficient. Ratio of soluble phosphorus in surface layer to soluble phosphorus in runoff.*
- real *8, dimension(:), allocatable **psp**
 - Phosphorus availability index. The fraction of fertilizer P remaining in labile pool after initial rapid phase of P sorption.*
- real *8, dimension(:), allocatable **sdnco**
 - denitrification threshold: fraction of field capacity triggering denitrification*
- real *8 **r2adj_bsn**
 - basinwide retention parameter adjustment factor (greater than 1)*
- real *8 **yield**
- real *8 **burn_frlb**
- real *8 **pst_kg**
- real *8 **yieldgrn**
- real *8 **yieldbms**
- real *8 **yieldtbr**
- real *8 **yieldn**
- real *8 **yieldp**
- real *8 **hi_bms**
- real *8 **hi_rsd**
- real *8 **yieldrsd**
- real *8, dimension(:), allocatable **I_k1**
- real *8, dimension(:), allocatable **I_k2**
- real *8, dimension(:), allocatable **I_lambda**
- real *8, dimension(:), allocatable **I_beta**
- real *8, dimension(:), allocatable **I_gama**
- real *8, dimension(:), allocatable **I_harea**
- real *8, dimension(:), allocatable **I_vleng**
- real *8, dimension(:), allocatable **I_vslope**
- real *8, dimension(:), allocatable **I_ktc**
- real *8, dimension(:), allocatable **biofilm_mumax**
- real *8, dimension(:), allocatable **biofilm_kinv**
- real *8, dimension(:), allocatable **biofilm_klw**
- real *8, dimension(:), allocatable **biofilm_kla**

- real *8, dimension(:), allocatable **biofilm_cdet**
- real *8, dimension(:), allocatable **biofilm_bm**
- real *8, dimension(:,:), allocatable **hru_rufr**
- real *8, dimension(:,:), allocatable **daru_km**
- real *8, dimension(:,:), allocatable **ru_k**
- real *8, dimension(:,:), allocatable **ru_c**
- real *8, dimension(:,:), allocatable **ru_eiq**
- real *8, dimension(:,:), allocatable **ru_ovsl**
- real *8, dimension(:,:), allocatable **ru_a**
- real *8, dimension(:,:), allocatable **ru_ovs**
- real *8, dimension(:,:), allocatable **ru_ktc**
- real *8, dimension(:), allocatable **gwq_ru**
- real *8, dimension(:), allocatable **qdayout**
- integer, dimension(:), allocatable **ils2**
- integer, dimension(:), allocatable **ils2flag**
- integer **iru**
- integer **mru**
- integer **irch**
- integer **isub**
- integer **idum**
- integer **mhyd_bsn**
- integer **ipest**
- integer **ils_nofig**
- integer **mhru1**
- integer, dimension(:), allocatable **mhyd1**
- integer, dimension(:), allocatable **irtun**
- real *8 **wshd_sepno3**
- real *8 **wshd_sepnh3**
- real *8 **wshd_seporgn**
- real *8 **wshd_sepfon**
- real *8 **wshd_seporgp**
- real *8 **wshd_sepfop**
- real *8 **wshd_sepsolp**
- real *8 **wshd_sepbod**
- real *8 **wshd_sepmm**
- integer, dimension(:), allocatable **isep_hru**
- real *8 **fixco**
nitrogen fixation coefficient
- real *8 **nfixmx**
maximum daily n-fixation (kg/ha)
- real *8 **res_stlr_co**
reservoir sediment settling coefficient
- real *8 **rsd_covco**
residue cover factor for computing frac of cover
- real *8 **vcrit**
critical velocity
- real *8 **wshd_sw**
- real *8 **wshd_snob**
- real *8 **wshd_pndfr**
- real *8 **wshd_pndv**
- real *8 **wshd_pndsed**
- real *8 **percop**

pesticide percolation coefficient (0-1)

0: concentration of pesticide in surface runoff is zero

1: percolate has same concentration of pesticide as surface runoff

- real *8 **wshd_wetfr**
- real *8 **wshd_resfr**
- real *8 **wshd_resha**
- real *8 **wshd_pndha**
- real *8 **wshd_fminp**
- real *8 **wshd_ftotn**
- real *8 **wshd_fnh3**
- real *8 **wshd_fno3**
- real *8 **wshd_forgn**
- real *8 **wshd_forgp**
- real *8 **wshd_ftotp**
- real *8 **wshd_yldn**
- real *8 **wshd_yldp**
- real *8 **wshd_fixn**
- real *8 **wshd_pup**
- real *8 **wshd_wstrs**
- real *8 **wshd_nstrs**
- real *8 **wshd_pstrs**
- real *8 **wshd_tstrs**
- real *8 **wshd_astrs**
- real *8 **ffcb**

initial soil water content expressed as a fraction of field capacity

- real *8 **wshd_hmn**
- real *8 **wshd_rwn**
- real *8 **wshd_hmp**
- real *8 **wshd_rmn**
- real *8 **wshd_dnit**
- real *8 **wdpq**

die-off factor for persistent bacteria in soil solution (1/day)

- real *8 **wshd_rmp**
- real *8 **wshd_voln**
- real *8 **wshd_nitn**
- real *8 **wshd_pas**
- real *8 **wshd_pal**
- real *8 **wof_p**

wash off fraction for persistent bacteria on foliage during a rainfall event

- real *8 **wshd_plch**
- real *8 **wshd_raino3**
- real *8 **ressedc**
- real *8 **basno3f**
- real *8 **basorgnf**
- real *8 **wshd_pinlet**
- real *8 **wshd_ptile**
- real *8 **sftmp**

Snowfall temperature (deg C)

- real *8 **smfmn**

Minimum melt rate for snow during year (Dec. 21) where deg C refers to the air temperature. (mm/deg C/day)

- real *8 **smfmx**

Maximum melt rate for snow during year (June 21) where deg C refers to the air temperature. SMFMX and SM↔FMN allow the rate of snow melt to vary through the year. These parameters are accounting for the impact of soil temperature on snow melt. (mm/deg C/day)

- real *8 **smtmp**
Snow melt base temperature. Mean air temperature at which snow melt will occur. (deg C)
- real *8 **wgppq**
growth factor for persistent bacteria in soil solution (1/day)
- real *8 **basminpf**
- real *8 **basorgpf**
- real *8 **wdlpq**
die-off factor for less persistent bacteria in soil solution (1/day)
- real *8 **wshd_resv**
- real *8 **wshd_ressed**
- real *8 **basno3i**
- real *8 **basorgni**
- real *8 **basminpi**
- real *8 **wdps**
die-off factor for persistent bacteria adsorbed to soil particles (1/day)
- real *8 **wglpq**
growth factor for less persistent bacteria in soil solution (1/day)
- real *8 **basorgpi**
- real *8 **peakr**
- real *8 **pndsedin**
- real *8 **sw_excess**
- real *8 **albdays**
- real *8 **timp**
*Snow pack temperature lag factor (0-1)
1 = no lag (snow pack temp=current day air temp) as the lag factor goes to zero, the snow pack's temperature will be less influenced by the current day's air temperature.*
- real *8 **wtabelo**
- real *8 **tilep**
- real *8 **wt_shall**
- real *8 **sq_rto**
- real *8 **tloss**
- real *8 **inflpcp**
- real *8 **snomlt**
- real *8 **snofall**
- real *8 **fixn**
- real *8 **qtile**
- real *8 **crk**
- real *8 **latlyr**
- real *8 **pndloss**
- real *8 **wetloss**
- real *8 **potloss**
- real *8 **lpndloss**
- real *8 **lwetloss**
- real *8 **sedrch**
- real *8 **fertn**
- real *8 **sol_rd**
- real *8 **cfertn**
- real *8 **cfertp**
- real *8 **sepcrday**
- real *8 **bioday**
- real *8 **sepcrk**
- real *8 **sepcrktot**
- real *8 **fertno3**
- real *8 **ferth3**

- real *8 **fertorgn**
- real *8 **fertsolp**
- real *8 **fertorgp**
- real *8 **wgps**
 - growth factor for persistent bacteria adsorbed to soil particles (1/day)*
- real *8 **fertp**
- real *8 **grazn**
- real *8 **grazp**
- real *8 **soxy**
- real *8 **qdfr**
- real *8 **sdti**
- real *8 **rtwtr**
- real *8 **ressa**
- real *8 **wdlps**
 - die-off factor for less persistent bacteria absorbed to soil particles (1/day)*
- real *8 **wglps**
 - growth factor for less persistent bacteria adsorbed to soil particles (1/day)*
- real *8 **rttime**
- real *8 **rchdep**
- real *8 **rtevp**
- real *8 **rttlc**
- real *8 **da_km**
- real *8 **resflwi**
- real *8 **wdprch**
 - die-off factor for persistent bacteria in streams (1/day)*
- real *8 **resflwo**
- real *8 **respcp**
- real *8 **resev**
- real *8 **ressep**
- real *8 **ressedi**
- real *8 **ressedo**
- real *8 **dtot**
- real *8 **pperco_bsn**
 - phosphorus percolation coefficient. Ratio of soluble phosphorus in surface to soluble phosphorus in percolate*
- real *8 **nperco_bsn**
 - basin nitrate percolation coefficient (0-1)*
 - 0:concentration of nitrate in surface runoff is zero*
 - 1:percolate has same concentration of nitrate as surface runoff*
- real *8 **rsdco**
 - residue decomposition coefficient. The fraction of residue which will decompose in a day assuming optimal moisture, temperature, C:N ratio, and C:P ratio*
- real *8 **phoskd_bsn**
- real *8 **voltot**
- real *8 **msk_x**
 - weighting factor controlling relative importance of inflow rate and outflow rate in determining storage on reach*
- real *8 **volcrmin**
- real *8 **bactkdq**
 - bacteria soil partitioning coefficient. Ratio of solution bacteria in surface layer to solution bacteria in runoff soluble and sorbed phase in surface runoff.*
- real *8 **wdpf**
 - die-off factor for persistent bacteria on foliage (1/day)*
- real *8 **uno3d**
- real *8 **canev**
- real *8 **usle**

