The Agriculture and Land Use Greenhouse Gas Inventory Software (ALU)

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Presented by: Eleanor Milne, US EPA

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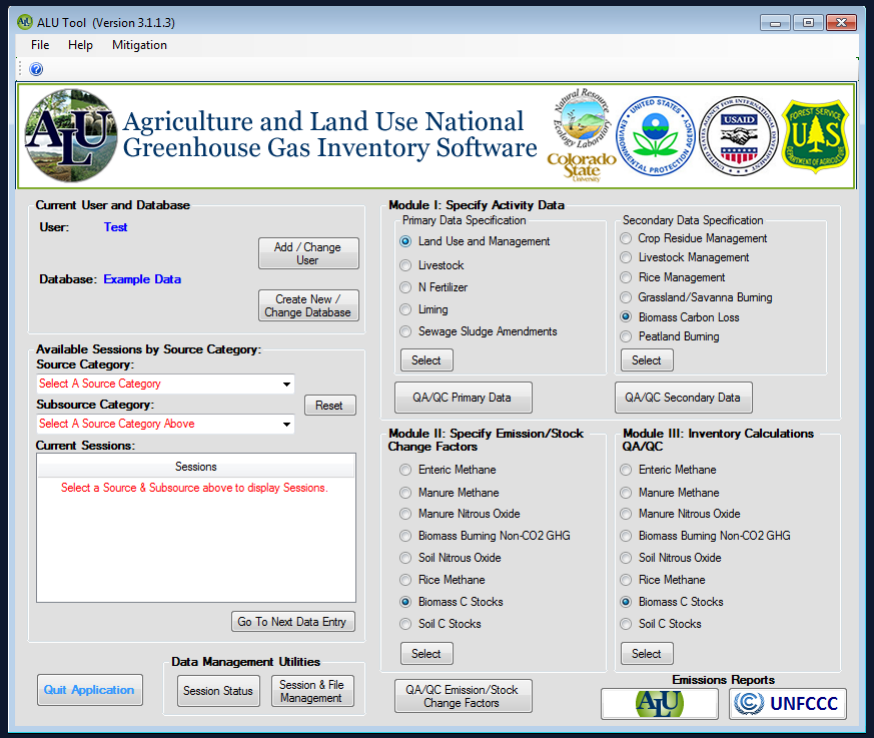
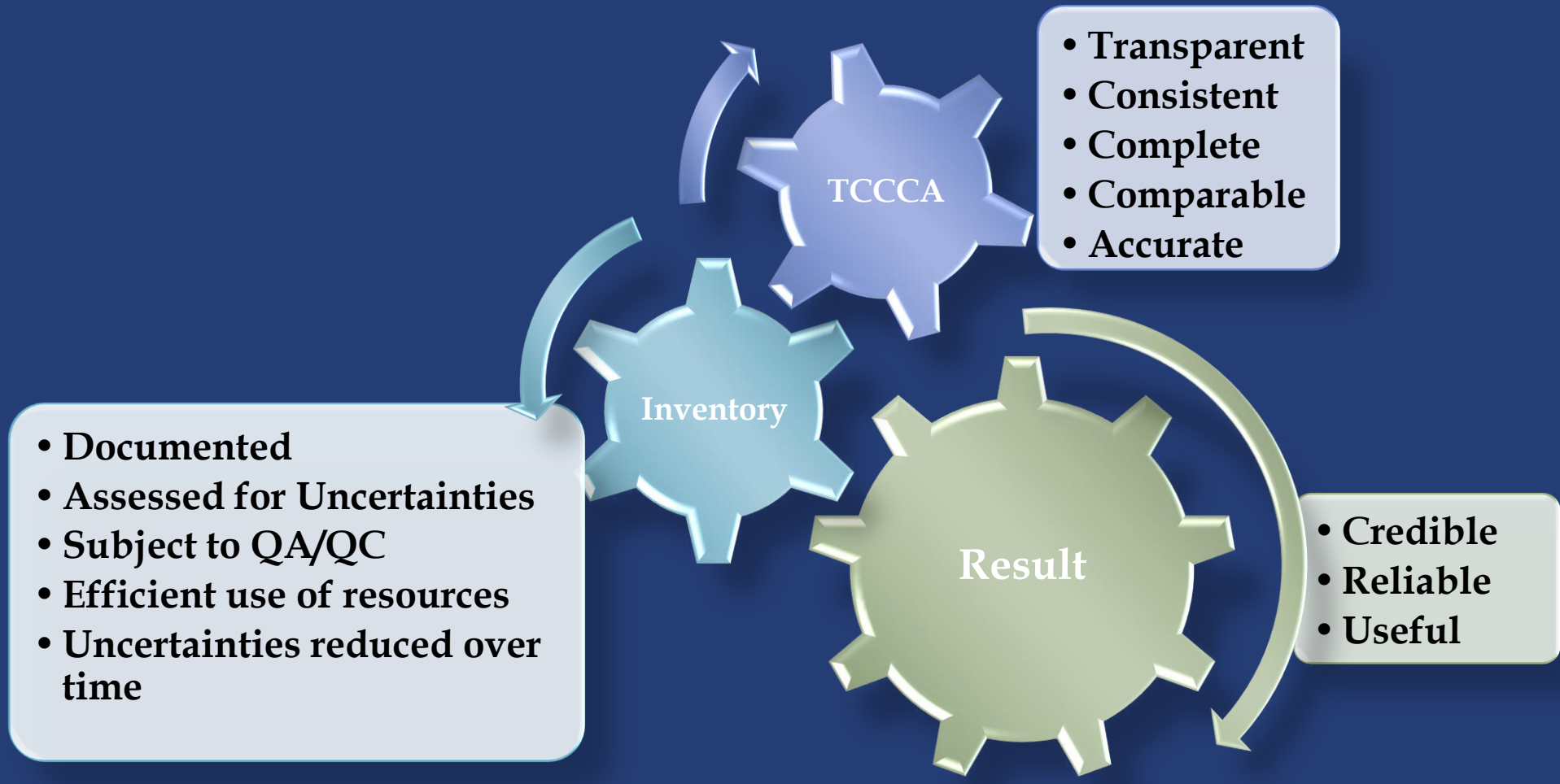
Colorado State University

Why was ALU Developed?

- Agriculture and Land Use Greenhouse Gas Inventory Software (ALU) provides advanced functionality
  - To provide more guidance to the compiler through the process of the inventory analysis for LULUCF and Agriculture sectors than spreadsheets tools
  - Provide data management capabilities and facilitate institutional memory with documentation
  - Provide utilities that encourage good practice!



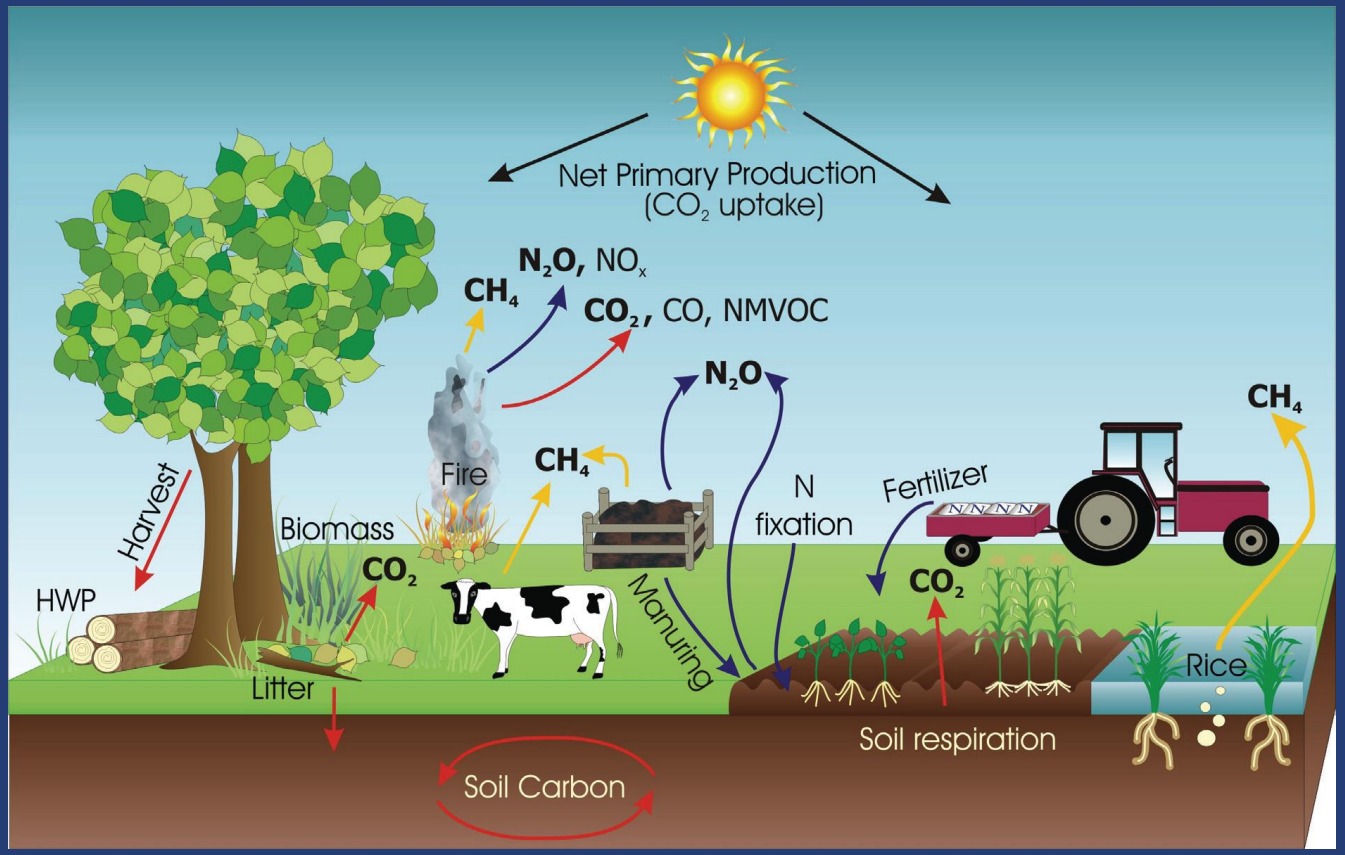
Basis for Good Practice



Source Categories in ALU

Biomass C Stock Changes

Non-CO_2 GHG Emissions from Burning



CH_4 and N_2O from Manure

Soil N_2O Emissions

Rice Methane

Enteric Methane

Soil C Stock Changes

From 2006 IPCC Guidelines

Data Management in ALU

- Agriculture and LULUCF require considerable data
- Relational database structure
  - Efficient storage of data
- Relate activity data directly to calculations
- Assign emission factors automatically

Advancing to Tier 2

- Tier 1 is acceptable for reporting but default emission factors can lead to significant biases
- It is good practice to apply Tier 2 or 3 for key sources
  - Why? Provides more accurate emission estimates
- ALU facilitates application of Tier 2 methods from activity data compilation to assignment of emission factors

