README-1ST FILE AQUATIC PLANT GROWTH MODELS

1- EXE-files

The program file is a self-extracting compressed archive of the application's installation routine. Download the file into a temporary subdirectory on your computer; then run the program file to extract the installation files. To actually install the application, copy the folder from the temporary subdirectory to your C-drive.

2- Document-files

The available documents are in Adobe version 3 format (Pdf). Download the document files into any subdirectory you choose. You can view or print the documents using Adobe Acrobat Reader 3.0, which can be downloaded by clicking on the Pdf Reader button and following the instructions.

3- Installation and execution of the model

System Requirements

There are few requirements for running the versions 3.0 of the aquatic plant growth models. In the text below VALLA is taken as an example. The instructions are identical, except for the name of the program, for the other models (POTAM, HYDRIL, and MILFO). The minimum RAM memory requirement should be at least 512 kb. A mathematical coprocessor is in general not required but will often speed up the calculations considerably. A free hard disk space of about 1 Mb is required.

Installing VALLA (Version 3.0)

The self-extracting installation file for VALLA should be downloaded to the user's C directory from the U.S. Army Corps of Engineers, Environmental Laboratory web page:
http://el.erdc.usace.army.mil/products.cfm?Topic=model&Type=aquatic
Double-click on WILDCEL.EXE to begin the self-extraction process. The "WinZip Self-Extractor" window will then appear. Under the "Unzip to folder" header, click "browse", then select "local disk (C:)" and then click "ok". You will then be returned to the "WinZip Self-Extractor" window where you must click "unzip". WinZip will then create on the C: drive a new folder "C:\WILDCEL" and extract the contents of the file WILDCEL.EXE to this folder.

The file WILDCEL.EXE contains all necessary input data files as well as a file used to display the model output graphically (TTSELECT.EXE). The names of the directories pertaining to the 3 other plant models are: SAGO, HYDRILLA, and MILFOIL, respectively. Input files included with the previously mentioned diskette are as follows:

a. MODEL.DAT

b. TIMER.DAT

c. CONTROL.DAT

d. RERUNS.DAT

Available weather data files are included in the subdirectory /WEATHER. The user can select any one of these weather files as input for the VALLA model or may choose to create a weather file specific to a particular site. The content of the weather data files is discussed below.

Executing VALLA (Version 3.0)

The VALLA model does not require interactive input during execution. The runs have been specified completely in the data files. To execute the model, simply type

VALLA <CR> (carriage return).

An introductory screen appears and the user is prompted to press <ENTER>. During execution, the model will display the run number, year number and day number on the screen each time output to file is done. During execution, errors and warnings may occur from the weather system and/or from the other modules of the model. These errors/ warnings generally consist of one line of text. If the simulation is terminated by an error during the dynamic section of the run, the outputs generated before the error in that particular run occurred, are written to a temporary file but are not written to the output file until the terminal section of the model is reached.

4- Program structure and data files

4.1. Program Structure

The source code for VALLA (Version 3.0) is written in Fortran77. The model runs within a system called the FORTRAN Simulation Environment (version 2.1), hereafter referred to as FSE. The FSE allows a simulation model to be written with emphasis on the modeling itself rather than on other things such as time, file i/o etc.
Subroutines called during the execution of the VALLA model include MODELS, MODEL, ASTRO, TOTASS, and ASSIM. A brief description of each subroutine follows:

MODELS - This subroutine is the interface routine between the FSE-driver and the simulation model. The FSE-driver calls this routine and transfers relevant 'environment' variables (such as TIME, OUTPUT etc.) to this routine.

MODEL - This subroutine is called from subroutine MODELS. It is the routine where specific calculations for wildcelery growth begin.

ASTRO - This subroutine is called from the MODEL routine each day of the simulation period. It calculates astronomic day length, photoperiodic day length, and diurnal radiation characteristics.

TOTASS - This subroutine is called in the MODEL subroutine. It calculates daily total gross assimilation by performing a Gaussian integration over time. At three different times of the day, radiation is computed and used to determine assimilation.

ASSIM - This subroutine is called from subroutine TOTASS. Plant biomass is distributed within the layers of the plant and the instantaneous carbon dioxide assimilation rate of the plant is computed in this subroutine.

4.2. Data files

Most of the parameters and initial values of the various processes are read from data files. This has the advantage that the model does not have to be recompiled and linked each time changes are implemented to the input data. There are four input files required to run the VALLA model (excluding the weather data file) with a potential for other input files available. The model also typically creates three output data files.