- real *8 **rcn**
- real *8 **surlag_bsn**
- real *8 **precipday**
- real *8 **thbact**
temperature adjustment factor for bacteria die-off/growth
- real *8 **wlpq20**
overall rate change for less persistent bacteria in soil solution (1/day)
- real *8 **wlps20**
overall rate change for less persistent bacteria adsorbed to soil particles (1/day)
- real *8 **wpq20**
overall rate change for persistent bacteria in soil solution (1/day)
- real *8 **wps20**
overall rate change for persistent bacteria adsorbed to soil particles (1/day)
- real *8 **bactrop**
- real *8 **bactsedp**
- real *8 **wgpf**
growth factor for persistent bacteria on foliage (1/day)
- real *8 **bactlchp**
- real *8 **bactlchlp**
- real *8 **enratio**
- real *8 **wetpcp**
- real *8 **pndpcp**
- real *8 **wetsep**
- real *8 **pndsep**
- real *8 **wetev**
- real *8 **pndev**
- real *8 **pndsedo**
- real *8 **wetsedo**
- real *8 **pndflwi**
- real *8 **wetflwi**
- real *8 **pndflwo**
- real *8 **wetflwo**
- real *8 **wetsedi**
- real *8 **da_ha**
- real *8 **vpd**
- real *8 **evlai**
leaf area index at which no evaporation occurs. This variable is used in ponded HRUs where evaporation from the water surface is restricted by the plant canopy cover. Evaporation from the water surface equals potential ET when LAI = 0 and decreased linearly to 0 when LAI = EVLAI
- real *8 **evrch**
Reach evaporation adjustment factor. Evaporation from the reach is multiplied by EVRCH. This variable was created to limit the evaporation predicted in arid regions.
- real *8 **wdlpf**
die-off factor for less persistent bacteria on foliage (1/day)
- real *8 **bactrolp**
- real *8 **bactsedlp**
- real *8 **pet_day**
- real *8 **ep_day**
- real *8 **adj_pkr**
peak rate adjustment factor in the subbasin. Used in the MUSLE equation to account for impact of peak flow on erosion.
- real *8 **n_updis**

nitrogen uptake distribution parameter. This parameter controls the amount of nitrogen removed from the different soil layer layers by the plant. In particular, this parameter allows the amount of nitrogen removed from the surface layer via plant uptake to be controlled. While the relationship between UBN and N removed from the surface layer is affected by the depth of the soil profile, in general, as UBN increases the amount of N removed from the surface layer relative to the amount removed from the entire profile increases

- real *8 **nactfr**

nitrogen active pool fraction. The fraction of organic nitrogen in the active pool.

- real *8 **p_updis**

phosphorus uptake distribution parameter This parameter controls the amount of phosphorus removed from the different soil layers by the plant. In particular, this parameter allows the amount of phosphorus removed from the surface layer via plant uptake to be controlled. While the relationship between UBP and P uptake from the surface layer is affected by the depth of the soil profile, in general, as UBP increases the amount of P removed from the surface layer relative to the amount removed from the entire profile increases

- real *8 **snoev**
- real *8 **sno3up**
- real *8 **reactw**
- real *8 **sdiegropq**
- real *8 **sdiegrolpq**
- real *8 **sdiegrops**
- real *8 **sdiegrolps**
- real *8 **es_day**
- real *8 **wof_lp**

wash off fraction for less persistent bacteria on foliage during a rainfall event

- real *8 **sbactrop**
- real *8 **sbactrolp**
- real *8 **sbactsedp**
- real *8 **sbactsedlp**
- real *8 **ep_max**
- real *8 **sbactlchp**
- real *8 **sbactlchlp**
- real *8 **psp_bsn**
- real *8 **rchwtr**
- real *8 **resuspst**
- real *8 **setlpst**
- real *8 **bsprev**
- real *8 **bssprev**
- real *8 **spadyo**
- real *8 **spadyev**
- real *8 **spadysp**
- real *8 **spadyrfv**
- real *8 **spadyosp**
- real *8 **qday**
- real *8 **usle_ei**
- real *8 **al5**
- real *8 **pndsedc**
- real *8 **no3pcp**
- real *8 **rcharea**
- real *8 **volatpst**
- real *8 **ubw**

water uptake distribution parameter. This parameter controls the amount of water removed from the different soil layers by the plant. In particular, this parameter allows the amount of water removed from the surface layer via plant uptake to be controlled. While the relationship between UBW and H2O removed from the surface layer is affected by the depth of the soil profile, in general, as UBW increases the amount of water removed from the surface layer relative to the amount removed from the entire profile increases

- real *8 **uobn**

- nitrogen uptake normalization parameter. This variable normalizes the nitrogen uptake so that the model can easily verify that uptake from the different soil layers sums to 1.0*
- real *8 **uobp**
phosphorus uptake normalization parameter. This variable normalizes the phosphorus uptake so that the model can easily verify that uptake from the different soil layers sums to 1.0
 - real *8 **uobw**
water uptake normalization parameter. This variable normalizes the water uptake so that the model can easily verify that uptake from the different soil layers sums to 1.0
 - real *8 **wglpf**
growth factor for less persistent bacteria on foliage (1/day)
 - real *8 **wetsedc**
 - real *8 **respesti**
 - real *8 **rcor**
correction coefficient for generated rainfall to ensure that the annual means for generated and observed values are comparable (needed only if IDIST=1)
 - real *8 **rexp**
value of exponent for mixed exponential rainfall distribution (needed only if IDIST=1)
 - real *8 **snocov1**
1st shape parameter for snow cover equation. This parameter is determined by solving the equation for 50% snow cover
 - real *8 **snocov2**
2nd shape parameter for snow cover equation. This parameter is determined by solving the equation for 95% snow cover
 - real *8 **snocovmx**
Minimum snow water content that corresponds to 100% snow cover. If the snow water content is less than SNOC \leftrightarrow OVMX, then a certain percentage of the ground will be bare (mm H₂O)
 - real *8 **lyrtile**
 - real *8 **lyrtilex**
 - real *8 **sno50cov**
Fraction of SNOC OVMX that corresponds to 50% snow cover. SWAT assumes a nonlinear relationship between snow water and snow cover.
 - real *8 **ai0**
ratio of chlorophyll-a to algal biomass (ug chla/mg alg)
 - real *8 **ai1**
fraction of algal biomass that is nitrogen (mg N/mg alg)
 - real *8 **ai2**
fraction of algal biomass that is phosphorus (mg P/mg alg)
 - real *8 **ai3**
the rate of oxygen production per unit of algal photosynthesis (mg O₂/mg alg)
 - real *8 **ai4**
the rate of oxygen uptake per unit of algae respiration (mg O₂/mg alg)
 - real *8 **ai5**
the rate of oxygen uptake per unit of NH₃ nitrogen oxidation (mg O₂/mg N)
 - real *8 **ai6**
the rate of oxygen uptake per unit of NO₂ nitrogen oxidation (mg O₂/mg N)
 - real *8 **rhoq**
algal respiration rate (1/day or 1/hr)
 - real *8 **tfact**
fraction of solar radiation computed in the temperature heat balance that is photosynthetically active
 - real *8 **k_l**
*half-saturation coefficient for light (MJ/(m²*hr))*
 - real *8 **k_n**
michaelis-menton half-saturation constant for nitrogen (mg N/L)

- real *8 **k_p**
michaelis-menton half saturation constant for phosphorus (mg P/L)
- real *8 **lambda0**
non-algal portion of the light extinction coefficient (1/m)
- real *8 **lambda1**
*linear algal self-shading coefficient (1/(m*ug chla/L))*
- real *8 **lambda2**
*nonlinear algal self-shading coefficient ((1/m)(ug chla/L)**(-2/3))*
- real *8 **mumax**
maximum specific algal growth rate (1/day or 1/hr)
- real *8 **p_n**
algal preference factor for ammonia
- real *8 **rnum1**
- real *8 **autop**
- real *8 **auton**
- real *8 **etday**
- real *8 **hmntl**
- real *8 **rwntl**
- real *8 **hmptl**
- real *8 **rmn2tl**
- real *8 **rmptl**
- real *8 **wdntl**
- real *8 **cmn_bsn**
- real *8 **rmp1tl**
- real *8 **roctl**
- real *8 **gwseep**
- real *8 **revapday**
- real *8 **reswtr**
- real *8 **wdlprch**
die-off factor for less persistent bacteria in streams (1/day)
- real *8 **wdpres**
die-off factor for persistent bacteria in reservoirs (1/day)
- real *8 **bury**
- real *8 **difus**
- real *8 **reactb**
- real *8 **solpesto**
- real *8 **petmeas**
- real *8 **wdlpres**
die-off factor for less persistent bacteria in reservoirs (1/day)
- real *8 **sorpesto**
- real *8 **spcon_bsn**
- real *8 **spexp_bsn**
- real *8 **solpesti**
- real *8 **sorpesti**
- real *8 **msk_co1**
calibration coefficient to control impact of the storage time constant for the reach at bankfull depth (phi(10,:)) upon the storage time constant for the reach used in the Muskingum flow method
- real *8 **msk_co2**
calibration coefficient to control impact of the storage time constant for the reach at 0.1 bankfull depth (phi(13,:)) upon the storage time constant for the reach used in the Muskingum flow method
- real *8 **snoprev**
- real *8 **swprev**
- real *8 **shallstp**

- real *8 **deepstp**
- real *8 **ressolpo**
- real *8 **resorgno**
- real *8 **resorgpo**
- real *8 **resno3o**
- real *8 **reschlao**
- real *8 **resno2o**
- real *8 **resnh3o**
- real *8 **qdbank**
- real *8 **potpcpmm**
- real *8 **potevmm**
- real *8 **potsepmmm**
- real *8 **potflwo**
- real *8 **bactminlp**
Threshold detection level for less persistent bacteria. When bacteria levels drop to this amount the model considers bacteria in the soil to be insignificant and sets the levels to zero (cfu/m²)
- real *8 **bactminp**
Threshold detection level for persistent bacteria. When bacteria levels drop to this amount the model considers bacteria in the soil to be insignificant and sets the levels to zero (cfu/m²)
- real *8 **trnsrch**
fraction of transmission losses from main channel that enter deep aquifer
- real *8 **wp20p_plt**
overall rate change for persistent bacteria on foliage (1/day)
- real *8 **potsedo**
- real *8 **pest_sol**
- real *8 **bact_swf**
fraction of manure containing active colony forming units (cfu)
- real *8 **bactmx**
bacteria percolation coefficient. Ratio of solution bacteria in surface layer to solution bacteria in percolate
- real *8 **cncoef**
plant ET curve number coefficient
- real *8 **wp20lp_plt**
overall rate change for less persistent bacteria on foliage (1/day)
- real *8 **cdn_bsn**
- real *8 **sdnco_bsn**
- real *8 **bactmin**
- real *8 **cn_froz**
drainage coefficient (mm day⁻¹)
- real *8 **dorm_hr**
time threshold used to define dormant (hours)
- real *8 **smxco**
adjustment factor for max curve number s factor (0-1)
- real *8 **tb_adj**
adjustment factor for subdaily unit hydrograph basetime
- real *8 **chla_subco**
regional adjustment on sub chla_a loading (fraction)
- real *8 **depimp_bsn**
depth to impervious layer. Used to model perched water tables in all HRUs in watershed (mm)
- real *8 **ddrain_bsn**
depth to the sub-surface drain (mm)
- real *8 **tdrain_bsn**
time to drain soil to field capacity (hours)