Complete Representation of Land

- It is good practice to classify the entire national land base into managed/unmanaged land and the IPCC land use categories
  - Why? Allows for a full accounting of all emissions from managed land
  - Comparability among national inventories

- ALU facilitates use of remote sensing-based products to achieve a complete representation of managed land base across the time series

Documentation/Archiving

- It is good practice to be transparent and document methods for reporting purposes
  - Why? So that other parties understand how the estimates were derived
- Also, institutional memory requires documentation and archiving
- ALU provides utilities to facilitate documentation
  - Note boxes for documentation provided in software
- ALU makes archiving easier for the compiler
  - Back-up utilities provided

Consistency in Time Series

- It is good practice to have a consistent application of methods across the inventory time series
  - Why? Because evaluating trends in emissions is a goal of an inventory so that it is possible to determine if emissions are increasing or decreasing
- ALU facilitates recalculation and consistent application of methods across a time series
  - Easily re-assign emission factors to previous years' data when factors are developed
  - Updating past activity data is possible when new information becomes available

Quality Assurance/Quality Control

- It is good practice to conduct QA/QC
  - Why? Reviewing the data as a QA/QC measure uncovers errors by the compiler
  - Also can allow input of third parties who may have knowledge of other data relevant for the inventory
- ALU provides a utility that facilitates QA/QC
  - Interface displays data which can be validated as QA/QC is completed
  - Export QA/QC data for ease of distribution for review

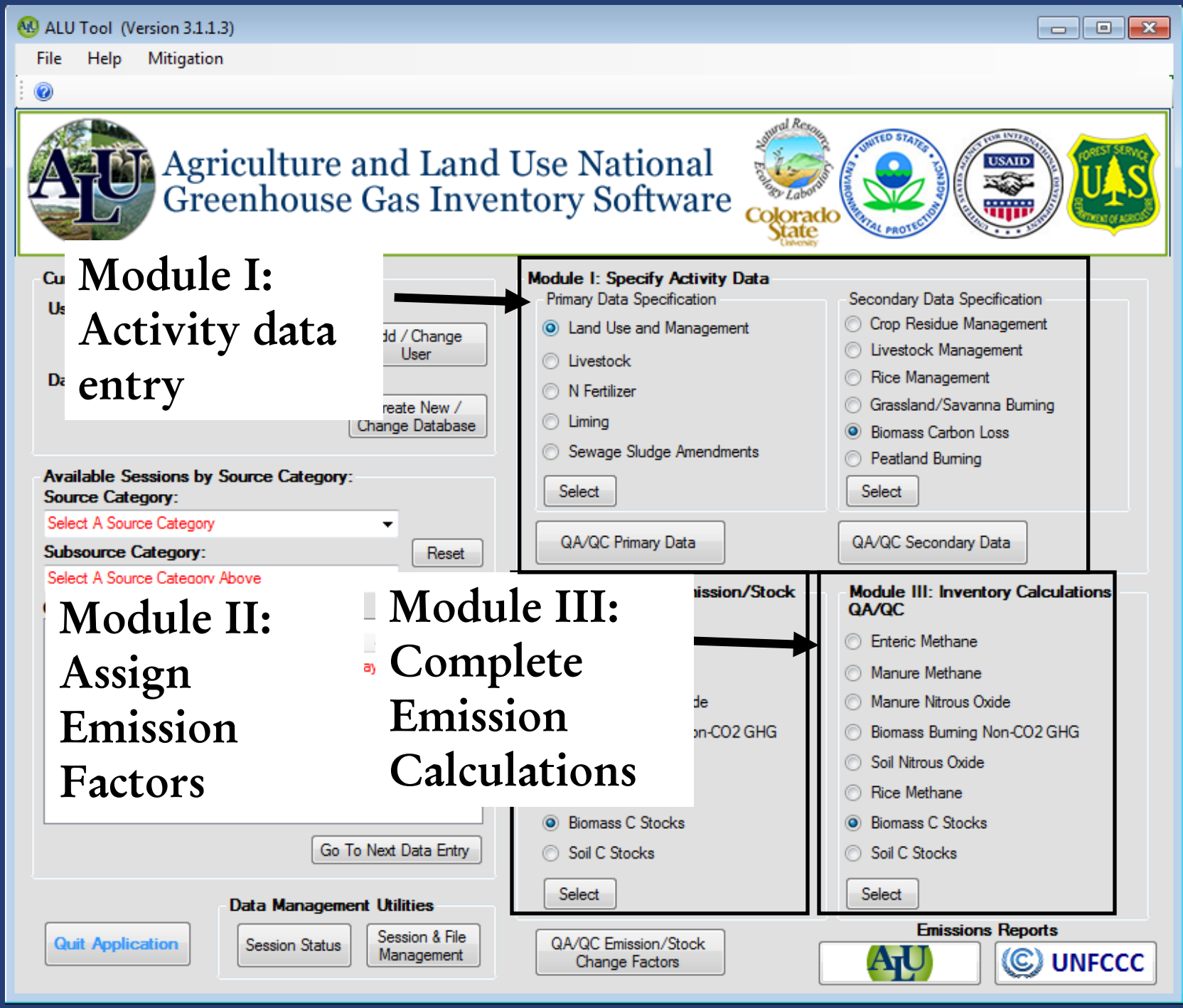
Estimate Uncertainty

- *Inventories following good practice "contain neither over- nor under-estimates so far as can be judged, and which uncertainties are reduced as far as is practicable" (IPCC GPG 2000).*
- Difficult to evaluate if uncertainty is not estimated
- ALU encourages the compilation of uncertainty data with the activity data collection and development Tier 2 emission factors

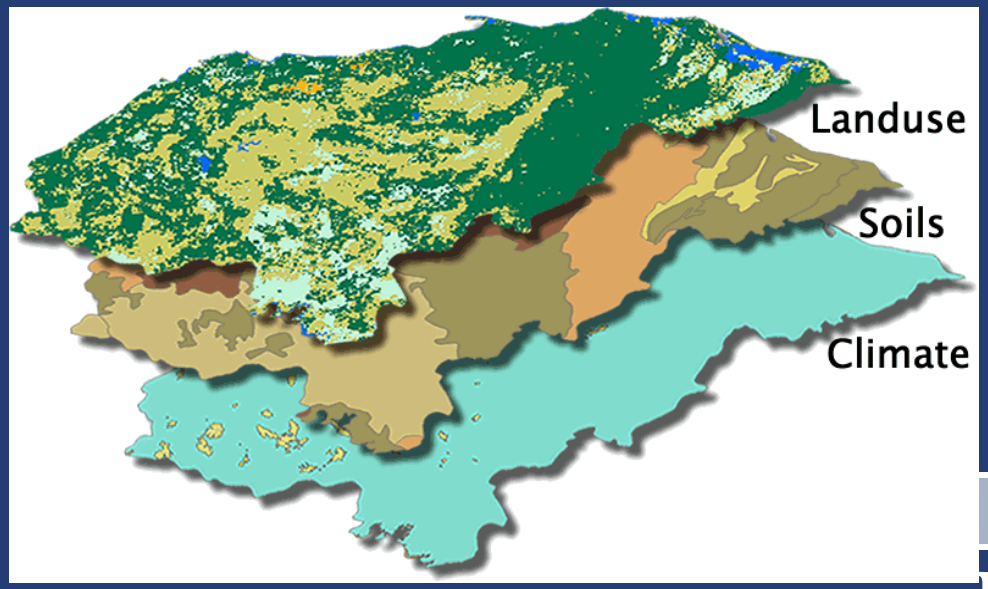
Reporting

- One of the main objectives of a national GHG inventory is to report emissions to the UNFCCC
- Reporting is generally done in spreadsheets
- Maps can be useful for illustrating variation in emissions across a country
- ALU provide emission reports that conform to the typical non-Annex I party reporting standards (i.e., UNFCCC software spreadsheet)
- ALU facilitates the development of emission maps to the extent that activity data and/or emission factors vary spatially

Example: ALU Land Use Session


ALU Tool (Version 3.1.1.3)
File
Help
Mitigation
Agriculture and Land Use National Greenhouse Gas Inventory Software
Module I: Activity data entry
Module II: Assign Emission Factors
Module III: Complete Emission Calculations
Module I: Specify Activity Data
Primary Data Specification
Land Use and Management
Livestock
N Fertilizer
Liming
Sewage Sludge Amendments
Select
QA/QC Primary Data
Secondary Data Specification
Crop Residue Management
Livestock Management
Rice Management
Grassland/Savanna Burning
Biomass Carbon Loss
Peatland Burning
Select
QA/QC Secondary Data
Module III: Inventory Calculations QA/QC
Enteric Methane
Manure Methane
Manure Nitrous Oxide
Biomass Burning Non-CO2 GHG
Soil Nitrous Oxide
Rice Methane
Biomass C Stocks
Soil C Stocks
Select
Available Sessions by Source Category:
Source Category:
Select A Source Category
Subsource Category:
Select A Source Category Above
Reset
Go To Next Data Entry
Biomass C Stocks
Soil C Stocks
Select
Data Management Utilities
Quit Application
Session Status
Session & File Management
QA/QC Emission/Stock Change Factors
Emissions Reports
UNFCCC