In these files, terms preceded by a * are not read by the program. Therefore, the terms the user desires to be read have to be ‘freed’ from this lock. For example, if only output of TGW is desired, then only TGW has to be ‘freed’ of the preceding *, while all other terms need to have a * in front of it in the Timer-file.

The MODEL.DAT files provided are annotated with explanations of the terms. The contents of the ASCI files can be viewed and edited using text editors such as NOTEPAD and WORDPAD., and printed.

4.2.1. Input files

The MODEL.DAT file: This data file contains initial constants, model parameters, as well as data used for functions. The original MODEL.DAT file, used with calibration runs, is stored in the sub-folder “/ModelX.dat”. For VALLA it is named VALLAVC3.DAT and can be copied to the C:/WILDCEL folder and renamed MODEL.DAT if the current file becomes corrupt.

The TIMER.DAT file: This data file specifies variables for the following:

a. Time control.

    (1) Start time and finish time.

    (2) Time step integration.

    (3) Year.

b. Output

    (1) Time between different outputs.

    (2) Format of the output file.

    (3) Selection of output variables.

c. Weather control

    (1) Directory in which the weather data are stored.

    (2) Country code.

    (3) Station number.

An example of the TIMER.DAT file is provided at the end of this README file.

The RERUNS.DAT file: If the reruns file is absent or empty, the model will execute a single run (one year) from the standard data files. By creating a reruns file, the model will execute additional runs with different parameters and/or initial values for the state variables (or even different input files). Therefore, the total number of runs made by the model is always one more than the number of rerun sets. The format of the rerun files is identical to that of the other data files, except that the names of variables may appear in the file more than once. An example of the RERUNS.DAT file is provided at the end of this README file.

The CONTROL.DAT file: This file contains the names of both input and output files used during the execution of VALLA. An example of the CONTROL.DAT file is provided at the end of this README file.

4.2.2. Output files

VALLA creates three standard output files with a potential fourth, binary file: RES.DAT (Appendix B), MODEL.LOG, WEATHER.LOG, and RES.BIN.

The RES.DAT file: This file contains the output of the model with the reruns (if present) merged below each other in the file. The file can be inspected using an on-screen text editor. The format of the output file RES.DAT depends on the value of the variable IPFORM from the timer file .

The MODEL.LOG file: This file may contain the messages from routines used during the simulation. Messages about replacements by the reruns facility can be particularly useful. To make sure the execution of the model is without errors this file should be inspected.

The WEATHER.LOG file: This file contains all the messages generated by the weather system. By default, all the comment headers of the data files, all warnings and all errors from the weather system are written to this log file. If errors or warnings occur during a run, a message is displayed shortly before the termination of the model about possible errors or warnings. These messages are explained in more detail in the log file.

The RES.BIN file: The variable "DELTMP" found in the TIMER.DAT file determines if the temporary output data (RES.BIN) should be deleted or saved at termination of the simulation (DELTMP = 'N', Do not Delete, DELTMP = 'Y', Delete). Using this file, it is possible to generate graphs of the model's output termination of the simulation. This can be done using the TTSELECT program, provided DELTMP is set to 'N' in the timer file. An executable of this program is included in this distribution package. For more details on TTSELECT, see ‘Displaying Output’.

4.2.3. Weather data files

The weather data system consists of two parts: the weather data files and a program to retrieve data from those files. A single data file can contain the daily weather data of one meteorological station for one particular year. The country name (abbreviated), station number and year to which the data refer are reflected in the name of the data file (e.g. USA6.978 applies to data from the American (USA) meteorological station in Binghamton (6) for the year 1978).

Daily values are provided for the following weather parameters:

Name	Unit
Global radiation(daily total)	$kJ/m^2/d$
Minimum air temperature	degrees Celsius
Maximum air temperature	degrees Celsius
Vapor pressure	kPa
Wind speed (daily average)	m/s
Rain (daily total)	mm/d

The user can create a weather data file that is unique to a particular site. The file consists of four parts: a file header containing some explanatory text, one line with location

parameters of the station, lines with measured data and, optionally, so-called status lines giving information on the way missing data should be handled by the reading program.

Displaying output

The program TTSELECT.EXE is included within this distribution package. Execution of this program allows the user to graphically view output parameters stored in the file RES.BIN. To use this feature of the package, after termination of the VALLA simulation, type the following command:

TTSELECT <CR> (carriage return).

A list of all possible output parameters will then be displayed at the top of the computer screen. The user must select two or more of these parameters by entering the parameter name separated by a space or comma (NOTE: Parameter names must be entered exactly as they appear on the screen). The first parameter entered (always TIME) will appear as the x-axis variable while all other variables entered will be plotted along the y-axis. Once all output parameter names are entered, the user must follow instructions on the screen by pressing a <CR> (carriage return). The output graph will then be displayed.