- real *8 **gdrain_bsn**
- real *8 **rch_san**
- real *8 **rch_sil**
- real *8 **rch_cla**
- real *8 **rch_sag**
- real *8 **rch_lag**
- real *8 **rch_gra**
- real *8 **hlife_ngw_bsn**
Half-life of nitrogen in groundwater? (days)
- real *8 **ch_opco_bsn**
- real *8 **ch_onco_bsn**
- real *8 **decr_min**
Minimum daily residue decay.
- real *8 **rcn_sub_bsn**
Concentration of nitrogen in the rainfall (mg/kg)
- real *8 **bc1_bsn**
- real *8 **bc2_bsn**
- real *8 **bc3_bsn**
- real *8 **bc4_bsn**
- real *8 **anion_excl_bsn**
- real *8, dimension(:), allocatable **wat_tbl**
- real *8, dimension(:), allocatable **sol_swpwt**
- real *8, dimension(:,:), allocatable **vwt**
- real *8 **re_bsn**
Effective radius of drains (range 3.0 - 40.0) (mm)
- real *8 **sdrain_bsn**
Distance bewtween two drain or tile tubes (range 7600.0 - 30000.0) (mm)
- real *8 **sstmaxd_bsn**
- real *8 **drain_co_bsn**
Drainage coeffcient (range 10.0 - 51.0) (mm-day-1)
- real *8 **latksatf_bsn**
Multiplication factor to determine lateral ksat from SWAT ksat input value for HRU (range 0.01 - 4.0)
- real *8 **pc_bsn**
Pump capacity (def val = 1.042 mm h-1 or 25 mm day-1) (mm h-1)
- integer **i_subhw**
- integer **imgt**
- integer **idlast**
- integer **iwtr**
- integer **ifrttyp**
- integer **mo_atmo**
- integer **mo_atmo1**
- integer **ifirstatmo**
- integer **iy_r_atmo**
- integer **iy_r_atmo1**
- integer **matmo**
- integer **mch**
maximum number of channels
- integer **mcr**
maximum number of crops grown per year
- integer **mcrdb**
max number of lu/lc defined in crop.dat
- integer **mfcast**
maximum number of forecast stations

- integer **mfdb**
max number of fertilizers in fert.dat
- integer **mhru**
maximum number of HRUs in watershed
- integer **mhyd**
maximum number of hydrograph nodes
- integer **mpdb**
max number of pesticides in pest.dat
- integer **mrq**
max number of rainfall/temp gages
- integer **mcut**
maximum number of cuttings per year
- integer **mgr**
maximum number of grazings per year
- integer **mnr**
max number of years of rotation
- integer **myr**
max number of years of simulation
- integer **isubwq**
subbasin water quality code
0 do not calculate algae/CBOD 1 calculate algae/CBOD drainmod tile equations
- integer **ffcst**
- integer **isproj**
special project code: 1 test rewind (run simulation twice)
- integer **nbyr**
number of calendar years simulated
- integer **irte**
water routing method:
0 variable storage method
1 Muskingum method

- integer **nhru**
- integer **mo**
- integer **immo**
- integer **nrch**
- integer **nres**
- integer **i_mo**
- integer **wndsim**
wind speed input code
1 measured data read for each subbasin
2 data simulated for each subbasin
- integer **icode**
- integer **ihout**
- integer **inum1**
- integer **inum2**
- integer **inum3**
- integer **inum4**
- integer **ihru**
- integer **icfac**
icfac = 0 for C-factor calculation using Cmin (as described in manual)
= 1 for new C-factor calculation from RUSLE (no minimum needed)
- integer **inum5**
- integer **inum6**

- integer **inum7**
- integer **inum8**
- integer **mrech**
maximum number of rehour files
- integer **nrgage**
number of raingage files
- integer **nrgfil**
number of rain gages per file
- integer **nrtot**
total number of rain gages
- integer **ntgage**
number of temperature gage files
- integer **ntgfil**
number of temperature gages per file
- integer **nttot**
total number of temperature gages
- integer **tmpsim**
temperature input code
1 measured data read for each subbasin
2 data simulated for each subbasin
- integer **icrk**
crack flow code
1: compute flow in cracks
- integer **irtpest**
number of pesticide to be routed through the watershed
- integer **igropt**
Qual2E option for calculating the local specific growth rate of algae
1: multiplicative.
- integer **lao**
Qual2E light averaging option. Qual2E defines four light averaging options. The only option currently available in SWAT is #2.
- integer **npmx**
- integer **curyr**
- integer **iihru**
- integer **itdrn**
tile drainage equations flag/code
1 simulate tile flow using subroutine drains(wt_shall)
0 simulate tile flow using subroutine origtile(wt_shall,d)
- integer **iwt dn**
water table depth algorithms flag/code
1 simulate wt_shall using subroutine new water table depth routine
0 simulate wt_shall using subroutine original water table depth routine
- integer **ismax**
maximum depressional storage selection flag/code
0 = static depressional storage
1 = dynamic storage based on tillage and cumulative rainfall
- integer **iroutunit**
not being implemented in this version drainmod tile equations
- integer **ires_nut**
- integer **iclb**
auto-calibration flag
- integer **mrecc**
maximum number of reccnst files

- integer **mrecd**
maximum number of recday files
- integer **mrecm**
maximum number of recmon files
- integer **mtil**
max number of tillage types in till.dat
- integer **mudb**
maximum number of urban land types in urban.dat
- integer **idist**
rainfall distribution code
0 for skewed normal dist
1 for mixed exponential distribution
- integer **mrecy**
maximum number of recyear files
- integer **nyskip**
number of years to not print output
- integer **slrsim**
solar radiation input code
1 measured data read for each subbasin
2 data simulated for each subbasin
- integer **ideg**
channel degradation code
1: compute channel degradation (downcutting and widening)
- integer **ievent**
rainfall/runoff code
0 daily rainfall/curve number technique 1 sub-daily rainfall/Green&Ampt/hourly routing 3 sub-daily rainfall/↔
Green&Ampt/hourly routing
- integer **ipet**
code for potential ET method
0 Priestley-Taylor method
1 Penman/Monteith method
2 Hargreaves method
3 read in daily potential ET data
- integer **iopera**
- integer **idaf**
beginning day of simulation (julian date)
- integer **idal**
ending day of simulation (julian date)
- integer **rhsim**
relative humidity input code
1 measured data read for each subbasin
2 data simulated for each subbasin
- integer **id1**
- integer **leapyr**
- integer **mo_chk**
- integer **nhtot**
number of relative humidity records in file
- integer **nstot**
number of solar radiation records in file
- integer **nwtot**
number of wind speed records in file
- integer **ifirsts**
- integer **ifirsth**
- integer **ifirstw**

- integer **icst**
- integer **ilog**
streamflow print code
- integer **itotr**
number of output variables printed (output.rch)
- integer **iy**
beginning year of simulation (year)
- integer **iwq**
stream water quality code
0 do not model stream water quality
1 model stream water quality (QUAL2E & pesticide transformations)
- integer **i**
forecast region number (none)
- integer **iskip**
- integer **ifirstpet**
- integer **iprp**
print code for output.pst file
0 do not print pesticide output
1 print pesticide output
- integer **itotb**
number of output variables printed (output.sub)
- integer **itots**
number of output variables printed (output.hru)
- integer **itoth**
number of HRUs printed (output.hru/output.wtr)
- integer **pcpsim**
rainfall input code
1 measured data read for each subbasin
2 data simulated for each subbasin
- integer **nd_30**
- integer **iops**
- integer **iphr**
- integer **isto**
- integer **isol**
- integer **fcstcycles**
number of times forecast period is simulated (using different weather generator seeds each time)
- integer **fcstday**
beginning date of forecast period (julian date)
- integer **fcstyr**
beginning year of forecast period
- integer **iscen**
scenarios counter
- integer **subtot**
- integer **ogen**
- integer **mapp**
maximum number of applications
- integer **mlyr**
maximum number of soil layers
- integer **mpst**
max number of pesticides used in wshed
- integer **mres**
maximum number of reservoirs
- integer **msub**

- maximum number of subbasins*
- integer **igen**
 - random number generator code:*
 - 0: use default numbers*
 - 1: generate new numbers in every simulation*
- integer **iprint**
 - print code: 0=monthly, 1=daily, 2=annual*
- integer **iida**
- integer **icn**
 - CN method flag (for testing alternative method):*
 - 0 use traditional SWAT method which bases CN on soil moisture*
 - 1 use alternative method which bases CN on plant ET.*
- integer **ised_det**
 - max half-hour rainfall fraction calc option:*
 - 0 generate max half-hour rainfall fraction from triangular distribution*
 - 1 use monthly mean max half-hour rainfall fraction*
- integer **fcstcnt**
- integer **mtran**
- integer **idtil**
- integer, dimension(100) **ida_lup**
- integer, dimension(100) **iy_r_lup**
- integer **no_lup**
- integer **no_up**
- integer **nostep**
- character(len=8) **date**
 - date simulation is performed where leftmost eight characters are set to a value of `yyyymmdd`, where `yyyy` is the year, `mm` is the month and `dd` is the day*
- character(len=10) **time**
 - time simulation is performed where leftmost ten characters are set to a value of `hhmmss.sss`, where `hh` is the hour, `mm` is the minutes and `ss.sss` is the seconds and milliseconds*
- character(len=5) **zone**
 - time difference with respect to Coordinated Universal Time (ie Greenwich Mean Time)*
- character(len=80) **prog**
 - SWAT program header string.*
- character(len=13) **calfile**
 - name of file containing calibration parameters*
- character(len=13) **rhfile**
 - relative humidity file name (.hmd)*
- character(len=13) **slrfile**
 - solar radiation file name (.slr)*
- character(len=13) **wndfile**
 - wind speed file name (.wnd)*
- character(len=13) **petfile**
 - potential ET file name (.pet)*
- character(len=13) **atmofile**
- character(len=13) **lucfile**
- character(len=13) **septdb**
 - name of septic tank database file (septwq1.dat)*
- character(len=13) **dpd_file**
- character(len=13) **wpd_file**
- character(len=13) **rib_file**
- character(len=13) **sfb_file**
- character(len=13) **lid_file**

