Appendix 3
Description on Excel files accompanying WaNuLCAS model

The WaNuLCAS model is accompanied by 2 excel file; Wanulcas.xls and TreeParameterization.xls. Wanulcas.xls contains input parameters and routines to generate these input parameters. The input parameters are linked to WaNuLCAS model. See table in Appendix 2, page 149 for short descriptions of Wanulcas.xls content. TreeParameterization.xls is developed to generate input parameters for tree. There are several other help files to assist users in generating input parameters as well as better understand WaNuLCAS model. See our web page for more information.

Wanulcas.xls

The basic purpose of this Excel file is to ease users in modifying input parameters needed to run WaNuLCAS model. Input parameters in this file are linked to the model (in the WaNuLCAS.stm file).

There are two ways to change input parameters in excel, making sure changes also occur inside the model:

1. Change input values in excel ONLY if you run the model and excel simultaneously with links established, or
2. Change input values in excel before hand then save the file. When you run the model and establish links with excel later, make sure you press Ctrl-U, Ctrl-Y or Ctrl W. This is an updating macro built within this file, that re-activates the links and sends the current parameter values of the excel file to their counterparts in stella. The macro activated by Ctrl-U will update crop and tree parameters, the Ctrl-Y will update the soil and Ctrl W will update climate parameters.

The second option also allows you to store a number of parameter sets for specific locations under separate names (e.g. WanSite1.xls) and use them for simulations by renaming them to Wanulcas.xls and running the update macro's.

If in doubt whether parameters are actually sent across, you can open a table in Stella and ask to show (a sample of) the parameter values in the model and compare them with the input you expected to be used.

Below are comprehensive explanation of each sheet and the relevant WaNuLCAS input parameters are tabulated. Refer to Appendix 7 for definition of acronyms.

READ ME sheet

This is the main menu of Wanulcas.xls. It contains general information and button commands to browse other sheets.

Pedotransfer sheet

The 'Pedotransfer' sheet contains calculation tools to help generating tables of soil hydraulic parameters. The routine is based from Wösten et al. (1998).

You will need to enter 5 input parameters for basic soil properties in the 'Input' section of this sheet. The pedotransfer function then estimates the parameters of a Van Genuchten equation and tabulates the relations between soil water content, hydraulic conductivity and pressure head.

The saturated hydraulic conductivity Ksat generated in this equation is used as a default value, representing a soil with little structure and macroporosity. The model will use the KsatInit value that you specify yourself - if it differs from the default value it is possible to simulate a gradual collapse of soil structure (with a rate governed by S_KStructDecay, set at 0.001); macroporosity can be re-created by 'Worm' activity (see Section 3.3.6).

In WaNuLCAS two definitions of 'field capacity' are used to determine the maximum soil water content one day after a rainfall event:

- Fieldcap1 = the soil water content (found in cell O11) at which downward drainage will become less then a small value Kcrit (set in cell B36 of the input section, e.g.. 0.1 cm d-1), and
- Fieldcap2 = the soil water content that is in hydrostatic equilibrium with a water table at a distance defined from the bottom of layer 4 (default distance is 0). This second value is calculated inside the Stella model.

For the actual calculations the highest of these two values for any cell is used.

The results generated by the pedotransfer routine are found in the 'Output' section of this sheet. These generated values are input parameters for WaNuLCAS model.

WaNuLCAS input parameters	Location in Excel
W_PhiTheta	cells N13 – N64
W_Ptheta	cells O13 – O64
W_PhiP (this is linked to 4 tables in the stella: W_PhiPH, W_PhiPMH, W_PhiPML, W_PhiP)	cells R13 – R64
W_ThetaPMax, W_ThetaP	cells U13 – U64
KsatDflt (default value, endpoint of loss of soil structure)	N11
Ksat (value used to initializa the model)	M11
Field Capacity1 (conductivity-limited)	O11

These input parameters need to be copied to the sheet 'Soil Hydraulic' properties. To copy the parameters for soil layer i and zone j, fill in i and j in cell N8 and N9 then click on the **COPY** button.

You can set up the model with the same properties for all zones and layers by repeating this for i = 1...4 and j = 1...4, modify the properties by layer or use different properties for any of the 16 cells.