Utilize Spatial Data

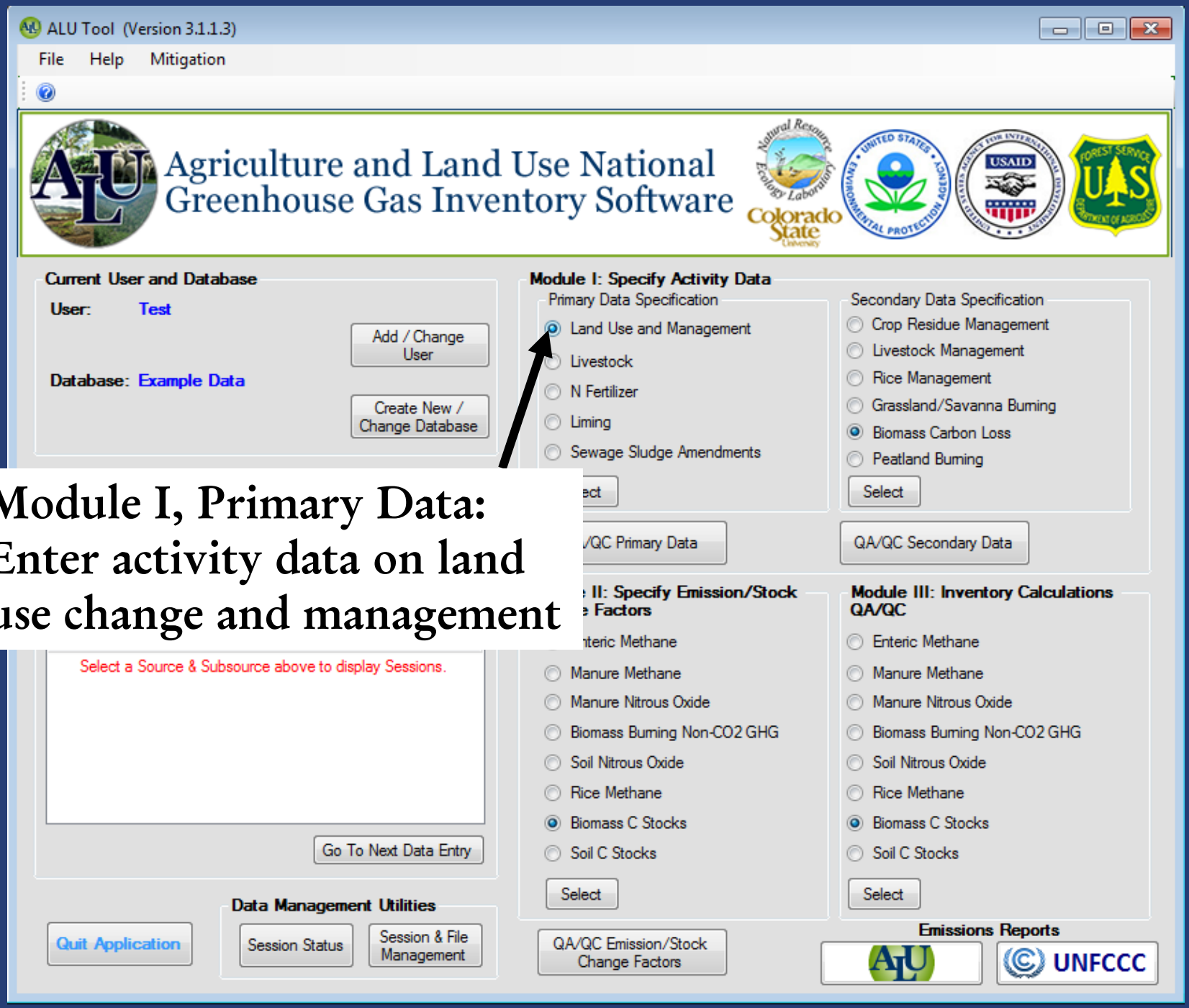


(Geographic Information System)

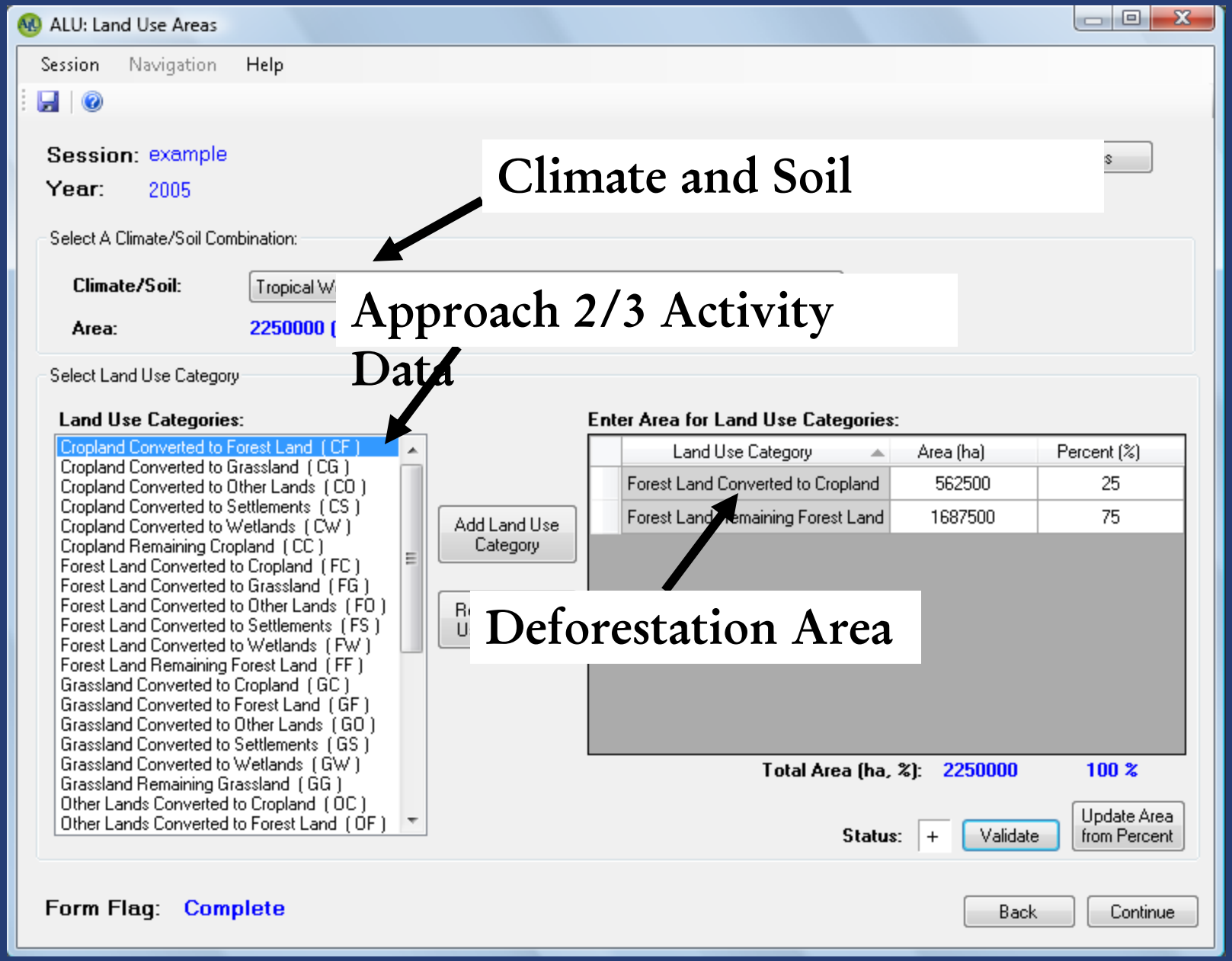
Export

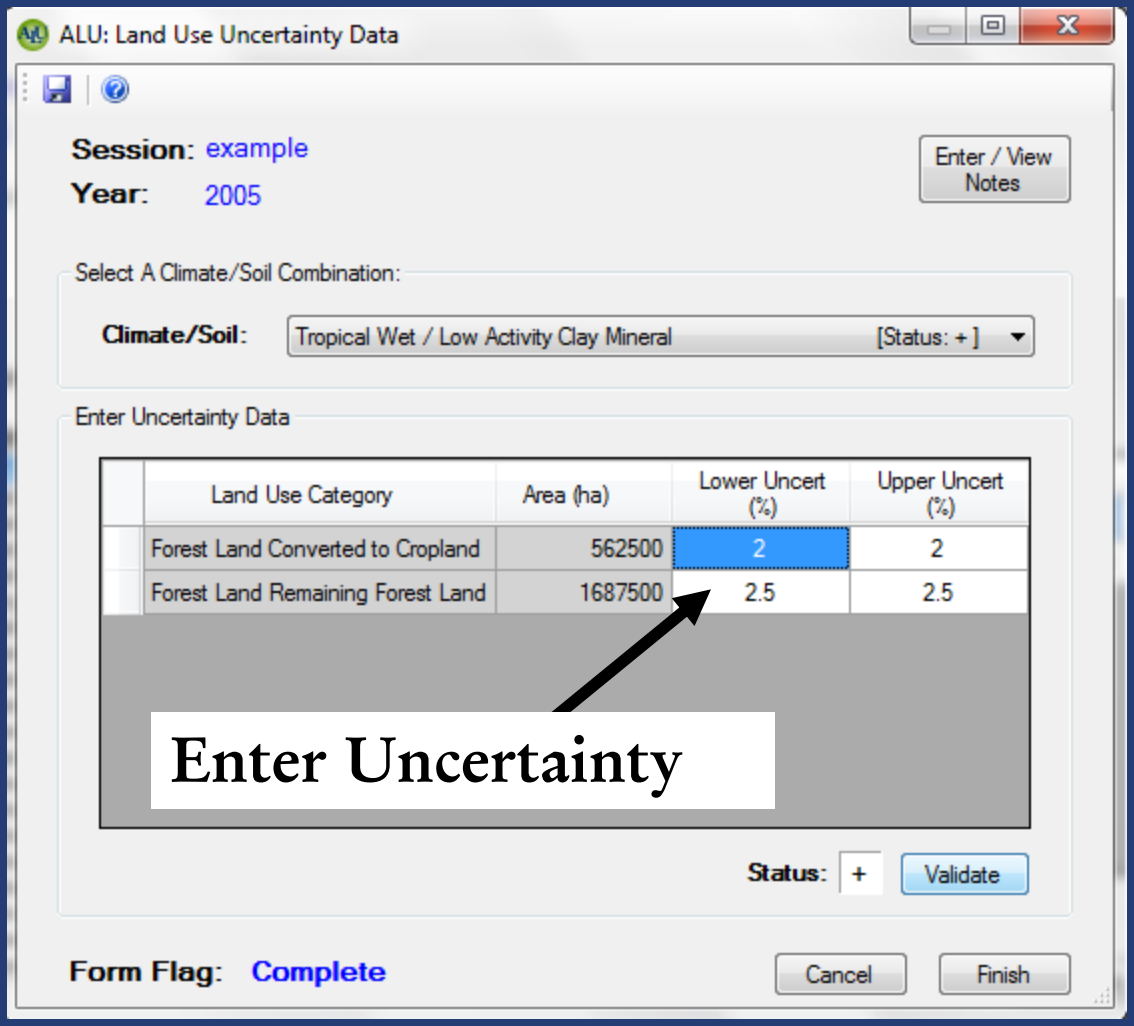
Text File
(Import into ALU)

```
1102,TRMM,HAC,FL,35117.19922
1103,TRMM,HAC,GL,65306
1104,TRMM,HAC,GL,9724.410156
1105,TRMM,HAC,OL,215.460006
1106,TRMM,HAC,SM,373.23001
1107,TRMM,HAC,CL,4032.090087
1109,TRMM,HAC,WL,7.559999
1110,TRMM,HAC,FL,0.449999
1111,TRMM,HAC,WL,2316.23999
1202,TMSD,HAC,FL,106793
1203,TMSD,HAC,GL,721293
1204,TMSD,HAC,GL,292541
1205,TMSD,HAC,OL,20048.59961
1206,TMSD,HAC,SM,4145.759765
1207,TMSD,HAC,CL,229119
1209,TMSD,HAC,WL,3208.050048
1210,TMSD,HAC,FL,31221.69922
1211,TMSD,HAC,WL,41818.60156
3102,TRMM,VOL,FL,51673.30078
3103,TRMM,VOL,GL,20436.19922
3104,TRMM,VOL,GL,3905.370117
```