- integer, dimension(9) **idg**
array location of random number seed used for a given process
- integer, dimension(:), allocatable **ifirstr**
- integer, dimension(:), allocatable **ifirsthr**
- integer, dimension(8) **values**
values(1): year simulation is performed
values(2): month simulation is performed
values(3): day in month simulation is performed
values(4): time difference with respect to Coordinated Universal Time (ie Greenwich Mean Time)
values(5): hour simulation is performed
values(6): minute simulation is performed
values(7): second simulation is performed
values(8): millisecond simulation is performed
- integer, dimension(13) **ndays**
julian date for last day of preceding month (where the array location is the number of the month) The dates are for leap years (julian date)
- integer, dimension(13) **ndays_noleap**
- integer, dimension(13) **ndays_leap**
- integer **mapex**
- real *8, dimension(:), allocatable **flodaya**
- real *8, dimension(:), allocatable **seddaya**
- real *8, dimension(:), allocatable **orgndaya**
- real *8, dimension(:), allocatable **orgpdaya**
- real *8, dimension(:), allocatable **no3daya**
- real *8, dimension(:), allocatable **minpdaya**
- real *8, dimension(:), allocatable **hi_targ**
index target of cover defined at planting
- real *8, dimension(:), allocatable **bio_targ**
- real *8, dimension(:), allocatable **tnyld**
- integer, dimension(:), allocatable **idapa**
- integer, dimension(:), allocatable **iypa**
- integer, dimension(:), allocatable **ifirsta**
- integer, dimension(100) **mo_transb**
- integer, dimension(100) **mo_transe**
- integer, dimension(100) **ih_tran**
- integer **msdb**
- integer **iseptic**
- real *8, dimension(:), allocatable **sptqs**
- real *8, dimension(:), allocatable **percp**
- real *8, dimension(:), allocatable **sptbodconcs**
- real *8, dimension(:), allocatable **spttssconcs**
- real *8, dimension(:), allocatable **spttnconcs**
- real *8, dimension(:), allocatable **sptnh4concs**
- real *8, dimension(:), allocatable **sptno3concs**
- real *8, dimension(:), allocatable **sptno2concs**
- real *8, dimension(:), allocatable **sptorgnconcs**
- real *8, dimension(:), allocatable **spttpconcs**
- real *8, dimension(:), allocatable **sptminps**
- real *8, dimension(:), allocatable **sptorgps**
- real *8, dimension(:), allocatable **sptfcolis**
- real *8, dimension(:), allocatable **failyr**
- real *8, dimension(:), allocatable **qstemm**
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- real *8, dimension(:), allocatable **bio_bod**
- real *8, dimension(:), allocatable **biom**

- real *8, dimension(:), allocatable **rbiom**
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- real *8, dimension(:), allocatable **coeff_fecal**
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- real *8, dimension(:), allocatable **coeff_solpslp**
- real *8, dimension(:), allocatable **coeff_solpintc**
- real *8, dimension(:), allocatable **coeff_psortpmax**
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- integer, dimension(:), allocatable **isep_iyr**
- integer, dimension(:), allocatable **sep_strm_dist**
- integer, dimension(:), allocatable **sep_den**
- real *8, dimension(:), allocatable **sol_sumno3**
- real *8, dimension(:), allocatable **sol_sumsolp**
- real *8, dimension(:), allocatable **strsw_sum**
- real *8, dimension(:), allocatable **strstmp_sum**
- real *8, dimension(:), allocatable **strsn_sum**
- real *8, dimension(:), allocatable **strsp_sum**
- real *8, dimension(:), allocatable **strsa_sum**
- real *8, dimension(:), allocatable **spill_hru**
- real *8, dimension(:), allocatable **tile_out**
- real *8, dimension(:), allocatable **hru_in**
- real *8, dimension(:), allocatable **spill_precip**
- real *8, dimension(:), allocatable **pot_seep**
- real *8, dimension(:), allocatable **pot_evap**
- real *8, dimension(:), allocatable **pot_sedin**
- real *8, dimension(:), allocatable **pot_solp**
- real *8, dimension(:), allocatable **pot_solpi**
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- real *8, dimension(:), allocatable **pot_orgpi**
- real *8, dimension(:), allocatable **pot_orgn**

- real *8, dimension(:), allocatable **pot_orgni**
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- real *8, dimension(:), allocatable **pot_mpa**
- real *8, dimension(:), allocatable **pot_mpai**
- real *8, dimension(:), allocatable **pot_no3i**
- real *8, dimension(:), allocatable **precip_in**
- real *8, dimension(:), allocatable **tile_sedo**
- real *8, dimension(:), allocatable **tile_no3o**
- real *8, dimension(:), allocatable **tile_solpo**
- real *8, dimension(:), allocatable **tile_orgno**
- real *8, dimension(:), allocatable **tile_orgpo**
- real *8, dimension(:), allocatable **tile_minpso**
- real *8, dimension(:), allocatable **tile_minpao**
- integer **ia_b**
- integer **ihumus**
- integer **itemp**
- integer **isnow**
- integer, dimension(41) **icolrsv**
- integer, dimension(**mhruo**) **icols**
- integer, dimension(**mrcho**) **icolr**
- integer, dimension(**msubo**) **icolb**
- integer, dimension(46) **ipdvar**
output variable codes for output.rch file
- integer, dimension(**mhruo**) **ipdvas**
output variable codes for output.hru file
- integer, dimension(**msubo**) **ipdvab**
output variable codes for output.sub file
- integer, dimension(:), allocatable **ipdhru**
HRUs whose output information will be printed to the output.hru and output.wtr files.
- real *8, dimension(**mstdo**) **wshddayo**
- real *8, dimension(**mstdo**) **wshdmono**
- real *8, dimension(**mstdo**) **wshdyro**
- real *8, dimension(16) **fcstaa0**
- real *8, dimension(**mstdo**) **wshdaao**
- real *8, dimension(:,:), allocatable **wpstdayo**
- real *8, dimension(:,:), allocatable **wpstmono**
- real *8, dimension(:,:), allocatable **wpstyro**
- real *8, dimension(:,:), allocatable **yldkg**
- real *8, dimension(:,:), allocatable **bio_hv**
- real *8, dimension(:,:), allocatable **wpstaa0**
- real *8, dimension(:,:), allocatable **rchmono**
- real *8, dimension(:,:), allocatable **rchyro**
- real *8, dimension(:,:), allocatable **rchaao**
- real *8, dimension(:,:), allocatable **rchdy**
- real *8, dimension(:,:), allocatable **hrumono**
- real *8, dimension(:,:), allocatable **hruyro**
- real *8, dimension(:,:), allocatable **hruaao**
- real *8, dimension(:,:), allocatable **submono**
- real *8, dimension(:,:), allocatable **subyro**
- real *8, dimension(:,:), allocatable **subaao**
- real *8, dimension(:,:), allocatable **resoutm**
- real *8, dimension(:,:), allocatable **resouty**
- real *8, dimension(:,:), allocatable **resouta**

- real *8, dimension(12, 8) **wshd_aamon**
- real *8, dimension(:,:), allocatable **wtrmon**
- real *8, dimension(:,:), allocatable **wtryr**
- real *8, dimension(:,:), allocatable **wtraa**
- real *8, dimension(:,:), allocatable **sub_smfmx**
- real *8, dimension(:,:), allocatable **sub_smfmn**
- real *8, dimension(:,:), allocatable **hrupstd**
- real *8, dimension(:,:), allocatable **hrupsta**
- real *8, dimension(:,:), allocatable **hrupstm**
- real *8, dimension(:,:), allocatable **hrupsty**
- integer, dimension(:), allocatable **ifirstt**
- integer, dimension(:), allocatable **ifirstpcp**
- integer, dimension(:), allocatable **elevp**
- integer, dimension(:), allocatable **elevt**
- real *8, dimension(:,:), allocatable **ftmpmn**
avg monthly minimum air temperature (deg C)
- real *8, dimension(:,:), allocatable **ftmpmx**
avg monthly maximum air temperature (deg C)
- real *8, dimension(:,:), allocatable **ftmpstdmn**
standard deviation for avg monthly minimum air temperature (deg C)
- real *8, dimension(:,:), allocatable **ftmpstdmx**
standard deviation for avg monthly maximum air temperature (deg C)
- real *8, dimension(:,:), allocatable **fpcp_stat**
fpcp_stat(:,1,:): average amount of precipitation falling in one day for the month (mm/day)
fpcp_stat(:,2,:): standard deviation for the average daily precipitation (mm/day)
fpcp_stat(:,3,:): skew coefficient for the average daily precipitation (none)
- real *8, dimension(:,:), allocatable **fpr_w**
fpr_w(1,:): probability of wet day after dry day in month (none)
fpr_w(2,:): probability of wet day after wet day in month (none)
fpr_w(3,:): proportion of wet days in the month (none)
- real *8, dimension(:), allocatable **flwin**
- real *8, dimension(:), allocatable **flwout**
- real *8, dimension(:), allocatable **bankst**
- real *8, dimension(:), allocatable **ch_wi**
- real *8, dimension(:), allocatable **ch_d**
- real *8, dimension(:), allocatable **ch_onco**
channel organic n concentration (ppm)
- real *8, dimension(:), allocatable **ch_opco**
channel organic p concentration (ppm)
- real *8, dimension(:), allocatable **ch_orgn**
- real *8, dimension(:), allocatable **ch_orgp**
- real *8, dimension(:), allocatable **drift**
- real *8, dimension(:), allocatable **rch_dox**
- real *8, dimension(:), allocatable **rch_bactp**
- real *8, dimension(:), allocatable **alpha_bnk**
- real *8, dimension(:), allocatable **alpha_bnke**
- real *8, dimension(:), allocatable **disolvp**
- real *8, dimension(:), allocatable **algae**
- real *8, dimension(:), allocatable **sedst**
- real *8, dimension(:), allocatable **rchstor**
- real *8, dimension(:), allocatable **organicn**
- real *8, dimension(:), allocatable **organicp**
- real *8, dimension(:), allocatable **chlora**
- real *8, dimension(:), allocatable **nitraten**