There are several options available once the graph is displayed: (a) the plot can be saved as a file, (b) it can be saved as a screen dump file for later printing, or (c) it can be printed on a Hewlett Packard DeskJet or LaserJet printer. If desired, another set of parameters can be viewed by entering different output parameters. At anytime, the user may exit the TTSELECT.EXE program by typing CONTROL Z followed by a <CR> (carriage return).

5- Running the model within a shell and rapid displaying output

Here a brief description is provided of how the FSE-shell drives the VALLA model. All execution starts with a MAIN program. This is a short program which displays the header and calls the FSE-driver. The FSE-driver then performs a number of actions. It reads the input and output file names needed by the model from the file CONTROL.DAT. This file contains the names of the input files TIMER.DAT, RERUNS.DAT and MODEL.DAT. The CONTROL.DAT file also contains names of the model's output files (RES.DAT and MODEL.LOG). From the weather control variables in the TIMER.DAT file, the weather system determines which weather data file is required.

The FSE-driver then calls a MODELS subroutine and transfers all relevant 'environment' variables (such as TIME, OUTPUT, ... etc.) to this routine. The MODELS subroutine provides the interface between the FSE-driver and the simulation model. This routine in

turn calls the MODEL subroutine which begins execution of the various routines within the VALLA source code.

It is not necessary to know the FORTRAN details of what is going on in the FSE-driver.

For references: please click on ‘Related publications’.

Output Parameters Available

Abbreviation	Explanation	Dimension
DAVTMP	Daily average temperature	^{o}C
DAYL	Day length	h
DDTMP	Daily average daytime temperature	^{o}C
DTEFF	Daily effective temperature	^{o}C
DTGA	Daily total gross CO_2 assimilation of the plant	g $CO_2.m^{-2}.d^{-1}$
DPT	Water depth	m
DVS	Development phase of the plant	-
FGROS	Instantaneous CO_2 assimilation rate of the plant	g $CO_2.m^{-2}.h^{-1}$
GPHOT	Daily total gross assimilation rate of the community	g $CH_2O.m^{-2}.d^{-1}$
IRS	Total irradiance just under the water surface	$J.m^{-2}.s^{-1}$
MAINT	Maintenance respiration rate of the plant	g $CH_2O.m^{-2}\cdot d^{-1}$
NDTUB	Dormant tuber number	dormant tubers.m^{-2}
NGTUB	Sprouting tuber number	spr.tubers.m^{-2}
NNTUB	New tuber number	new tubers.m^{-2}
NTM	Tuber density measured (field site)	tubers.m^{-2}
NTUBD	Dead tuber number	dead tubers.m^{-2}
REMOB	Remobilization rate of carbohydrates	g $CH_2O.m^{-2}.d^{-1}$
TEFF	Factor accounting for effect of temperature on maintenance respiration, remobilization, and maximum relative tuber growth rate	-
TGW	Total live plant dry weight (excluding tubers)	g $DW.m^{-2}$
TGWM	Total live plant dry weight measured (field site)	g $DW.m^{-2}$
TMPSUM	Temperature sum after 1 January	^{o}C
TRANS	Translocation rate of carbohydrates	g $CH_2O.m^{-2}.d^{-1}$
TREMOB	Total remobilization	g $CH_2O.m^{-2}$
TW	Total live + dead plant dry weight (excluding tubers)	g $DW.m^{-2}$
TWGTUB	Total dry weight of sprouting tubers	g $DW.m^{-2}$
TWLVD	Total dry weight of dead leaves	g $DW.m^{-2}$
TWLVG	Total dry weight of live leaves	g $DW.m^{-2}$
TWNTUB	Total dry weight of new tubers	g $DW.m^{-2}$
TWRTD	Total dry weight of dead roots	g $DW.m^{-2}$
TWRTG	Total dry weight of live roots	g $DW.m^{-2}$
TWSTD	Total dry weight of dead stems 2 or 3 cohorts	g $DW.m^{-2}$
TWSTG	Total dry weight of live stems 2 or 3 cohorts	g $DW.m^{-2}$
TWTUB	Total dry weight of tubers	g $DW.m^{-2}$
TWTUBD	Total dry weight of dead tubers	g $DW.m^{-2}$
WTMP	Daily water temperature	^{o}C