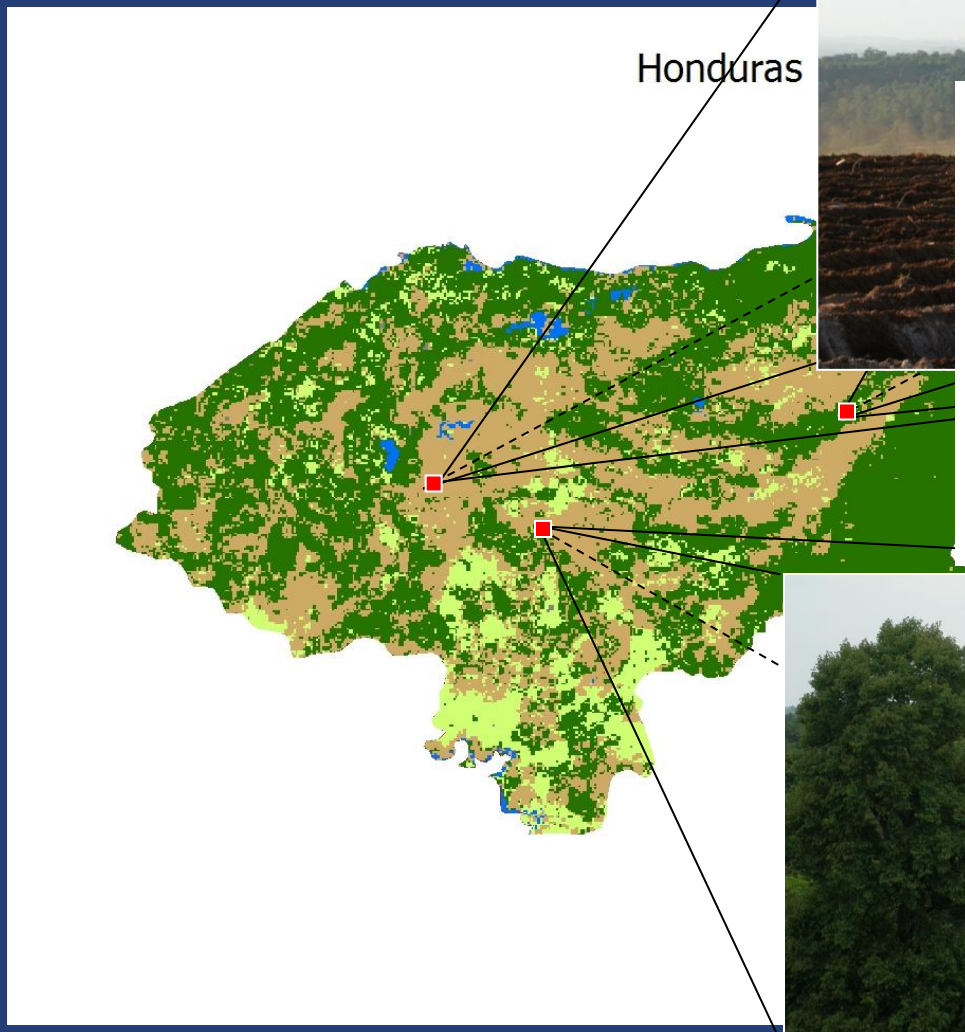


Module I, Primary Data: Enter activity data on land use change and management


ALU: Land Use Areas
Session
Navigation
Help
Session: example
Year: 2005
Climate and Soil
Select A Climate/Soil Combination:
Climate/Soil:
Tropical W
Area:
2250000 (
Approach 2/3 Activity Data
Select Land Use Category
Land Use Categories:
Cropland Converted to Forest Land (CF)
Cropland Converted to Grassland (CG)
Cropland Converted to Other Lands (CO)
Cropland Converted to Settlements (CS)
Cropland Converted to Wetlands (CW)
Cropland Remaining Cropland (CC)
Forest Land Converted to Cropland (FC)
Forest Land Converted to Grassland (FG)
Forest Land Converted to Other Lands (FO)
Forest Land Converted to Settlements (FS)
Forest Land Converted to Wetlands (FW)
Forest Land Remaining Forest Land (FF)
Grassland Converted to Cropland (GC)
Grassland Converted to Forest Land (GF)
Grassland Converted to Other Lands (GO)
Grassland Converted to Settlements (GS)
Grassland Converted to Wetlands (GW)
Grassland Remaining Grassland (GG)
Other Lands Converted to Cropland (OC)
Other Lands Converted to Forest Land (OF)
Add Land Use Category
Enter Area for Land Use Categories:
Land Use Category
Area (ha)
Percent (%)
Forest Land Converted to Cropland
562500
25
Forest Land Remaining Forest Land
1687500
75
Deforestation Area
Total Area (ha, %):
2250000
100 %
Status:
+
Validate
Update Area from Percent
Form Flag:
Complete
Back
Continue


ALU: Land Use Uncertainty Data
Session: example
Year: 2005
Enter / View Notes
Select A Climate/Soil Combination:
Climate/Soil: Tropical Wet / Low Activity Clay Mineral [Status: +]
Enter Uncertainty Data
Land Use Category
Area (ha)
Lower Uncert (%)
Upper Uncert (%)
Forest Land Converted to Cropland
562500
2
2
Forest Land Remaining Forest Land
1687500
2.5
2.5
Enter Uncertainty
Status: +
Validate
Form Flag: Complete
Cancel
Finish