- real *8, dimension(:), allocatable **nitriten**
- real *8, dimension(:), allocatable **ch_li**
- real *8, dimension(:), allocatable **ch_si**
- real *8, dimension(:), allocatable **ch_bnk_san**
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- real *8, dimension(:), allocatable **ch_bnk_cla**
- real *8, dimension(:), allocatable **ch_bnk_gra**
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- real *8, dimension(:), allocatable **ch_bed_gra**
- real *8, dimension(:), allocatable **depf**
- real *8, dimension(:), allocatable **depsanfp**
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- real *8, dimension(:), allocatable **depsagfp**
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- real *8, dimension(:), allocatable **deprch**
- real *8, dimension(:), allocatable **deprfp**
- real *8, dimension(:), allocatable **prf**
- real *8, dimension(:), allocatable **r2adj**
- real *8, dimension(:), allocatable **spcon**

linear parameter for calculating sediment reentrained in channel sediment routing

- real *8, dimension(:), allocatable **spexp**

exponent parameter for calculating sediment reentrained in channel sediment routing

- real *8, dimension(:), allocatable **sanst**
- real *8, dimension(:), allocatable **silst**
- real *8, dimension(:), allocatable **clast**
- real *8, dimension(:), allocatable **sagst**
- real *8, dimension(:), allocatable **lagst**
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- real *8, dimension(:), allocatable **potsagi**
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- real *8, dimension(:), allocatable **silyld**
- real *8, dimension(:), allocatable **clayld**
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- real *8 **resgrai**
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- real *8 **pndlago**
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- real *8, dimension(:), allocatable **rs3**
- real *8, dimension(:), allocatable **rs4**
- real *8, dimension(:), allocatable **rs5**
- real *8, dimension(:), allocatable **rs6**
- real *8, dimension(:), allocatable **rs7**
- real *8, dimension(:), allocatable **rk1**
- real *8, dimension(:), allocatable **rk2**
- real *8, dimension(:), allocatable **rk3**
- real *8, dimension(:), allocatable **rk4**
- real *8, dimension(:), allocatable **rk5**
- real *8, dimension(:), allocatable **bc1**
rate constant for biological oxidation of NH3 to NO2 in reach at 20 deg C (1/hr)
- real *8, dimension(:), allocatable **bc2**
rate constant for biological oxidation of NO2 to NO3 in reach at 20 deg C (1/hr)
- real *8, dimension(:), allocatable **bc3**
rate constant for hydrolysis of organic N to ammonia in reach at 20 deg C (1/hr)
- real *8, dimension(:), allocatable **bc4**
rate constant for the decay of organic P to dissolved P in reach at 20 deg C (1/hr)
- real *8, dimension(:), allocatable **rk6**
- real *8, dimension(:), allocatable **ammonian**
- real *8, dimension(:), allocatable **orig_sedpstconc**
- real *8, dimension(:,:), allocatable **wurch**
- integer, dimension(:), allocatable **icanal**
- integer, dimension(:), allocatable **itb**
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- real *8, dimension(:), allocatable **dep_chan**
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- real *8, dimension(:), allocatable **dr_sub**

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- real *8, dimension(:), allocatable **sub_gwsolp**
- real *8, dimension(:), allocatable **sub_km**
- real *8, dimension(:), allocatable **sub_tc**
- real *8, dimension(:), allocatable **wlat**
- real *8, dimension(:), allocatable **sub_pet**
- real *8, dimension(:), allocatable **co2**
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- real *8 **vap_tile**
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- real *8, dimension(:, :), allocatable **sol_stpwt**
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- real *8, dimension(:, :), allocatable **sub_hhwtmp**
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- integer, dimension(:), allocatable **subgis**
- integer, dimension(:), allocatable **fcst_reg**
- integer, dimension(:), allocatable **irelh**
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- real *8, dimension(:,:), allocatable **sol_prk**
- real *8, dimension(:,:), allocatable **volcr**
- real *8, dimension(:,:), allocatable **pperco_sub**

subbasin phosphorus percolation coefficient. Ratio of soluble phosphorus in surface to soluble phosphorus in percolate

- real *8, dimension(:,:), allocatable **sol_actp**
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- real *8, dimension(:,:), allocatable **sol_up**
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- flag for types of pesticide used in watershed array location is pesticide ID number*
0: pesticide not used
1: pesticide used
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 - integer, dimension(:), allocatable **nop**
 - integer, dimension(:), allocatable **yr_skip**
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- real *8, dimension(:), allocatable **snotmp**
- real *8, dimension(:), allocatable **gdrain**
- drain tile lag time (hours)*
- real *8, dimension(:), allocatable **ddrain**
- real *8, dimension(:), allocatable **sol_crk**
- real *8, dimension(:), allocatable **dayl**
- real *8, dimension(:), allocatable **brt**
- real *8, dimension(:), allocatable **sstmaxd**
- static maximum depressional storage; read from .sdr (mm)*
- real *8, dimension(:), allocatable **ddrain_hru**
- real *8, dimension(:), allocatable **re**
- real *8, dimension(:), allocatable **sdrain**
- real *8, dimension(:), allocatable **stmaxd**
- real *8, dimension(:), allocatable **drain_co**
- real *8, dimension(:), allocatable **pc**
- real *8, dimension(:), allocatable **latksatf**
- real *8, dimension(:), allocatable **twash**
- real *8, dimension(:), allocatable **rnd2**
- real *8, dimension(:), allocatable **rnd3**
- real *8, dimension(:), allocatable **sol_cns**
- real *8, dimension(:), allocatable **doxq**
- real *8, dimension(:), allocatable **rnd8**
- real *8, dimension(:), allocatable **rnd9**
- real *8, dimension(:), allocatable **percn**
- real *8, dimension(:), allocatable **sol_sumwp**
- real *8, dimension(:), allocatable **tauton**
- real *8, dimension(:), allocatable **tautop**
- real *8, dimension(:), allocatable **cbodu**
- real *8, dimension(:), allocatable **chl_a**
- real *8, dimension(:), allocatable **qdr**
- real *8, dimension(:), allocatable **tfertn**
- real *8, dimension(:), allocatable **tfertp**
- real *8, dimension(:), allocatable **tgrazn**
- real *8, dimension(:), allocatable **tgrazp**
- real *8, dimension(:), allocatable **latno3**
- real *8, dimension(:), allocatable **latq**
- real *8, dimension(:), allocatable **minpgw**
- real *8, dimension(:), allocatable **no3gw**
- real *8, dimension(:), allocatable **npInt**
- real *8, dimension(:), allocatable **tileq**
- real *8, dimension(:), allocatable **tileno3**
- real *8, dimension(:), allocatable **sedminpa**
- real *8, dimension(:), allocatable **sedminps**
- real *8, dimension(:), allocatable **sedorgn**
- real *8, dimension(:), allocatable **sedorgp**
- real *8, dimension(:), allocatable **sedyld**
- real *8, dimension(:), allocatable **sepbtm**
- real *8, dimension(:), allocatable **strsn**
- real *8, dimension(:), allocatable **strsp**
- real *8, dimension(:), allocatable **strstmp**
- real *8, dimension(:), allocatable **surfq**

- real *8, dimension(:), allocatable **surqno3**
- real *8, dimension(:), allocatable **tcfrtn**
- real *8, dimension(:), allocatable **tcfrtp**
- real *8, dimension(:), allocatable **hru_ha**
- real *8, dimension(:), allocatable **hru_dafr**
- real *8, dimension(:), allocatable **drydep_no3**
- real *8, dimension(:), allocatable **drydep_nh4**
- real *8, dimension(:), allocatable **phubase**
- real *8, dimension(:), allocatable **bio_yrms**
- real *8, dimension(:), allocatable **hvstiadj**
- real *8, dimension(:), allocatable **laimxfr**
- real *8, dimension(:), allocatable **laiday**
- real *8, dimension(:), allocatable **chlap**
- real *8, dimension(:), allocatable **pnd_psed**
- real *8, dimension(:), allocatable **wet_psed**
- real *8, dimension(:), allocatable **seccip**
- real *8, dimension(:), allocatable **plantn**
- real *8, dimension(:), allocatable **plt_et**
- real *8, dimension(:), allocatable **plt_pet**
- real *8, dimension(:), allocatable **plantp**
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- real *8, dimension(:), allocatable **bio_aamx**
- real *8, dimension(:), allocatable **lai_yrmx**
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- real *8, dimension(:), allocatable **lat_pst**
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- real *8, dimension(:), allocatable **orig_potvol**
- real *8, dimension(:), allocatable **fld_fr**
- real *8, dimension(:), allocatable **orig_alai**
- real *8, dimension(:), allocatable **orig_bioms**
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- real *8, dimension(:), allocatable **orig_phuacc**
- real *8, dimension(:), allocatable **orig_sumix**
- real *8, dimension(:), allocatable **pltfr_p**
- real *8, dimension(:), allocatable **orig_phu**
- real *8, dimension(:), allocatable **phu_plt**
- real *8, dimension(:), allocatable **orig_shallst**
- real *8, dimension(:), allocatable **orig_deepst**
- real *8, dimension(:), allocatable **orig_pndvol**
- real *8, dimension(:), allocatable **orig_pndsed**
- real *8, dimension(:), allocatable **rip_fr**
- real *8, dimension(:), allocatable **orig_pndno3**
- real *8, dimension(:), allocatable **orig_pndsolp**
- real *8, dimension(:), allocatable **orig_pndorgn**
- real *8, dimension(:), allocatable **orig_pndorgp**
- real *8, dimension(:), allocatable **orig_wetvol**
- real *8, dimension(:), allocatable **orig_wetsed**
- real *8, dimension(:), allocatable **orig_wetno3**
- real *8, dimension(:), allocatable **orig_wetsolp**
- real *8, dimension(:), allocatable **orig_wetorgn**
- real *8, dimension(:), allocatable **orig_wetorgp**
- real *8, dimension(:), allocatable **orig_solcov**
- real *8, dimension(:), allocatable **orig_solsw**
- real *8, dimension(:), allocatable **orig_potno3**
- real *8, dimension(:), allocatable **orig_potsed**