TIMER.DAT File Provided

```
*-----------------------------------------------------------------------------------------------------------*
* TIMER file contains                                                                                       *
*                                                                                                           *
* - The used DRIVER and TRACE in case of GENERAL translation                                                *
* - The TIMER variables used in both translation modes                                                      *
* - Additional TIMER variables in case of GENERAL translation                                               *
* - The WEATHER control variables if weather data are used                                                  *
* - Miscellaneous FSE variables in case of FSE translation                                                  *
*                                                                                                           *
* File: VALLA.FOR                                                                                           *
* Date: 09-08-97                                                                                            *
* Time: 15:40:06                                                                                            *

* TIMER variables used in GENERAL and FSE translation modes                                                 *
* ----------------------------------------------------------------------------------------------------------*
 STTIME        = 1.          ! start time
 FINTIM        = 365.        ! finish time
 DELT          = 1.          ! time step (for Runge-Kutta first guess)
 PRDEL         = 1.          ! output time step
 IPFORM        = 4           ! code for output table format:
                             ! 4 = spaces between columns
                             ! 5 = TAB's between columns (spreadsheet output)
                             ! 6 = two column output

                             ! The string array PRSEL contains the output variables for
                             ! which formatted tables have to be made. One or more times
                             ! there is a series of variable names terminated by the word
                             ! <TABLE>.
                             ! The translator writes the variables in each PRINT statement
                             ! to a separate table.
 PRSEL =
* 'DAVTMP',
* 'DAYL  ',
* 'DDTMP ',
* 'DTEFF ',
* 'DTGA  ',
* 'DVS   ',
* 'FGROS ',
* 'GPHOT ',
* 'IRS   ',
* 'MAINT ',
 'NDTUB ',
* 'NGTUB ',
* 'NNTUB ',
* 'NTM  ',
* 'NTUBD ',
* 'NTUBPD',
* 'REMOB ',
*  'TEFF  ',
 'TGW   ',
* 'TGWM  ',
* 'TRANS ',
* 'TREMOB',
* 'TW    ',
```

```
* 'TWGTUB',
* 'TWLVD ',
* 'TWLVG ',
* 'TWNTUB',
* 'TWRTD ',
 'TWRTG ',
* 'TWSTD ',
* 'TWSTG ',
* 'TWTUB ',
* 'TWTUBD',
*'WTMP ',
        '<TABLE>'
 COPINF = 'N'            ! Switch variable whether to copy the input files
                         ! to the output file ('N' = do not copy,
                         ! 'Y' = copy)
 DELTMP = 'N'           ! Switch variable what should be done with the
                         ! temporary output file ('N' = do not delete,
                         ! 'Y' = delete)
 IFLAG  = 1101           ! Indicates where weather error and warnings
                         ! go (1101 means errors and warnings to log
                         ! file, errors to screen, see FSE manual)
*IOBSD = 1991,182        ! List of observation data for which output is
                         ! required. The list should consist of pairs
                         ! <year>,<day> combination


* WEATHER control variables
* ----------------------------------------
 WTRDIR        =        'C:\WILDCEL\WEATHER\'
 CNTR          =        'USA'          ! Country code
 ISTN          =        6              ! Station code
 IYEAR         =        1978           ! Year
```

Example of RERUNS.DAT File

```
*-------------------------------------------------------------------------------------------------------*
* RERUNS file ... to produce multiple runs ...                                                          *
* File: VALLA.FOR                                                                                       *
* Date: 09-12-95                                                                                        *
* Time: 11:00:00                                                                                        *
*-------------------------------------------------------------------------------------------------------*

* RERUNS variables used in GENERAL and FSE translation modes
* ----------------------------------------------------------------------------------------
 YRNUM        = 2.     ! 2nd year of simulation
 HAR          = 1.     !1=YES, harvesting does occur
 HARDAY       = 74.    ! Harvesting occurs on Julian day number 74
 HARDEP       = 1.0    ! Harvesting depth is 1.0 m
 YRNUM        = 3.     ! 3rd year of simulation
 HAR          = 1.     ! 1=YES, harvesting does occur
 HARDAY       = 181.   ! Harvesting occurs on Julian day number 181
 HARDEP       = 0.5    ! Harvesting depth is 0.5 m
```