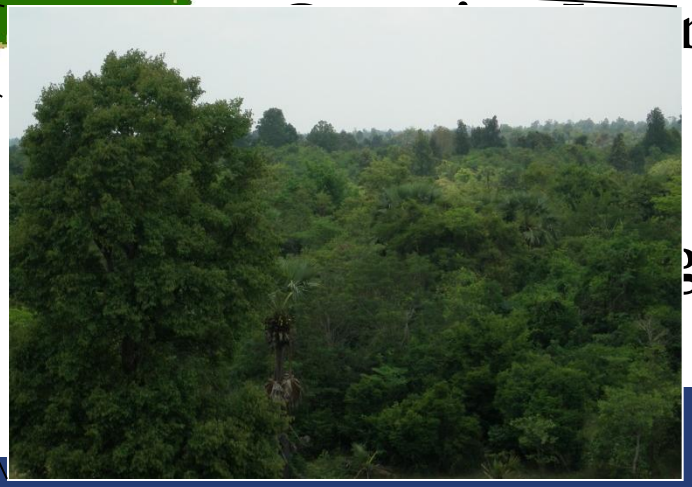
Management Data

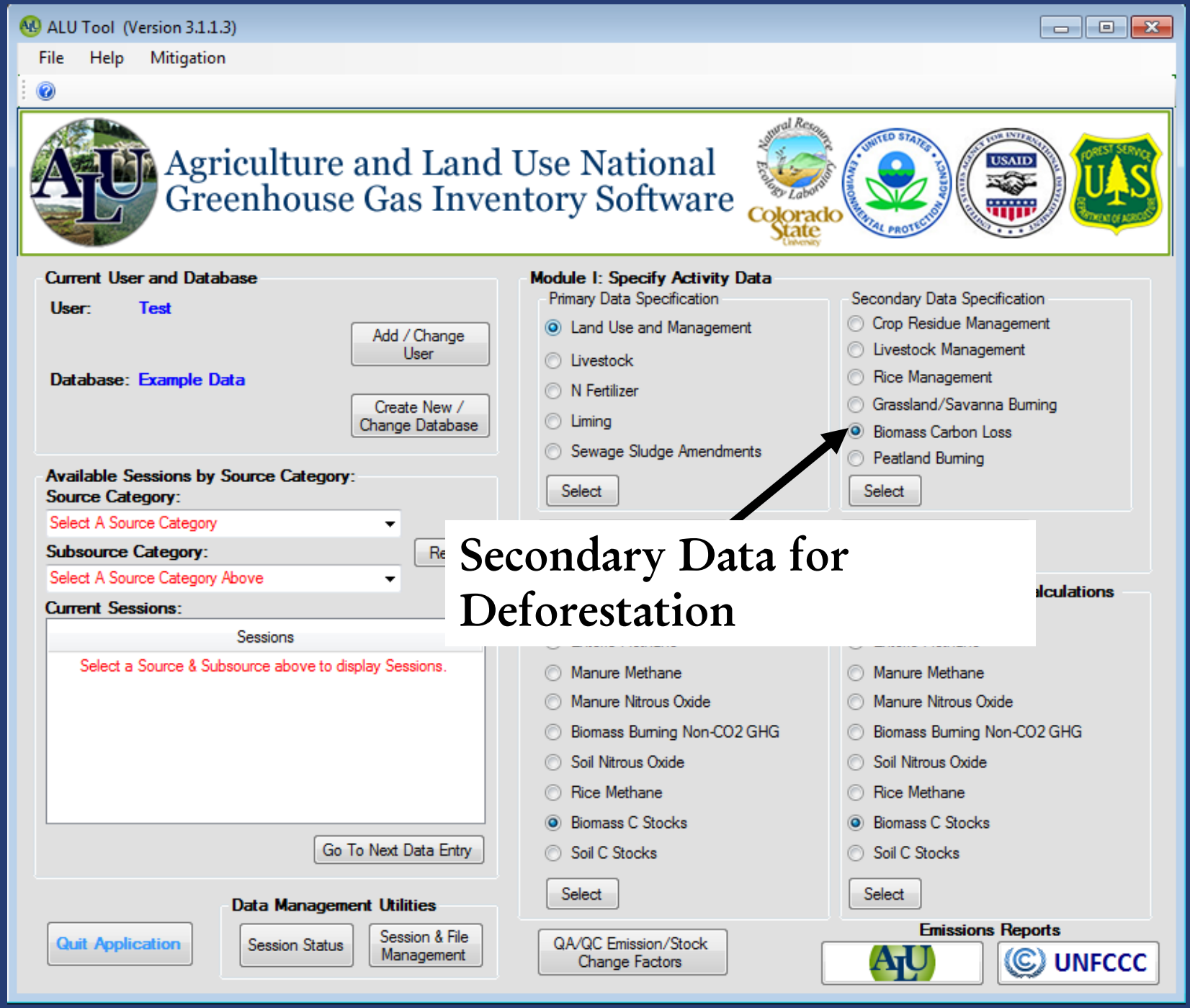


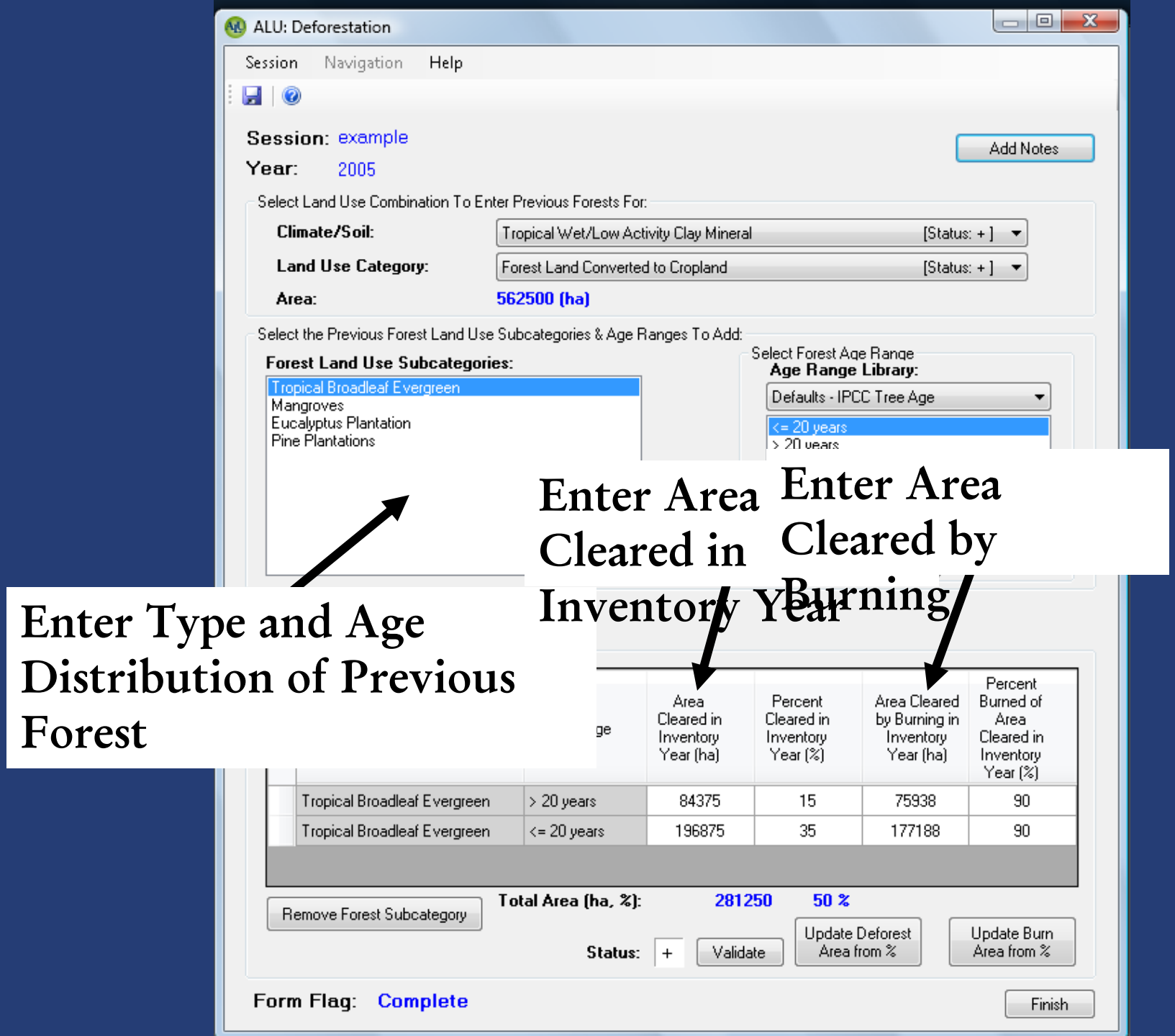
Deforestation
Timber Harvest
Fuelwood Gathering
Shifting Cultivation
Fires
Other Disturbance