- real *8, dimension(:), allocatable **wtab**
- real *8, dimension(:), allocatable **wtab_mn**
- real *8, dimension(:), allocatable **wtab_mx**
- real *8, dimension(:), allocatable **shallst_n**
- real *8, dimension(:), allocatable **gw_nloss**
- real *8, dimension(:), allocatable **rchrg_n**
- real *8, dimension(:), allocatable **det_san**
- real *8, dimension(:), allocatable **det_sil**
- real *8, dimension(:), allocatable **det_cla**
- real *8, dimension(:), allocatable **det_sag**
- real *8, dimension(:), allocatable **det_lag**
- real *8, dimension(:), allocatable **tnylda**
- real *8, dimension(:), allocatable **afrt_surface**
- real *8 **ftr_surface**
- real *8, dimension(:), allocatable **auto_nyr**
- real *8, dimension(:), allocatable **auto_napp**
- real *8, dimension(:), allocatable **manure_kg**
- real *8, dimension(:), allocatable **auto_nstrs**
- real *8, dimension(:, :), allocatable **rcn_mo**
- real *8, dimension(:, :), allocatable **rammo_mo**
- real *8, dimension(:, :), allocatable **drydep_no3_mo**
- real *8, dimension(:, :), allocatable **drydep_nh4_mo**
- real *8, dimension(:), allocatable **rcn_d**
- real *8, dimension(:), allocatable **rammo_d**
- real *8, dimension(:), allocatable **drydep_no3_d**
- real *8, dimension(:), allocatable **drydep_nh4_d**
- real *8, dimension(:, :), allocatable **yldn**
- real *8, dimension(:, :), allocatable **gwati**
- real *8, dimension(:, :), allocatable **gwatn**
- real *8, dimension(:, :), allocatable **gwatl**
- real *8, dimension(:, :), allocatable **gwatw**
- real *8, dimension(:, :), allocatable **gwatd**
- real *8, dimension(:, :), allocatable **gwatveg**
- real *8, dimension(:, :), allocatable **gwata**
- real *8, dimension(:, :), allocatable **gwats**
- real *8, dimension(:, :), allocatable **gwatspcon**
- real *8, dimension(:, :), allocatable **rfqeo_30d**
- real *8, dimension(:, :), allocatable **eo_30d**
- real *8, dimension(:, :), allocatable **wgncur**
- real *8, dimension(:, :), allocatable **wgnold**
- real *8, dimension(:, :), allocatable **wrt**
- real *8, dimension(:, :), allocatable **psetlp**
- real *8, dimension(:, :), allocatable **zdb**
- real *8, dimension(:, :), allocatable **pst_surq**
- real *8, dimension(:, :), allocatable **pst_enr**
- real *8, dimension(:, :), allocatable **plt_pst**
- real *8, dimension(:, :), allocatable **pst_sed**
- real *8, dimension(:, :), allocatable **psetlw**
- real *8, dimension(:, :), allocatable **pcpband**
- real *8, dimension(:, :), allocatable **wupnd**
- real *8, dimension(:, :), allocatable **tavband**
- real *8, dimension(:, :), allocatable **phi**
- real *8, dimension(:, :), allocatable **wat_phi**
- real *8, dimension(:, :), allocatable **wushal**
- real *8, dimension(:, :), allocatable **wudeep**

- real *8, dimension(:,:), allocatable **tmnband**
- real *8, dimension(:,:), allocatable **snoeb**
- real *8, dimension(:,:), allocatable **nsetlw**
- real *8, dimension(:,:), allocatable **snotmpeb**
- real *8, dimension(:,:), allocatable **bss**
- real *8, dimension(:,:), allocatable **surf_bs**
- real *8, dimension(:,:), allocatable **tmxband**
- real *8, dimension(:,:), allocatable **nsetlp**
- real *8, dimension(:,:), allocatable **rainsub**
- real *8, dimension(:,:), allocatable **frad**
- real *8, dimension(:), allocatable **rstpbsb**
- real *8, dimension(:,:), allocatable **orig_snoeb**
- real *8, dimension(:,:), allocatable **orig_pltpst**
- real *8, dimension(:,:), allocatable **terr_p**
- real *8, dimension(:,:), allocatable **terr_cn**
- real *8, dimension(:,:), allocatable **terr_sl**
- real *8, dimension(:,:), allocatable **drain_d**
- real *8, dimension(:,:), allocatable **drain_t**
- real *8, dimension(:,:), allocatable **drain_g**
- real *8, dimension(:,:), allocatable **drain_idep**
- real *8, dimension(:,:), allocatable **cont_cn**
- real *8, dimension(:,:), allocatable **cont_p**
- real *8, dimension(:,:), allocatable **filt_w**
- real *8, dimension(:,:), allocatable **strip_n**
- real *8, dimension(:,:), allocatable **strip_cn**
- real *8, dimension(:,:), allocatable **strip_c**
- real *8, dimension(:,:), allocatable **strip_p**
- real *8, dimension(:,:), allocatable **fire_cn**
- real *8, dimension(:,:), allocatable **cropno_upd**
- real *8, dimension(:,:), allocatable **hi_upd**
- real *8, dimension(:,:), allocatable **laimx_upd**
- real *8, dimension(:,:), allocatable **pst_lag**
- real *8, dimension(:,:), allocatable **phug**
- integer, dimension(:), allocatable **nrelease**
- integer, dimension(:), allocatable **swtrg**
- integer, dimension(:), allocatable **hrupest**
- integer, dimension(:), allocatable **nro**
- integer, dimension(:), allocatable **nrot**
- integer, dimension(:), allocatable **nfert**
- integer, dimension(:), allocatable **igro**
- integer, dimension(:), allocatable **nair**
- integer, dimension(:), allocatable **ipnd1**
- integer, dimension(:), allocatable **ipnd2**
- integer, dimension(:), allocatable **nirr**
- integer, dimension(:), allocatable **iflod1**
- integer, dimension(:), allocatable **iflod2**
- integer, dimension(:), allocatable **ndtarg**
- integer, dimension(:), allocatable **iaftrtyp**
- integer, dimension(:), allocatable **nstress**
- integer, dimension(:), allocatable **igrotree**
- integer, dimension(:), allocatable **grz_days**
- integer, dimension(:), allocatable **nmgt**
- integer, dimension(:), allocatable **icr**
- integer, dimension(:), allocatable **ncut**
- integer, dimension(:), allocatable **nsweep**

- integer, dimension(:), allocatable **nafert**
- integer, dimension(:), allocatable **irn**
- integer, dimension(:), allocatable **irrno**
- integer, dimension(:), allocatable **sol_nly**
- integer, dimension(:), allocatable **npcp**
- integer, dimension(:), allocatable **igrz**
- integer, dimension(:), allocatable **ndeat**
- integer, dimension(:), allocatable **ngr**
- integer, dimension(:), allocatable **ncf**
- integer, dimension(:), allocatable **idorm**
- integer, dimension(:), allocatable **urblu**
- integer, dimension(:), allocatable **hru_sub**
- integer, dimension(:), allocatable **ldrain**
- integer, dimension(:), allocatable **hru_seq**
- integer, dimension(:), allocatable **iurban**
- integer, dimension(:), allocatable **iday_fert**
- integer, dimension(:), allocatable **icfrt**
- integer, dimension(:), allocatable **ndcfrt**
- integer, dimension(:), allocatable **irip**
- integer, dimension(:), allocatable **ifld**
- integer, dimension(:), allocatable **hrugis**
- integer, dimension(:), allocatable **orig_igro**
- integer, dimension(:), allocatable **ntil**
- integer, dimension(:), allocatable **irrsc**
- integer, dimension(:), allocatable **iwatable**
- integer, dimension(:), allocatable **curyr_mat**
- integer, dimension(:), allocatable **ncpest**
- integer, dimension(:), allocatable **icpst**
- integer, dimension(:), allocatable **ndcpst**
- integer, dimension(:), allocatable **iday_pest**
- integer, dimension(:), allocatable **irr_flag**
- integer, dimension(:), allocatable **irra_flag**
- integer, dimension(:,:), allocatable **rndseed**

random number generator seed. The seeds in the array are used to generate random numbers for the following purposes:

- (1) wet/dry day probability*
- (2) solar radiation*
- (3) precipitation*
- (4) USLE rainfall erosion index*
- (5) wind speed*
- (6) 0.5 hr rainfall fraction*
- (7) relative humidity*
- (8) maximum temperature*
- (9) minimum temperature*
- (10) generate new random numbers*

- integer, dimension(:,:), allocatable **iterr**
- integer, dimension(:,:), allocatable **iyterr**
- integer, dimension(:,:), allocatable **itdrain**
- integer, dimension(:,:), allocatable **iydrain**
- integer, dimension(:,:), allocatable **ncrops**
- integer, dimension(:), allocatable **manure_id**
- integer, dimension(:,:), allocatable **mgt_sdr**
- integer, dimension(:,:), allocatable **idplrot**
- integer, dimension(:,:), allocatable **icont**
- integer, dimension(:,:), allocatable **iycont**
- integer, dimension(:,:), allocatable **ifilt**