Phosphorus sheet

The 'Phosphorus' sheet contains a procedure to calculate Ka_P, the apparent P adsorption constant as a function of the P concentration and P availability indices such as the P_Bray value. To run this, click on button **Psorption isotherm & Soil Database**. In this section you need to fill in the soil type for each layer of your soil in cells M8...M11. We provide default values for 9 soil types, as listed in U12....U20 If you have your own data, you can fill in parameters of a single or two-term Langmuir isotherm to describe your soil type. The parameters currently used for each soil layer are found in cells N8...R11. You also have to specify the bulk density of each layer (it is possible to use a value here that differs from the one used in the pedotransfer sheet...).

The parameters of the Langmuitr sorption isotherm are used to derive values of Ka_P for each layer, tabulated in the '**P Sorption Output**' section of the worksheet These values are linked to the WaNuLCAS.stm model.

This sheet also includes a section to initialize P in each cell (zone * layer), on the basis of indices of P availability such as the P_Bray value. To do this, you first have to specify two properties of the P availability index: the volume

ratio of soil to solution used during the extraction, and the relative sorption affinity in the extraction medium (at the temperature and other conditions used). For two methods we provide these parameters P-water (compare De Willigen and Van Noordwijk, 1987) and P-Bray (with a tentative, poorly tested estimate of the relative sorption affinity of 2% of the original value).

Once the method has been thus defined, click on '**Initial P Soil**' and fill in the initial P soil indices for each cell (AD8...AG11). The values will be converted to amount of soil P in the units expected in WaNuLCAS.stm in cells (AD14...AG17). These converted values are linked to the Stella model.

WaNuLCAS input parameters	**Location**
Initial P in soil, N_Init*i*[P,Zone]; *i* = 1, .., 4	cells AC14 – AF17
N_KaPDef[Layer]	cells C93 – C143, E93 – E143, G93 – G143, I934 – I143

Weather sheet

This sheet stores daily data for 3 weather components in WaNuLCAS: Rainfall, Soil Temperature and Potential Evaporation. Default length of data and links are 1 year (365 days). These data are linked.

WaNuLCAS input parameters	**Location**
Rain_Data	cells C5 – C369
Temp_DailyData	cells D5 – D369
Temp_DailyPotEvap	cells E5 – E369

Slash&Burn sheet

This sheet holds input parameters related to impacts of slash and burn on soil as a function of increased temperature at the soil surface.

WaNuLCAS input parameters	Location
S&B_SurfLitBurnFrac	cells B12 – B26
S&B_NecroBurnFrac	cells C12 – C26
S&B_DeadWoodBurnFrac	cells D12 – D26
S&B_AerosolFrac	cells E12 – E26
S&B_NvolatFrac	cells F12 – F26
S&B_PvolatFrac	cells G12 – G26
S&B_SOMBurnFrac	cells J12 – J19
S&B_FirMortSeedBank	cells K12 – K19
S&B_FirIndPMobiliz	cells L12 – L19
S&B_FirImpPSorption	cells O12 – O26

Crop Management sheet

This sheet holds a schedule for planting crops (by zone and type) and applying N or P fertilizers. The current simulation year is defined as YEAR 0.

In this sheet you will be able to define the type of crop you plan to use in the simulation. In cell B2-F2 fill the letter code of crop type associated with the code in the database. It is written as options on the left hand side or see sheet **CROP LIBRARY**. The type of crop you choose here determine the parameter values copied to sheet **CROP PARAMETERS** and **PROFITABILITY**, where the values are linked to model.

WaNuLCAS input parameters	Location
Ca_PlantYear[Zone]	cells B11 – B31, G11 – G31, L11 – L31, Q11 – Q31
Ca_PlantDoY[Zone]	cells C11 – C31, H11 – H31, M11 – M31, R11 – R31
Ca_CType[Zone]	cells D11 – D31, I11 – I31, N11 – N31, S11 – S31
Ca_FertOrExtOrgAppYear	cells V11 – V51
Ca_FertOrExtOrgAppDoY	cells W11 – W51
Ca_FertApply?[SINut]	cells X11 – X51, Y11 – Y51
Ca_ExtOrgApply?[Type]	cells Z11 – Z51, AA11 – AA51
Ca_FertOrExtOrgAmount[Zone] []	cells AB11 – AB51, AC11 – AC51, AD11 – AD51, AE11 – AE51

You have a maximum of 5 different crop type to grow in one simulation. The letter code you fill in here will be converted to crop type value of 1 to 5, which you will use as input parameter in column **D**, **I**, **N** and **S**.

Tree Management sheet

This sheet holds a schedule for tree planting, pruning and timber harvesting. As in **CROP MANAGEMENT** the current simulation year is defined as YEAR 0.