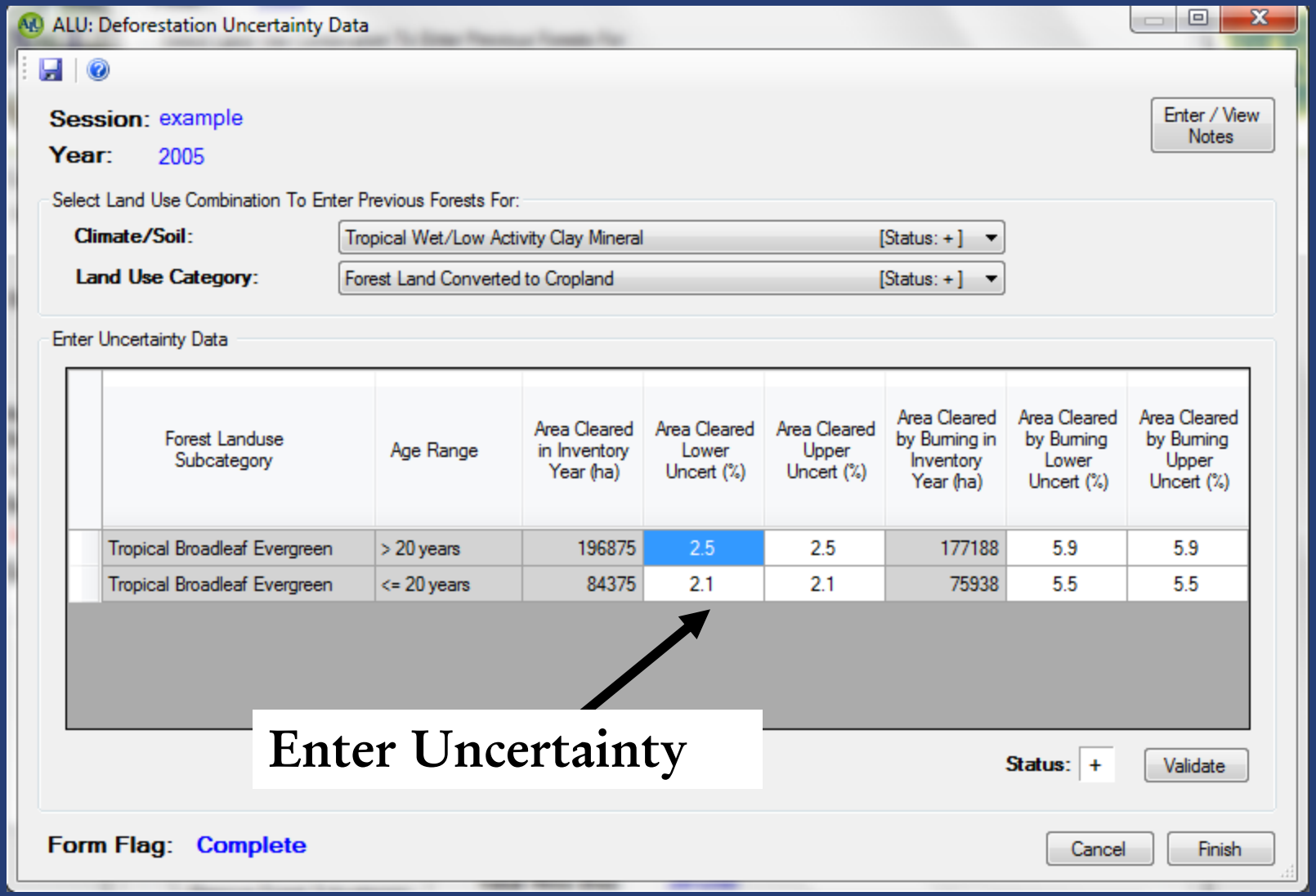
nsity

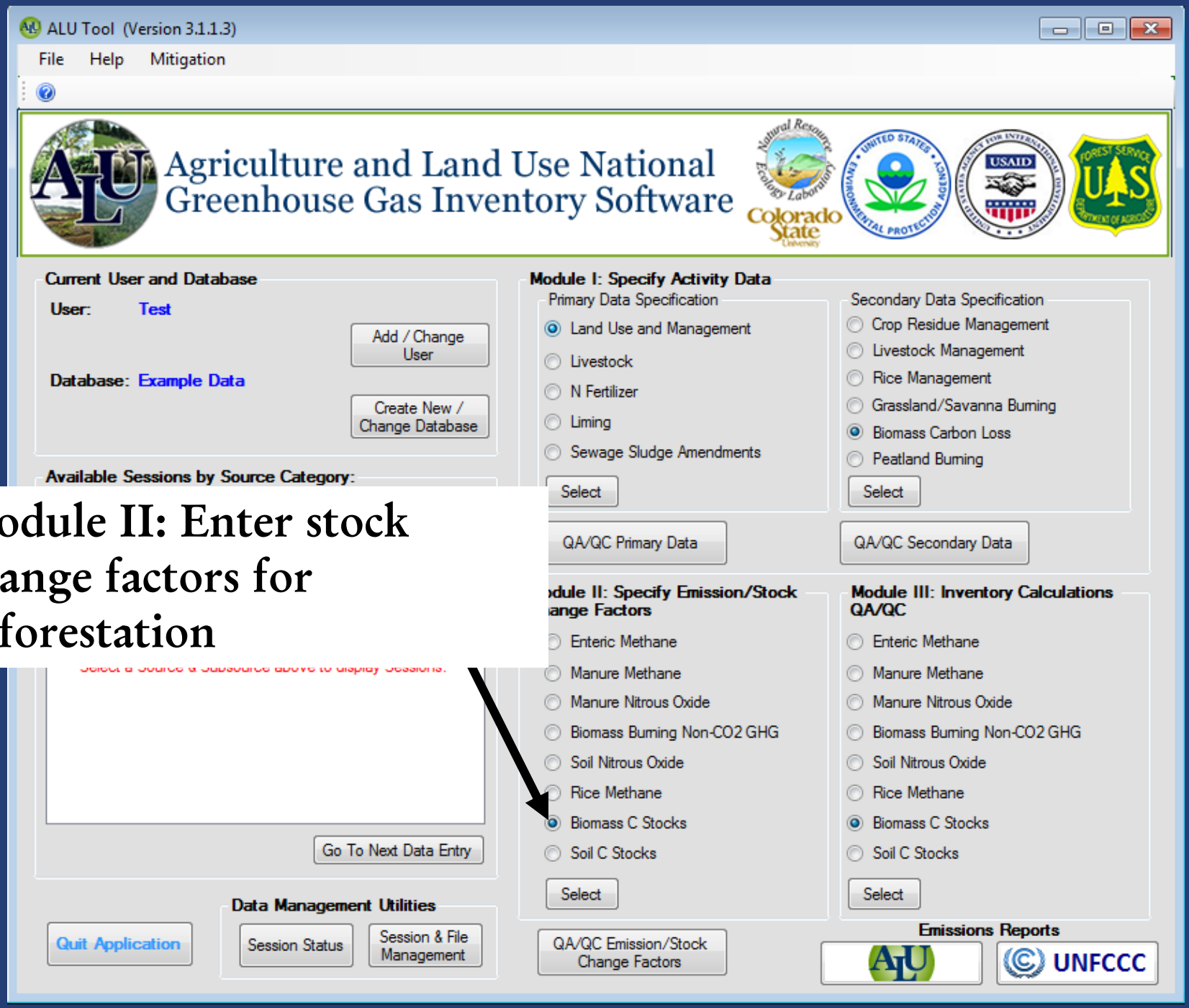
gement



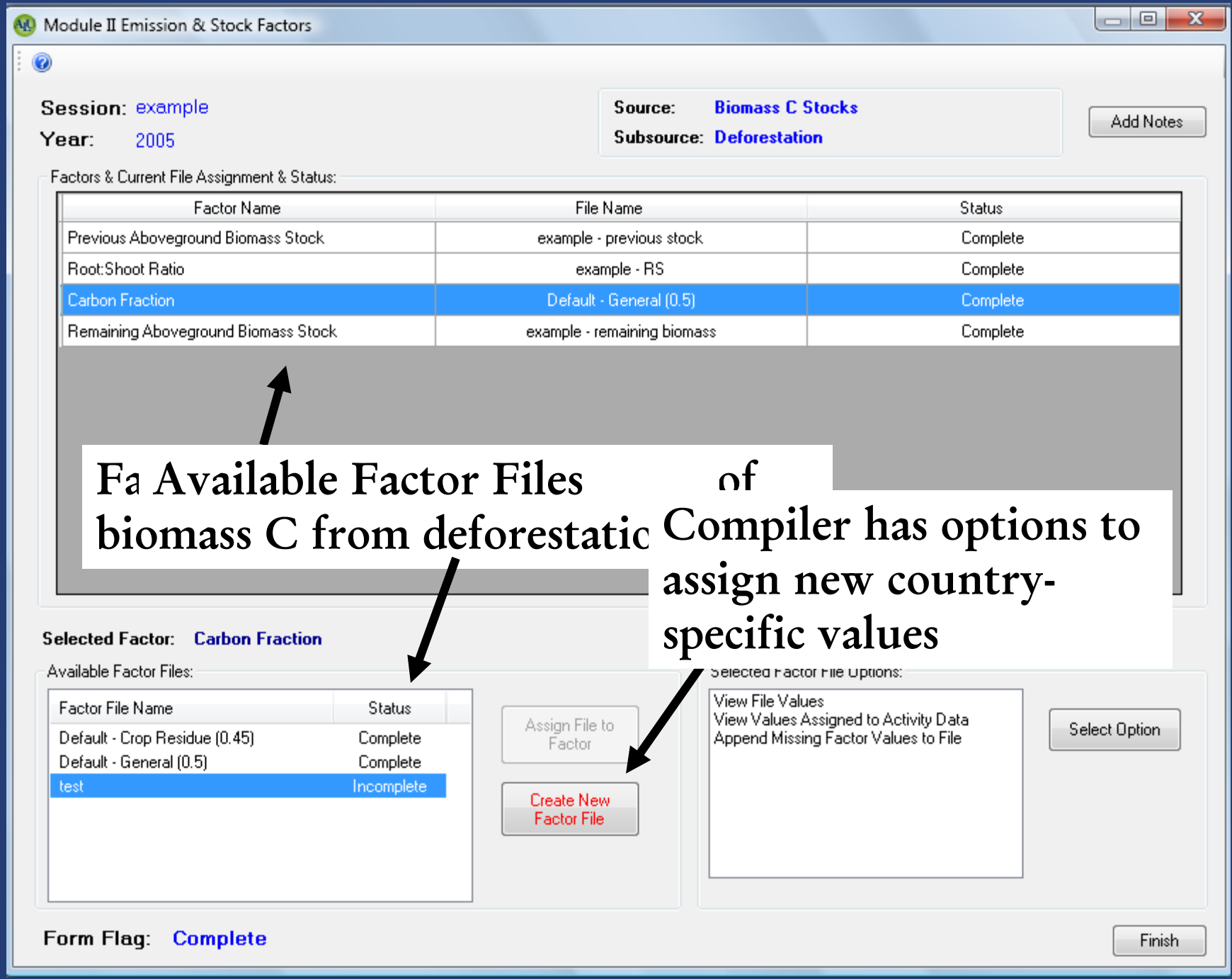

ALU Tool (Version 3.1.1.3)
File
Help
Mitigation
Agriculture and Land Use National Greenhouse Gas Inventory Software
Current User and Database
User: Test
Add / Change User
Database: Example Data
Create New / Change Database
Available Sessions by Source Category:
Source Category:
Select A Source Category
Subsource Category:
Select A Source Category Above
Current Sessions:
Sessions
Select a Source & Subsource above to display Sessions.
Go To Next Data Entry
Data Management Utilities
Session Status
Session & File Management
Quit Application
Module I: Specify Activity Data
Primary Data Specification
Land Use and Management
Livestock
N Fertilizer
Liming
Sewage Sludge Amendments
Select
Secondary Data Specification
Crop Residue Management
Livestock Management
Rice Management
Grassland/Savanna Burning
Biomass Carbon Loss
Peatland Burning
Select
Manure Methane
Manure Nitrous Oxide
Biomass Burning Non-CO2 GHG
Soil Nitrous Oxide
Rice Methane
Biomass C Stocks
Soil C Stocks
Select
QA/QC Emission/Stock Change Factors
Emissions Reports
UNFCCC
Secondary Data for Deforestation


ALU: Deforestation
Session Navigation Help
Session: example
Year: 2005
Add Notes
Select Land Use Combination To Enter Previous Forests For:
Climate/Soil: Tropical Wet/Low Activity Clay Mineral [Status: +]
Land Use Category: Forest Land Converted to Cropland [Status: +]
Area: 562500 (ha)
Select the Previous Forest Land Use Subcategories & Age Ranges To Add:
Forest Land Use Subcategories:
Tropical Broadleaf Evergreen
Mangroves
Eucalyptus Plantation
Pine Plantations
Select Forest Age Range
Age Range Library:
Defaults - IPCC Tree Age
<= 20 years
> 20 years
Enter Type and Age Distribution of Previous Forest
Enter Area Cleared in Inventory Year
Enter Area Cleared by Burning
Area Cleared in Inventory Year (ha)
Percent Cleared in Inventory Year (%)
Area Cleared by Burning in Inventory Year (ha)
Percent Burned of Area Cleared in Inventory Year (%)
Tropical Broadleaf Evergreen > 20 years 84375 15 75938 90
Tropical Broadleaf Evergreen <= 20 years 196875 35 177188 90
Remove Forest Subcategory
Total Area (ha, %): 281250 50 %
Status: +
Validate
Update Deforest Area from %
Update Burn Area from %
Form Flag: Complete
Finish


ALU: Deforestation Uncertainty Data
Session: example
Year: 2005
Enter / View Notes
Select Land Use Combination To Enter Previous Forests For:
Climate/Soil: Tropical Wet/Low Activity Clay Mineral [Status: +]
Land Use Category: Forest Land Converted to Cropland [Status: +]
Enter Uncertainty Data
Forest Landuse Subcategory
Age Range
Area Cleared in Inventory Year (ha)
Area Cleared Lower Uncert (%)
Area Cleared Upper Uncert (%)
Area Cleared by Burning in Inventory Year (ha)
Area Cleared by Burning Lower Uncert (%)
Area Cleared by Burning Upper Uncert (%)
Tropical Broadleaf Evergreen > 20 years 196875 2.5 2.5 177188 5.9 5.9
Tropical Broadleaf Evergreen <= 20 years 84375 2.1 2.1 75938 5.5 5.5
Enter Uncertainty
Status: +
Validate
Form Flag: Complete
Cancel
Finish



Module II: Enter stock change factors for deforestation


Module II Emission & Stock Factors
Session: example
Year: 2005
Source: Biomass C Stocks
Subsource: Deforestation
Add Notes
Factors & Current File Assignment & Status:
Factor Name
File Name
Status
Previous Aboveground Biomass Stock
example - previous stock
Complete
Root:Shoot Ratio
example - RS
Complete
Carbon Fraction
Default - General (0.5)
Complete
Remaining Aboveground Biomass Stock
example - remaining biomass
Complete
Fa Available Factor Files
biomass C from deforestatic
of
Compiler has options to assign new country-specific values
Selected Factor: Carbon Fraction
Available Factor Files:
Factor File Name
Status
Default - Crop Residue (0.45)
Complete
Default - General (0.5)
Complete
test
Incomplete
Assign File to Factor
Create New Factor File
Selected Factor File Options:
View File Values
View Values Assigned to Activity Data
Append Missing Factor Values to File
Select Option
Form Flag: Complete
Finish

Create New Factor File

Filename: example
Factor: Previous Aboveground Biomass Stock (Bwp)
Units: [tonnes dm/ha]

Source: Biomass C Stocks
Subsource: Deforestation

Clim	Soil	LU	PrevLUSub	AgeRange	Bwp	Lower Uncert (%)	Upper Uncert (%)
Tropical Wet	Low Activity Clay ...	Forest Land Conv...	Tropical Broadleaf...	<= 20 years	275	30	30
Tropical Wet	Low Activity Clay ...	Forest Land Conv...	Tropical Broadleaf...	> 20 years	275	18	18

Enter Fa Enter Uncertainty

Abbreviation Legend:

Clim = Climate
Soil = Soil
LU = Land Use Category
PrevLUSub = Previous Land Use Subcategory
AgeRange = Age Range
Bwp = Previous Aboveground Biomass Stock

Documentation:

IPCC Good Practice Guidance

Fill Multiple Values:
- Fill All Factor Cells
- Fill Selected Cells
- Fill All Lower Uncert
- Fill All Upper Uncert