- integer, dimension(:,:), allocatable **iyfilt**
- integer, dimension(:,:), allocatable **istrip**
- integer, dimension(:,:), allocatable **iystrip**
- integer, dimension(:,:), allocatable **iopday**
- integer, dimension(:,:), allocatable **iopyr**
- integer, dimension(:,:), allocatable **mgt_ops**
- real *8, dimension(:), allocatable **wshd_pstap**
- real *8, dimension(:), allocatable **wshd_pstdg**
- integer, dimension(12) **ndmo**
- integer, dimension(:), allocatable **npno**
- integer, dimension(:), allocatable **mcrhru**
- character(len=13), dimension(18) **rfile**
rainfall file names (.pcp)
- character(len=13), dimension(18) **tfile**
temperature file names (.tmp)
- character(len=4), dimension(1000) **urbname**
- character(len=1), dimension(:), allocatable **hydgrp**
- character(len=1), dimension(:), allocatable **kirr**
- character(len=16), dimension(:), allocatable **snam**
- character(len=17), dimension(300) **pname**
- character(len=13), dimension(79) **heds**
- character(len=13), dimension(24) **hedb**
- character(len=13), dimension(46) **hedr**
- character(len=13), dimension(41) **hedrsv**
- character(len=13), dimension(40) **hedwtr**
- character(len=4), dimension(60) **title**
description lines in file.cio (1st 3 lines)
- character(len=4), dimension(5000) **cpnm**
- character(len=17), dimension(50) **fname**
- real *8, dimension(:,:,:), allocatable **flomon**
- real *8, dimension(:,:,:), allocatable **solpstmon**
- real *8, dimension(:,:,:), allocatable **srbspstmon**
- real *8, dimension(:,:,:), allocatable **sedmon**
- real *8, dimension(:,:,:), allocatable **orgnmon**
- real *8, dimension(:,:,:), allocatable **orgpmon**
- real *8, dimension(:,:,:), allocatable **no3mon**
- real *8, dimension(:,:,:), allocatable **minpmon**
- real *8, dimension(:,:,:), allocatable **nh3mon**
- real *8, dimension(:,:,:), allocatable **no2mon**
- real *8, dimension(:,:,:), allocatable **bactpmon**
- real *8, dimension(:,:,:), allocatable **bactlpmon**
- real *8, dimension(:,:,:), allocatable **cmtl1mon**
- real *8, dimension(:,:,:), allocatable **cmtl2mon**
- real *8, dimension(:,:,:), allocatable **cmtl3mon**
- real *8, dimension(:,:,:), allocatable **chlamon**
- real *8, dimension(:,:,:), allocatable **disoxmon**
- real *8, dimension(:,:,:), allocatable **cbodmon**
- real *8, dimension(:,:), allocatable **floyr**
- real *8, dimension(:,:), allocatable **sedyr**
- real *8, dimension(:,:), allocatable **orgnyr**
- real *8, dimension(:,:), allocatable **orgpyr**
- real *8, dimension(:,:), allocatable **no3yr**
- real *8, dimension(:,:), allocatable **minpyr**
- real *8, dimension(:,:), allocatable **nh3yr**

- real *8, dimension(:,:), allocatable **no2yr**
- real *8, dimension(:,:), allocatable **bactpyr**
- real *8, dimension(:,:), allocatable **bactlpyr**
- real *8, dimension(:,:), allocatable **cmtl1yr**
- real *8, dimension(:,:), allocatable **cmtl2yr**
- real *8, dimension(:,:), allocatable **cmtl3yr**
- real *8, dimension(:,:), allocatable **chlayr**
- real *8, dimension(:,:), allocatable **disoxyr**
- real *8, dimension(:,:), allocatable **cbodyr**
- real *8, dimension(:,:), allocatable **solpstyr**
- real *8, dimension(:,:), allocatable **srbspstyr**
- real *8, dimension(:,:), allocatable **sol_mc**
- real *8, dimension(:,:), allocatable **sol_mn**
- real *8, dimension(:,:), allocatable **sol_mp**
- real *8, dimension(:), allocatable **flocnst**
- real *8, dimension(:), allocatable **sedcnst**
- real *8, dimension(:), allocatable **orgncnst**
- real *8, dimension(:), allocatable **orgpcnst**
- real *8, dimension(:), allocatable **no3cnst**
- real *8, dimension(:), allocatable **minpcnst**
- real *8, dimension(:), allocatable **nh3cnst**
- real *8, dimension(:), allocatable **no2cnst**
- real *8, dimension(:), allocatable **bactpcnst**
- real *8, dimension(:), allocatable **cmtl1cnst**
- real *8, dimension(:), allocatable **cmtl2cnst**
- real *8, dimension(:), allocatable **bactlpcnst**
- real *8, dimension(:), allocatable **cmtl3cnst**
- real *8, dimension(:), allocatable **chlacnst**
- real *8, dimension(:), allocatable **disoxcnst**
- real *8, dimension(:), allocatable **cbodcnst**
- real *8, dimension(:), allocatable **solpstcnst**
- real *8, dimension(:), allocatable **srbspstcnst**
- integer **nstep**
max number of time steps per day
- integer **idt**
length of time step used to report precipitation data for sub-daily modeling (minutes)
- real *8, dimension(:), allocatable **hrtwtr**
- real *8, dimension(:), allocatable **hhstor**
- real *8, dimension(:), allocatable **hdepth**
- real *8, dimension(:), allocatable **hsdti**
- real *8, dimension(:), allocatable **hrchwtr**
- real *8, dimension(:), allocatable **halgae**
- real *8, dimension(:), allocatable **horgn**
- real *8, dimension(:), allocatable **hnh4**
- real *8, dimension(:), allocatable **hno2**
- real *8, dimension(:), allocatable **hno3**
- real *8, dimension(:), allocatable **horgp**
- real *8, dimension(:), allocatable **hsolp**
- real *8, dimension(:), allocatable **hbod**
- real *8, dimension(:), allocatable **hdisox**
- real *8, dimension(:), allocatable **hchla**
- real *8, dimension(:), allocatable **hsedyld**
- real *8, dimension(:), allocatable **hsedst**
- real *8, dimension(:), allocatable **hharea**

- real *8, dimension(:), allocatable **hsolpst**
- real *8, dimension(:), allocatable **hsorpst**
- real *8, dimension(:), allocatable **hhqday**
- real *8, dimension(:), allocatable **precipdt**
- real *8, dimension(:), allocatable **hhtime**
- real *8, dimension(:), allocatable **hbactp**
- real *8, dimension(:), allocatable **hbactlp**
- integer, dimension(10) **ivar_orig**
- real *8, dimension(10) **rvar_orig**
- integer **nsave**
number of save commands in .fig file
- integer **nauto**
- integer **iatmodep**
- real *8, dimension(:), allocatable **wattemp**
- real *8, dimension(:), allocatable **lkpst_mass**
- real *8, dimension(:), allocatable **lkspst_mass**
- real *8, dimension(:), allocatable **vel_chan**
- real *8, dimension(:), allocatable **vfscon**
- real *8, dimension(:), allocatable **vfsratio**
- real *8, dimension(:), allocatable **vfsch**
- real *8, dimension(:), allocatable **vfsi**
- real *8, dimension(:, :), allocatable **filter_i**
- real *8, dimension(:, :), allocatable **filter_ratio**
- real *8, dimension(:, :), allocatable **filter_con**
- real *8, dimension(:, :), allocatable **filter_ch**
- real *8, dimension(:, :), allocatable **sol_n**
- integer **cswat**
= 0 Static soil carbon (old mineralization routines)
= 1 C-FARM one carbon pool model
= 2 Century model
- real *8, dimension(:, :), allocatable **sol_bdp**
- real *8, dimension(:, :), allocatable **tillagef**
- real *8, dimension(:), allocatable **rtfr**
- real *8, dimension(:), allocatable **stsol_rd**
- integer **urban_flag**
- integer **dorm_flag**
- real *8 **bf_flg**
- real *8 **iabstr**
- real *8, dimension(:), allocatable **ubnrunoff**
- real *8, dimension(:), allocatable **ubntss**
- real *8, dimension(:, :), allocatable **sub_ubnrunoff**
- real *8, dimension(:, :), allocatable **sub_ubntss**
- real *8, dimension(:, :), allocatable **ovrlnd_dt**
- real *8, dimension(:, :), allocatable **hhsurf_bs**
- integer **iuh**
unit hydrograph method: 1=triangular UH; 2=gamma funtion UH;
- integer **sed_ch**
channel routing for HOURLY; 0=Bagnold; 2=Brownlie; 3=Yang;
- real *8 **eros_expo**
an exponent in the overland flow erosion equation ranges 1.5-3.0
- real *8 **eros_spl**
coefficient of splash erosion varing 0.9-3.1
- real *8 **rill_mult**
Multiplier to USLE_K for soil susceptible to rill erosion, range 0.5-2.0.

- real *8 **sedprev**
- real *8 **c_factor**
- real *8 **ch_d50**
median particle diameter of channel bed (mm)
- real *8 **sig_g**
geometric standard deviation of particle sizes for the main channel. Mean air temperature at which precipitation is equally likely to be rain as snow/freezing rain.
- real *8 **uhalpha**
alpha coefficient for estimating unit hydrograph using a gamma function (*.bsn)
- real *8 **abstinit**
- real *8 **abstmax**
- real *8, dimension(:,:), allocatable **hhsedy**
- real *8, dimension(:,:), allocatable **sub_subp_dt**
- real *8, dimension(:,:), allocatable **sub_hhsedy**
- real *8, dimension(:,:), allocatable **sub_atmp**
- real *8, dimension(:), allocatable **rhy**
- real *8, dimension(:), allocatable **init_abstrc**
- real *8, dimension(:), allocatable **dratio**
- real *8, dimension(:), allocatable **hrtevp**
- real *8, dimension(:), allocatable **hrttlc**
- real *8, dimension(:,:), allocatable **rchhr**
- real *8, dimension(:), allocatable **hhresflwi**
- real *8, dimension(:), allocatable **hhresflwo**
- real *8, dimension(:), allocatable **hhressedi**
- real *8, dimension(:), allocatable **hhressedo**
- character(len=4), dimension(:), allocatable **lu_nodrain**
- integer, dimension(:), allocatable **bmpdrain**
- real *8, dimension(:), allocatable **sub_cn2**
- real *8, dimension(:), allocatable **sub_ha_urb**
- real *8, dimension(:), allocatable **bmp_recharge**
- real *8, dimension(:), allocatable **sub_ha_imp**
- real *8, dimension(:), allocatable **subdr_km**
- real *8, dimension(:), allocatable **subdr_ickm**
- real *8, dimension(:,:), allocatable **sf_im**
- real *8, dimension(:,:), allocatable **sf_iy**
- real *8, dimension(:,:), allocatable **sp_sa**
- real *8, dimension(:,:), allocatable **sp_pvol**
- real *8, dimension(:,:), allocatable **sp_pd**
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- real *8, dimension(:,:), allocatable **sp_sede**
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- integer, dimension(:), allocatable **tillage_days**
- real *8, dimension(:), allocatable **tillage_factor**
- real *8 **dthy**
time interval for subdaily routing
- integer, dimension(4) **ihx**
- integer, dimension(:), allocatable **nhy**
- real *8, dimension(:), allocatable **rchx**
- real *8, dimension(:), allocatable **rcss**
- real *8, dimension(:), allocatable **qcap**
- real *8, dimension(:), allocatable **chxa**
- real *8, dimension(:), allocatable **chxp**
- real *8, dimension(:, :, :), allocatable **qhy**
- real *8 **ff1**
- real *8 **ff2**