Example of CONTROL.DAT file

```
*-------------------------------------------------------------------------------------------------------*
* CONTROL.DAT data file contains:                                                                       *
*       - File names to be used by FSE 2.1                                                              *
*       - The input files (except FILEIR) may be used in reruns; up to                                  *
*         five input data files may be used (FILEI1-5)                                                  *
*-------------------------------------------------------------------------------------------------------*

   FILEON       = 'RES.DAT'          ! Normal output file
   FILEOL       = 'MODEL.LOG'        ! Log file
   FILEIR       = 'RERUNS.DAT'       ! Reruns file
   FILEIT       = 'TIMER.DAT'        ! File with timer data
   FILEI1       = 'MODEL.DAT'        ! First input data file

* FILEI2       = ' '                ! Second input data file (not used)
* FILEI3       = ' '                ! Third input data file (not used)
* FILEI4       = ' '                ! Fourth input data file (not used)
* FILEI5       = ' '                ! Fifth input data file (not used)
```

Example of RES.DAT File

```
*-------------------------------------------------------------------------*
* Output table number  :  0 (=first output table)                         *
* Output table format  : Table output                                     *
 * Simulation results                                                     *
 *-------------------------------------------------------------------------*

    TIME        NDTUB         TGW

 1.00000       233.00       .00000
 2.00000       231.95       .00000
 3.00000       230.91       .00000
 4.00000       229.87       .00000
 5.00000       228.83       .00000
 6.00000       227.80       .00000
 7.00000       226.78       .00000
 8.00000       225.76       .00000
 9.00000       224.74       .00000
 10.0000       223.73       .00000
    .             .          .
    .             .          .
 363.000       122.33       8.6301
 364.000       121.78       8.4910
 365.000       121.19       8.3485
```

Weather Data File Provided

```
*-------------------------------------------------------------------------------------------------------------------*
* Country: United States of America                                                                                 *
* Station: Binghamton,NY (Solar & wind from Ithaca, NY)                                                             *
* Year: 1978                                                                                                        *
*  Source: Cornell University                                                                                       *
*  Author: Jeffrey Schultz                                                                                          *
*  Longitude: 75 50 W                                                                                               *
*  Latitude: 42 15 N                                                                                                *
*  Elevation: 000 m.                                                                                                *
*  WMO-code: - ;US station code 4174, in this file changed to 1                                                     *
*            Phone 607-255-1751 .. ftp//:mist.cit.cornell.edu                                                       *
*  Comments: Data obtained from Jeffrey Schultz (Cornell University, Ithaca, NY)                                    *
*          Converted and arranged into weather files by Will Boyd (1997)                                            *
*          Elevation listed as 0 because unknown to us                                                              *
*  Columns:                                                                                                         *
*  ========                                                                                                         *
*  station number                                                                                                   *
*  year                                                                                                             *
*  day                                                                                                              *
*  irradiation (kJ m-2 d-1)                                                                                         *
*  minimum temperature (degrees Celsius)                                                                            *
*  maximum temperature (degrees Celsius)                                                                            *
*  vapour pressure (kPa)                                                                                            *
*  mean wind speed (m s-1)                                                                                          *
*  precipitation (mm d-1)                                                                                           *
*-------------------------------------------------------------------------------------------------------------------*
    75.83 42.25      000.        0.00     0.00
  1      1978            1      2806.   -10.6    -3.3     .000     2.4      3.6
  1      1978            2      4397.   -10.0    -3.3     .000     2.7      1.0
  1      1978            3      5067.   -13.3    -8.3     .000     3.1       .3
  1      1978            4      6994.   -12.2    -3.9     .000     3.3      0.0
  1      1978            5      7161.    -3.9      .0     .000     2.4       .0
  1      1978            6      2010.    -1.7     1.7     .000      .8      0.0
  1      1978            7      2973.    -1.7      .0     .000     1.2      4.8
  1      1978            8      1591.     -.6    10.6     .000     5.5     14.5
  1      1978            9      1173.   -15.0    11.1     .000     6.1     20.6
  1      1978           10      3099.   -15.6   -10.6     .000     4.9      7.4
  1      1978           11      2806.   -11.7    -7.2     .000     6.2      0.0
  1      1978           12      6366.   -11.7    -6.1     .000     3.3       .3
  1      1978           13      4356.    -7.8    -4.4     .000     1.3      3.3
  1      1978           14      3099.   -12.8    -5.0     .000     2.3     11.9
  1      1978           15      2052.   -13.9   -10.0     .000     3.2      0.0
  .      .               .         .       .       .        .       .        .
  .      .               .         .       .       .        .       .        .
  .      .               .         .       .       .        .       .        .
  1      1978          363      3350.   -15.0    -6.7     .000     2.4      0.0
  1      1978          364      6575.   -10.0     -.6     .000     1.3       .0
  1      1978          365      4272.    -1.7     5.0     .000     4.6      3.0
```

* Note: Longitude and latitude in the header are listed in degrees and minutes while they are listed in degrees only on the first line of the weather data.