Factor Value to Fill: 0 Fill Value

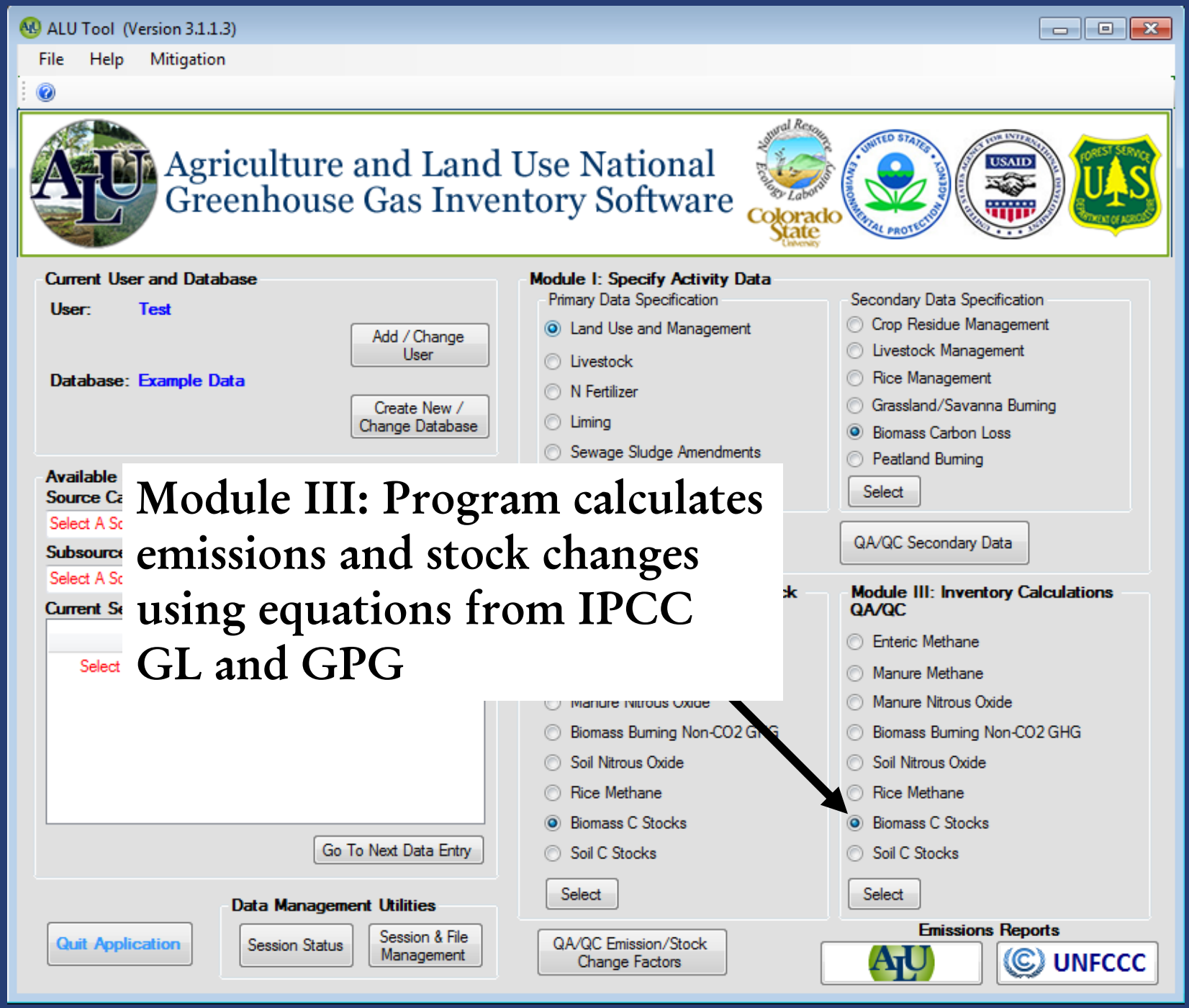
View/Enter Uncertainty

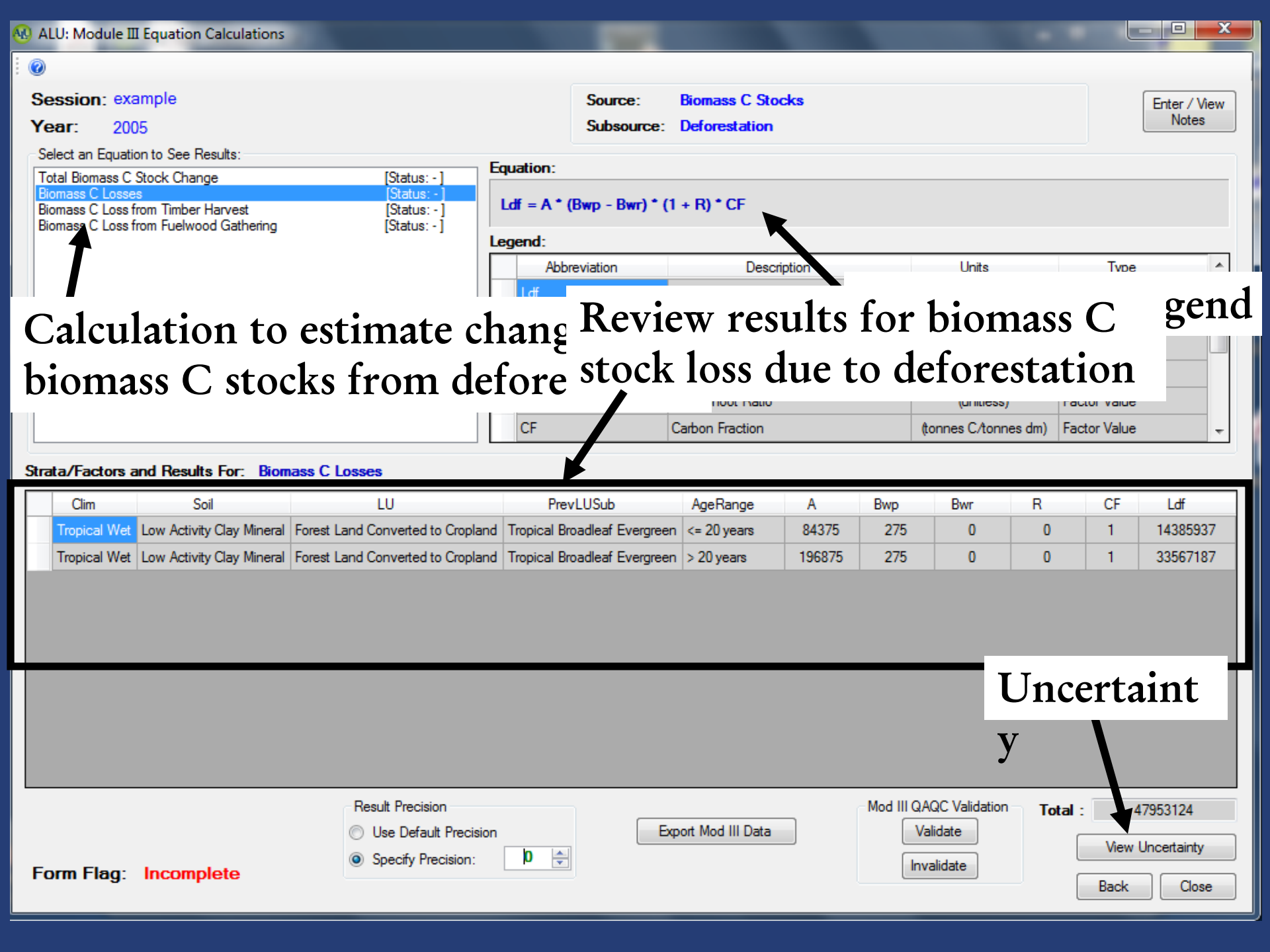
Uncertainty Validation:
Status: + Validate

Factor Value Validation:
Status: + Validate

Cancel Finish

Form Flag: Complete


ALU Tool (Version 3.1.1.3)
File
Help
Mitigation
Agriculture and Land Use National Greenhouse Gas Inventory Software
Current User and Database
User: Test
Add / Change User
Database: Example Data
Create New / Change Database
Module I: Specify Activity Data
Primary Data Specification
Land Use and Management
Livestock
N Fertilizer
Liming
Sewage Sludge Amendments
Secondary Data Specification
Crop Residue Management
Livestock Management
Rice Management
Grassland/Savanna Burning
Biomass Carbon Loss
Peatland Burning
Select
QA/QC Secondary Data
Module III: Program calculates emissions and stock changes using equations from IPCC GL and GPG
Module III: Inventory Calculations QA/QC
Enteric Methane
Manure Methane
Manure Nitrous Oxide
Biomass Burning Non-CO2 GHG
Soil Nitrous Oxide
Rice Methane
Biomass C Stocks
Soil C Stocks
Select
Go To Next Data Entry
Data Management Utilities
Session Status
Session & File Management
Quit Application
QA/QC Emission/Stock Change Factors
Emissions Reports
UNFCCC


ALU: Module III Equation Calculations
Session: example
Year: 2005
Source: Biomass C Stocks
Subsource: Deforestation
Enter / View Notes
Select an Equation to See Results:
Total Biomass C Stock Change [Status: -]
Biomass C Losses [Status: -]
Biomass C Loss from Timber Harvest [Status: -]
Biomass C Loss from Fuelwood Gathering [Status: -]
Equation:
Ldf = A * (Bwp - Bwr) * (1 + R) * CF
Legend:
Abbreviation
Description
Units
Type
CF
Carbon Fraction
(tonnes C/tonnes dm)
Factor Value
Calculation to estimate chang
biomass C stocks from defore
Review results for biomass C stock loss due to deforestation
gend
Strata/Factors and Results For: Biomass C Losses
Clim
Soil
LU
PrevLUSub
AgeRange
A
Bwp
Bwr
R
CF
Ldf
Tropical Wet
Low Activity Clay Mineral
Forest Land Converted to Cropland
Tropical Broadleaf Evergreen
<= 20 years
84375
275
0
0
1
14385937
Tropical Wet
Low Activity Clay Mineral
Forest Land Converted to Cropland
Tropical Broadleaf Evergreen
> 20 years
196875
275
0
0
1
33567187
Uncertaint
y
Result Precision
Use Default Precision
Specify Precision:
Export Mod III Data
Mod III QAQC Validation
Validate
Invalidate
Total :
47953124
View Uncertainty
Back
Close
Form Flag: Incomplete