5.1.1 Detailed Description

main module containing the global variables

Author

modified by Javier Burguete Tolosa

5.1.2 Variable Documentation

5.1.2.1 igropt

integer parm::igropt

Qual2E option for calculating the local specific growth rate of algae

1: multiplicative.

$$u = m_{\max} f_{ll} f_{nn} f_{pp}$$

2: limiting nutrient

$$u = m_{\max} f_{ll} \min(f_{nn}, f_{pp})$$

3: harmonic mean

$$u = m_{\max} f_{ll} \frac{2}{\frac{1}{f_{nn}} + \frac{1}{f_{pp}}}$$

Chapter 6

Data Type Documentation

6.1 `parm::ascrv` Interface Reference

Public Member Functions

- subroutine **ascrv** (`x1`, `x2`, `x3`, `x4`, `x5`, `x6`)

The documentation for this interface was generated from the following file:

- `modparm.f90`

6.2 `parm::atri` Interface Reference

Public Member Functions

- real *8 function **atri** (`at1`, `at2`, `at3`, `at4i`)

The documentation for this interface was generated from the following file:

- `modparm.f90`

6.3 `parm::aunif` Interface Reference

Public Member Functions

- real *8 function **aunif** (`x1`)

The documentation for this interface was generated from the following file:

- `modparm.f90`

6.4 parm::dstn1 Interface Reference

Public Member Functions

- real *8 function **dstn1** (rn1, rn2)

The documentation for this interface was generated from the following file:

- modparm.f90

6.5 parm::ee Interface Reference

Public Member Functions

- real *8 function **ee** (tk)

The documentation for this interface was generated from the following file:

- modparm.f90

6.6 parm::expo Interface Reference

Public Member Functions

- real *8 function **expo** (xx)

The documentation for this interface was generated from the following file:

- modparm.f90

6.7 parm::fcgd Interface Reference

Public Member Functions

- real *8 function **fcgd** (xx)

The documentation for this interface was generated from the following file:

- modparm.f90

6.8 parm::HQDAV Interface Reference

Public Member Functions

- subroutine **hqdav** (A, CBW, QQ, SSS, ZCH, ZX, CHW, FPW, jrch)

The documentation for this interface was generated from the following file:

- modparm.f90

6.9 parm::layersplit Interface Reference

Public Member Functions

- subroutine **layersplit** (dep_new)

The documentation for this interface was generated from the following file:

- modparm.f90

6.10 parm::ndenit Interface Reference

Public Member Functions

- subroutine **ndenit** (k, j, cdg, wdn, void)

The documentation for this interface was generated from the following file:

- modparm.f90

6.11 parm::qman Interface Reference

Public Member Functions

- real *8 function **qman** (x1, x2, x3, x4)

The documentation for this interface was generated from the following file:

- modparm.f90

6.12 parm::regres Interface Reference

Public Member Functions

- real *8 function **regres** (k)

The documentation for this interface was generated from the following file:

- modparm.f90

6.13 parm::rsedaa Interface Reference

Public Member Functions

- subroutine **rsedaa** (years)

The documentation for this interface was generated from the following file:

- modparm.f90

6.14 parm::tair Interface Reference

Public Member Functions

- real *8 function **tair** (hr, jj)

The documentation for this interface was generated from the following file:

- modparm.f90

6.15 parm::theta Interface Reference

Public Member Functions

- real *8 function **theta** (r20, thk, tmp)

The documentation for this interface was generated from the following file:

- modparm.f90

6.16 parm::vbl Interface Reference

Public Member Functions

- subroutine **vbl** (evx, spx, pp, qin, ox, vx1, vy, yi, yo, ysx, vf, vyf, aha)

The documentation for this interface was generated from the following file:

- modparm.f90

Chapter 7

File Documentation

7.1 `allocate_parms.f90` File Reference

this subroutine allocates array sizes

Functions/Subroutines

- subroutine `allocate_parms`

7.1.1 Detailed Description

this subroutine allocates array sizes

Author

modified by Javier Burguete

7.2 `ascrv.f90` File Reference

this subroutine computes shape parameters x_5 and x_6 for the S curve equation

Functions/Subroutines

- subroutine `ascrv` (x_1 , x_2 , x_3 , x_4 , x_5 , x_6)

7.2.1 Detailed Description

this subroutine computes shape parameters x_5 and x_6 for the S curve equation

Author

modified by Javier Burguete this subroutine computes shape parameters x_5 and x_6 for the S curve equation

$$x = \frac{y}{y + \exp(x_5 + x_6 y)}$$

given 2 (x, y) points along the curve. x_5 is determined by solving the equation with x and y values measured around the midpoint of the curve (approx. 50% of the maximum value for x) and x_6 is determined by solving the equation with x and y values measured close to one of the endpoints of the curve (100% of the maximum value for x). This subroutine is called from [readbsn.f90](#) and [readplant.f90](#)

Parameters

in	x1	value for x in the above equation for first datapoint, x1 should be close to 0.5 (the midpoint of the curve)
in	x2	value for x in the above equation for second datapoint, x2 should be close to 0.0 or 1.0
in	x3	value for y in the above equation corresponding to x1
in	x4	value for y in the above equation corresponding to x2
out	x5	1st shape parameter for S curve equation characterizing the midpoint of the curve
out	x6	2nd shape parameter for S curve equation characterizing the regions close to the endpoints of the curve

7.3 aunif.f90 File Reference

This function generates random numbers ranging from 0.0 to 1.0.

Functions/Subroutines

- real *8 function **aunif** (x1)

7.3.1 Detailed Description

This function generates random numbers ranging from 0.0 to 1.0.

Author

modified by Javier Burguete

Parameters

x1	random number generator seed (integer) where $0 < x1 < 2147483647$
----	--

Returns

random number ranging from 0.0 to 1.0

In the process of calculating the random number, the seed (x1) is set to a new value. This function implements the prime-modulus generator

$$x_i = 16807 x_i \bmod (2^{31} - 1)$$

using code which ensures that no intermediate result uses more than 31 bits. The theory behind the code is summarized in [1]

7.4 caps.f90 File Reference

this subroutine reads the input and output names given in file.cio and converts all capital letters to lowercase letters.

Functions/Subroutines

- subroutine **caps** (file_name)

7.4.1 Detailed Description

this subroutine reads the input and output names given in file.cio and converts all capital letters to lowercase letters.

Author

modified by Javier Burguete

Parameters

<i>file_name</i>	dummy argument, file name character string
------------------	--

7.5 gcycl.f90 File Reference

This subroutine initializes the random number seeds. If the user desires a different set of random numbers for each simulation run, the random number generator is used to reset the values of the seeds.

Functions/Subroutines

- subroutine **gcycl**

7.5.1 Detailed Description

This subroutine initializes the random number seeds. If the user desires a different set of random numbers for each simulation run, the random number generator is used to reset the values of the seeds.

Author

modified by Javier Burguete

7.6 getallo.f90 File Reference

This subroutine calculates the number of HRUs, subbasins, etc. in the simulation. These values are used to allocate array sizes.

Functions/Subroutines

- subroutine **getallo**

7.6.1 Detailed Description

This subroutine calculates the number of HRUs, subbasins, etc. in the simulation. These values are used to allocate array sizes.

Author

modified by Javier Burguete

7.7 main.f90 File Reference

this is the main program that reads input, calls the main simulation model, and writes output.

Functions/Subroutines

- program [main](#)

this is the main program that reads input, calls the main simulation model, and writes output.

7.7.1 Detailed Description

this is the main program that reads input, calls the main simulation model, and writes output.

7.7.2 Function/Subroutine Documentation

7.7.2.1 main()

```
program main ( )
```

this is the main program that reads input, calls the main simulation model, and writes output.

Author

modified by Javier Burguete Tolosa

7.8 readbsn.f90 File Reference

this subroutine reads data from the basin input file (.bsn). This file contains information related to processes modeled or defined at the watershed level

Functions/Subroutines

- subroutine **readbsn**

7.8.1 Detailed Description

this subroutine reads data from the basin input file (.bsn). This file contains information related to processes modeled or defined at the watershed level

Author

modified by Javier Burguete

7.9 readfcst.f90 File Reference

this subroutine reads the HRU forecast weather generator parameters from the .cst file

Functions/Subroutines

- subroutine **readfcst**

7.9.1 Detailed Description

this subroutine reads the HRU forecast weather generator parameters from the .cst file

Author

modified by Javier Burguete

7.10 readfile.f90 File Reference

this subroutine opens the main input and output files and reads watershed information from the file.cio

Functions/Subroutines

- subroutine **readfile**

7.10.1 Detailed Description

this subroutine opens the main input and output files and reads watershed information from the file.cio

Author

modified by Javier Burguete

7.11 readwwq.f90 File Reference

this subroutine reads the watershed stream water quality input data (.wwq file) and initializes the QUAL2E variables which apply to the entire watershed

Functions/Subroutines

- subroutine **readwwq**

7.11.1 Detailed Description

this subroutine reads the watershed stream water quality input data (.wwq file) and initializes the QUAL2E variables which apply to the entire watershed

Author

modified by Javier Burguete

7.12 simulate.f90 File Reference

this subroutine contains the loops governing the modeling of processes in the watershed

Functions/Subroutines

- subroutine **simulate**

7.12.1 Detailed Description

this subroutine contains the loops governing the modeling of processes in the watershed

Author

modified by Javier Burguete

Bibliography

[1] P Bratley, B L Fox, and L E Schrage. *A Guide to Simulation*. Springer-Verlag, New York, USA, 1983. [70](#)

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