This where you define the type of tree you plan to use in the simulation. In cell E4-G4 fill the letter code of tree type associated with the code in the database. It is written as options on the left hand side or see sheet **TREE LIBRARY**. The type of crop you choose here determine the parameter values copied to sheet **TREE PARAMETERS** and **PROFITABILITY**, where the values are linked to model.

It is possible to grow 3 different tree type simulteneously.

WaNuLCAS input parameters	Location
T_PlantY[Tree]	cells C11 – C31, E11 – E31, G11 – G31
T_PlantDoY[Tree]	cells D11 – D31, F11 – F31, H11 – H31
T_PrunY	cells K11 – K51
T_PrunDoY	cells L11 – L51
T_PrunFracD[Tree]	cells M11 – M51, O11 – O51, Q11 – Q51
T_PrunHarvFracD[Tree]	cells N11 – N51, P11 – P51, R11 – R51
T_WoodHarvY[Tree]	cells C37 – C57, E37 – E57, G37 – G57
T_WoodHarvDoY[Tree]	cells D37 – D57, F37 – F57, H37 – H57

Crop Library sheet

This sheet holds a database for crop specific parameters and crop related input-output for the system simulated. Overall there are 58 input parameters including 5 growth parameters as a function of crop stage. Some parameters are only required for specific settings in the simulation, e.g. there are three mutually exclusive ways of determining root length density in each cell in each time step, as governed by C_RootType.

Currently there are 10 possible type of crops in the database. For 5 of them we have provided default values, that is for crop Cassava, Maize, Upland Rice, Groundnut and Cowpea. If you have your own data you can fill your data values under crop type Yours1, ..., Yours5. For the whole list of input parameters stored, please refer directly to the excel sheet.

To choose the type of crop you use in simulation fill in relevant cell in sheet CROP MANAGEMENT.

Tree Library sheet

This sheet holds tree specific parameters. There are 95 input parameters. As in crop specific parameters, some inputs are only required if you run certain type of simulations.

All you need to fill in this sheet is the letter code of tree type (cell E8 - G9) associated with the code in the database. You have a maximum of 3 different tree type grow simultaneously in one simulation. The tree type you fill in is link to **PROFITABILITY** sheet

In the database we have so far provided only 2 default values for the trees Gliricidia sepium and Peltophorum dasyrrachis. If you have your own data you can fill in this value into the database (see cell L6).

For the whole list of input parameters stored, please refer directly to the excel sheet.

Soil Hydraulic sheet

This sheet contains soil hydraulic input parameters as generated and copied from Pedotransfer sheet. The cells here are linked to the WaNuLCAS model. There are no user inputs required here, as all input is generated by the pedotransfer sheet. You can, however, check that the COPY command has lead to the expected results or not.

Profitability sheet

The sheet contains input needed in the simulated systems and output produced. There are basically 3 categories of input, for the whole field, trees and crops. Input for the whole field you will need to fill in this sheet, while for plant input it is filled in database TREE/CROP LIBRARY

See directly in the excel sheet the whole list of input parameters.

Tree parameterization.xls

This file for generate input parameters in tree library in WaNuLCAS.xls. Below are the detail explanation for each sheet carried out.

Main sheet, this sheet is the main menu of tree parameterization.xls which is conducted in to two parts tree survey and FBA model. Tree survey is more for estimate the tree specific parameter while FBA model for estimate allometric branching for WaNuLCAS. It contains general information and button commands to browse tree survey and FBA model.

Survey sheet, this sheet contains 39 question that split in to 10 categories, growth stage, growth, canopy, light capture, rain interception, tree water, N fixation, N and P concentration, litterfall and litterquality. Users may answer all questions or only some of those related to the certain category.

WaNuLCAS sheet, while user answer the question on sheet survey, the input parameter for WaNuLCAS.xls (tree library sheet) will be automatically estimated on this sheet, later user can copy the result from this sheet to the tree library sheet.

WanFBA sheet, all input that needed to run FBA model are prepared on this sheet based on the observational data in the field. The input are needed split in to 4 categories, information of branching pattern, information of tree size, information of woody part and information of final links.

Input sheet, when user had finished fill in all the information, with 'Ctrl H' will be automatically estimated all input that needed to run the FBA model on this sheet, and 'Ctrl R' will be automatically estimated biomass allometric equation for each part (total biomass, wood, leaf and twig and litterfall). The biomass allometric equation will be automatically copied on sheet WaNuLCAS.

Sumoutput sheet, the sumoutput shows not only allometric equation but also all the important information that can be obtained from this program.

Estimate sheet, this sheet contains estimate input for WanFBA input compared to the default value.