ALU: Uncertainty Calculations

Session: example
Year: 2005

Source: Biomass C Stocks
Subsource: Deforestation

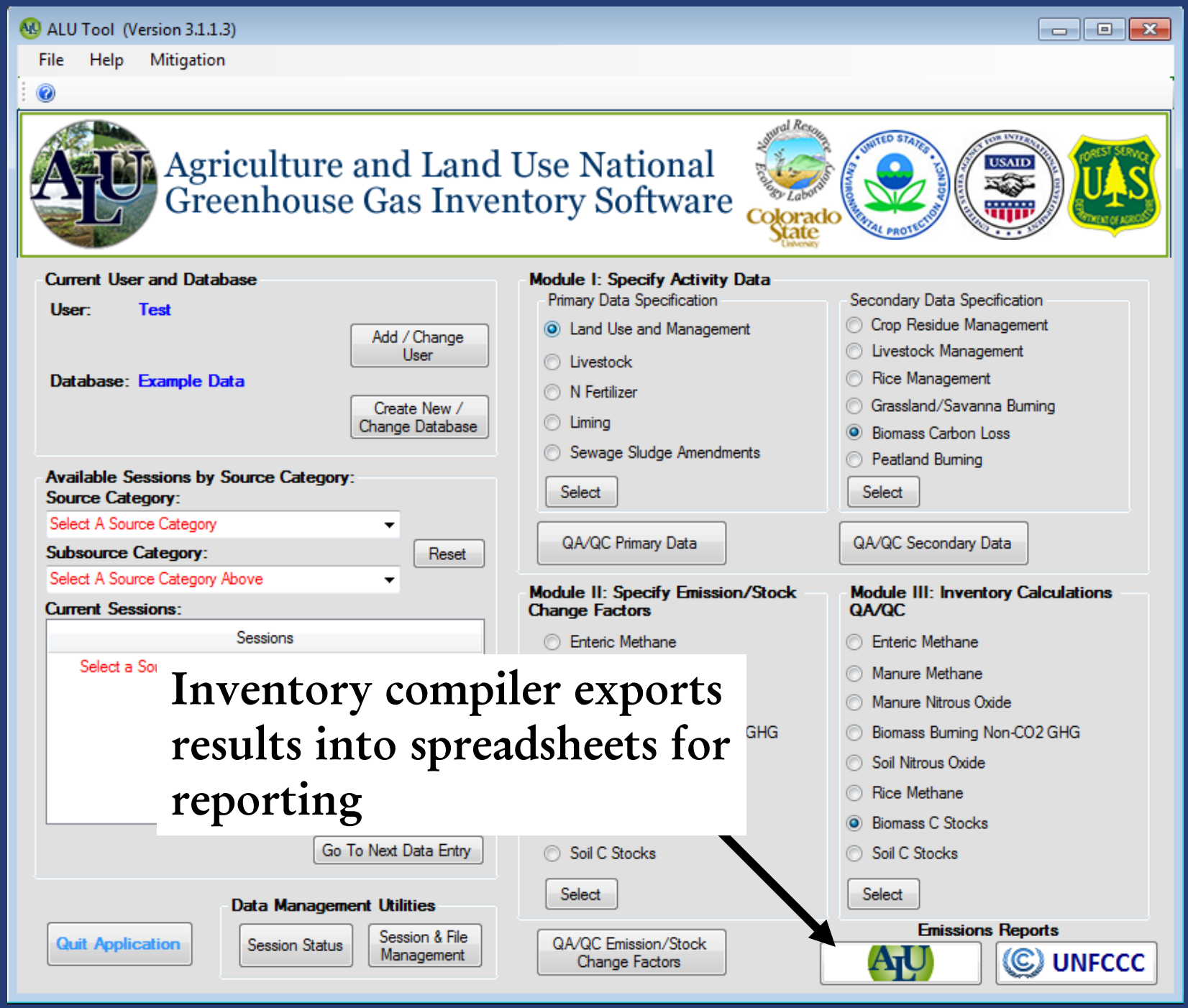
Enter / View Notes

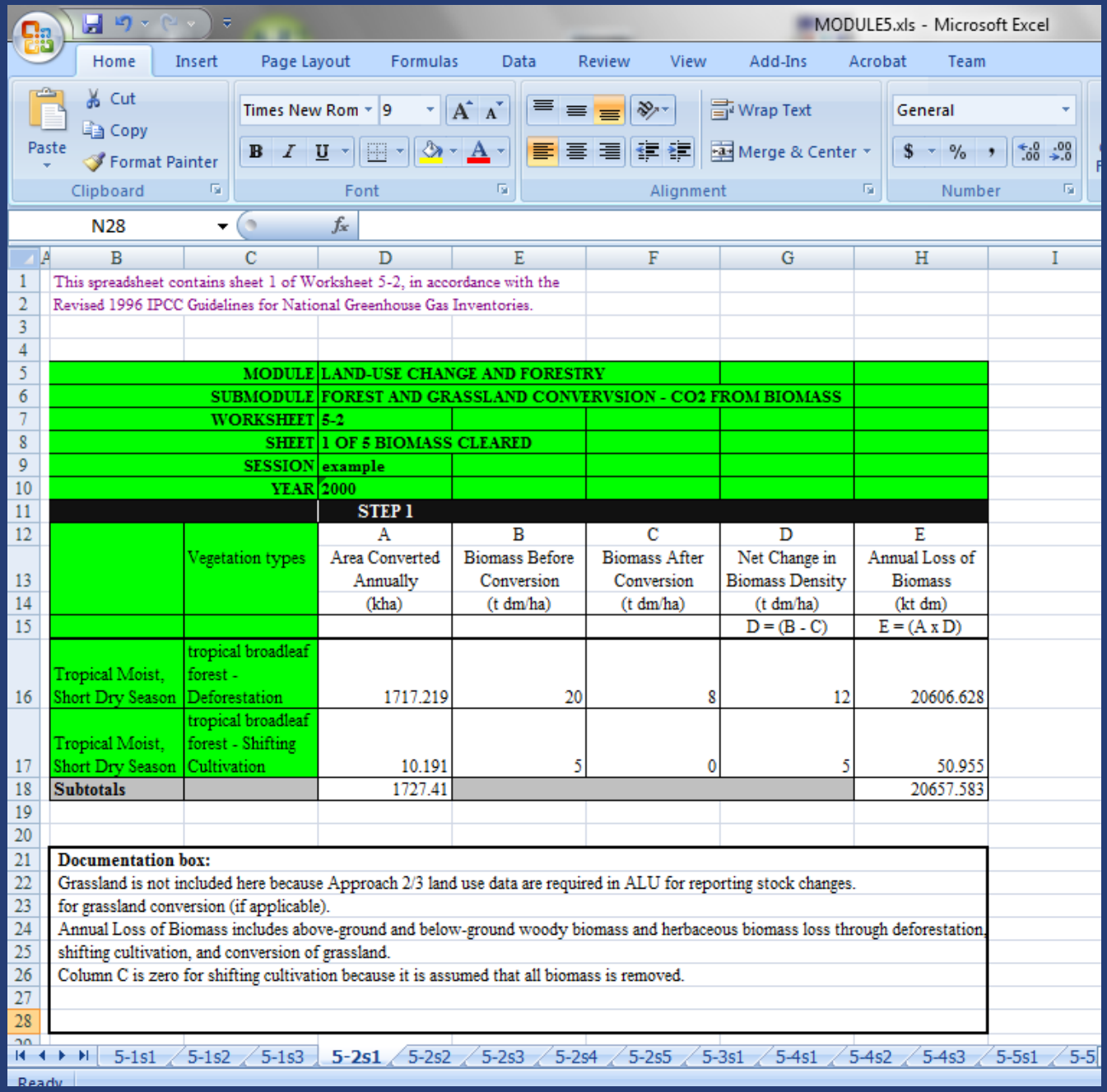
Uncertainty Calculations For: Biomass C Losses

Clim	Soil	LU	PrevLUSub	AgeRange	Ldf	95% Uncertainty (%)
Tropical Wet	Low Activity Clay Mineral	Forest Land Converted to Cropland	Tropical Broadleaf Evergreen	<= 20 years	14385937	59
Tropical Wet	Low Activity Clay Mineral	Forest Land Converted to Cropland	Tropical Broadleaf Evergreen	> 20 years	33567187	54

Total Uncertainty (%): 42

Close


ALU Tool (Version 3.1.1.3)
File
Help
Mitigation
Agriculture and Land Use National Greenhouse Gas Inventory Software
Current User and Database
User: Test
Add / Change User
Database: Example Data
Create New / Change Database
Available Sessions by Source Category:
Source Category:
Select A Source Category
Subsource Category:
Select A Source Category Above
Reset
Current Sessions:
Sessions
Select a So
Go To Next Data Entry
Data Management Utilities
Session Status
Session & File Management
Quit Application
Module I: Specify Activity Data
Primary Data Specification
Land Use and Management
Livestock
N Fertilizer
Liming
Sewage Sludge Amendments
Select
Secondary Data Specification
Crop Residue Management
Livestock Management
Rice Management
Grassland/Savanna Burning
Biomass Carbon Loss
Peatland Burning
Select
QA/QC Primary Data
QA/QC Secondary Data
Module II: Specify Emission/Stock Change Factors
Enteric Methane
GHG
Soil C Stocks
Select
QA/QC Emission/Stock Change Factors
Module III: Inventory Calculations QA/QC
Enteric Methane
Manure Methane
Manure Nitrous Oxide
Biomass Burning Non-CO2 GHG
Soil Nitrous Oxide
Rice Methane
Biomass C Stocks
Soil C Stocks
Select
Emissions Reports
UNFCCC
Inventory compiler exports results into spreadsheets for reporting



MODULE5.xls - Microsoft Excel

Home | Insert | Page Layout | Formulas | Data | Review | View | Add-Ins | Acrobat | Team

Cut | Copy | Format Painter | Paste | Clipboard | Times New Rom | 9 | Font | Wrap Text | Merge & Center | Alignment | General | Number

N28

This spreadsheet contains sheet 1 of Worksheet 5-2, in accordance with the
Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories.

MODULE	LAND-USE CHANGE AND FORESTRY
SUBMODULE	FOREST AND GRASSLAND CONVERVSION - CO2 FROM BIOMASS
WORKSHEET	5-2
SHEET	1 OF 5 BIOMASS CLEARED
SESSION	example
YEAR	2000

STEP 1

	Vegetation types	A Area Converted Annually (kha)	B Biomass Before Conversion (t dm/ha)	C Biomass After Conversion (t dm/ha)	D Net Change in Biomass Density (t dm/ha)	E Annual Loss of Biomass (kt dm)
					D = (B - C)	E = (A x D)
Tropical Moist, Short Dry Season	tropical broadleaf forest - Deforestation	1717.219	20	8	12	20606.628
Tropical Moist, Short Dry Season	tropical broadleaf forest - Shifting Cultivation	10.191	5	0	5	50.955
Subtotals		1727.41				20657.583

Documentation box:

Grassland is not included here because Approach 2/3 land use data are required in ALU for reporting stock changes.
for grassland conversion (if applicable).
Annual Loss of Biomass includes above-ground and below-ground woody biomass and herbaceous biomass loss through deforestation,
shifting cultivation, and conversion of grassland.
Column C is zero for shifting cultivation because it is assumed that all biomass is removed.

5-1s1 | 5-1s2 | 5-1s3 | 5-2s1 | 5-2s2 | 5-2s3 | 5-2s4 | 5-2s5 | 5-3s1 | 5-4s1 | 5-4s2 | 5-4s3 | 5-5s1 | 5-5

Ready

ALU Mitigation Analysis

Scope of Analysis

- Analyze the potential change in greenhouse gas emissions from changing management of land and livestock
- Use existing inventory in ALU as the baseline
- Include multiple source categories influenced by practice
  - Within Agriculture and LULUCF
- Biophysical potentials produced by ALU, but projections can be informed by economic forecasts of commodity production and consequences for management of land and livestock

Approaches for Mitigation Analysis

- Whole Session Approach
  - Focus on all practices
    - Maximum utility
  - Assesses all drivers of emissions and mitigation potential
    - i.e., Population growth, economic growth and technology
- Practice-Based Approach
  - Focus on specific practice
  - Assesses technology as a driver of emissions and mitigation potential

ALU Mitigation: Summary Report for Practice-Based Mitigation Analysis

Analysis Name: Deforestation example

Projection Year: 2030

Mitigation Strategy: Reduced Deforestation

Use Default Precision
Specify Precision: 0

Mitigation Potential (Difference in Total Greenhouse Gas Emissions):

Source	Subsource	Baseline Projection CO2 equivalents (Gg)	Mitigation Projection CO2 equivalents (Gg)	Mitigation Potential CO2 equivalents (Gg)
Biomass C Stocks	Deforestation	580233	87035	493198
Biomass Burning	Deforestation	4122	1001	3121
Total Greenhouse Gas Emissions*		584355	88036	496318

Summary of Baseline Projection Emissions:

Source	Subsource	Change in Biomass C Stocks (Gg C)	CH4 Emissions (Gg CH4)	CO Emissions (Gg CO)	N2O Emissions (Gg N2O)	NOx Emissions (Gg NOx)	CO2 equivalents (Gg)
Biomass C Stocks	Deforestation	158245	0	0	0	0	580233
Biomass Burning	Deforestation	0	178	1559	1	44	4122
Total Greenhouse Gas Emissions*		158245	178	1559	1	44	584355

Summary of Mitigation Projection Emissions:

Source	Subsource	Change in Biomass C Stocks (Gg C)	CH4 Emissions (Gg CH4)	CO Emissions (Gg CO)	N2O Emissions (Gg N2O)	NOx Emissions (Gg NOx)	CO2 equivalents (Gg)
Biomass C Stocks	Deforestation	23737	0	0	0	0	87035
Biomass Burning	Deforestation	0	43	379	0	11	1001
Total Greenhouse Gas Emissions*		23737	43	379	0	11	88036

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More Information:

http://www.epa.gov/climatechange/emissions/ghginventorycapacitybuilding/index.html

http://www.nrel.colostate.edu/projects/ALUsoftware/

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