VALUATION MODULE USER GUIDE

This guide outlines how to use the valuation suite, which takes temporally and spatially explicit inputs and outputs monetary values resulting from a specified experiment. The valuation suite models several elements in the Food-Energy-Water system (FEWS), which are as follows:

1. Food Production (corn & soybeans)
2. Electricity Production
3. Net Carbon Dioxide Emissions (including carbon sequestration)
4. Localized Pollutant Emissions (NO_x & SO_2)
5. Water Quality

The following sections outline the theory behind each element of the Valuation Suite, including 1) theoretical background, 2) required inputs, 3) underlying equations, and 4) monetary output(s). **The last section details how to operate the entire valuation suite with a table of inputs, as well as the AP3 Integrated Assessment Model**.

1. Food Production
    a. The food production component of the Valuation Suite estimates changes in surplus due to changes in crop yield. The food production module uses methods adapted from Alston (1998) that quantifies the magnitude of the shift in the crop's supply curve as a result of a change in crop yield, and outputs monetary values of surplus that result from this shift.
    b. To run the food production module, the user is required to provide the following inputs for the crop in question:
        i. Commodity (either "CORN" or "SOYBEANS)
        ii. Year and State (spelled out, not as a two-digit acronym)
        iii. Crop yields
        iv. Harvested area
        v. (OPTIONAL) Measures of supply and demand price elasticities (if the user wants to use elasticities that differ from the default elasticities used in the module)
    c. The underlying equations of this analysis are dependent on whether the area in question has a large enough market share such that a change to its crop yields would influence international market price for that crop.
    d. If the area in question is not a large enough producer of the crop to influence market price, the module uses the following equations:

$$\Delta CS = P_0 Q_0 Z(1 + 0.5Z\mu_D)$$
$$\Delta PS = P_0 Q_0 (K - Z)(1 + 0.5Z\mu_D)$$
$$\Delta TS = \Delta CS + \Delta PS = P_0 Q_0 K(1 + 0.5Z\mu_D)$$

Where:

P_0 = market price	Q_0 = initial quantity	$Z = \frac{K\varepsilon}{\varepsilon + \mu}$ Price change relative to its initial value	K = vertical shift in the supply curve, expressed as a proportion of P_0	μ_D= demand elasticity (absolute value)	ε_S= supply elasticity

e. When the area in question is a large enough producer of the crop to influence market price, trade effects with any entity outside the area (designated "ROW," or "Rest-of-World") must also be considered. Thus, the module uses the following equations for this case:

$$\Delta CS_{DOM} = P_0 C_{A,0} Z(1 + 0.5Z\mu_D)$$

$$\Delta PS_{DOM} = P_0 Q_{A,0}(K - Z)(1 + 0.5Z\mu_D)$$

$$\Delta TS_{DOM} = P_0 Q_0 K(1 + 0.5Z\mu_D)$$

$$\Delta CS_{ROW} = P_0 C_{B,0} Z(1 + 0.5Z\mu_B)$$

$$\Delta PS_{RO} \quad = P_0 Q_{B,0} Z(1 + 0.5Z\varepsilon_B)$$

$$\Delta TS_{ROW} = P_0 Q_0 Z(1 + 0.5Z\mu_B)$$

Where:

P_0 = initial market price	$C_{A,0}$ = initial consumption	$Z = \frac{K\varepsilon}{\varepsilon + \mu}$ Price change relative to its initial value	K = vertical shift in the supply curve, expressed as a proportion of P_0	$Q_{A,0}$ = initial production
$C_{B,0}$ = ROW initial consumption	μ_B= ROW demand elasticity (absolute value)	$Q_{B,0}$ = ROW initial production (if any)	ε_B= ROW supply elasticity	μ_D= demand elasticity (absolute value)

f. Calculation Outline

  i. The user inputs baseline and alternative scenario crop 1) yields and 2) harvested area for the desired location

  ii. The calculation module calculates baseline and alternative scenario crop production by multiplying these two inputs, and then converts this measure into bushel (BU) units

iii. The surplus equations are reliant on the K variable, so the module re-creates the area supply and demand curves to extract the vertical shift in the supply curve
iv. The slope of the initial supply curve is calculated using the price elasticity of supply and the ratio of market price to quantity supplied
v. The slope of the demand curve can also be calculated using this same calculation, except with the price elasticity of demand
vi. Then, assuming linear supply and demand curves, the calculation module calculates the intercept of the initial supply and demand curves using initial market price, initial production, and supply/demand curve slope
vii. Alternative scenario price can now be quantified. However, if the area in question does not produce enough of the crop to influence market price, alternative scenario price is unchanged from its baseline scenario price. If the area is a large enough producer to influence market price, then alternative scenario price can be found using alternative scenario production, demand curve slope, and the intercept of the demand curve
viii. The K factor is then calculated using baseline scenario price, alternative scenario price, alternative scenario production, supply curve slope, and intercept of the baseline scenario supply curve
ix. Finally, depending on whether the area is a large enough producer of the crop to influence market price, the calculation module calculates change in total surplus using the above equations. If the user would like to calculate multiple measures of surplus from different areas, these can be aggregated ex post to display total changes in surplus at higher spatial resolution

2. Electricity Production
    a. The electricity production component of the valuation suite estimates changes in value due to changes in electricity generation under a particular scenario.
    b. The module uses a methodology adapted from Logan et al. (2021), in which market and generation data is used to calculate the monetary value of a unit of generation by electricity-producing sector
    c. For each of the above electrical sectors, the user is required to provide the following inputs into the calculation module for both the baseline and alternative scenario cases:
        i. Year, State (two digit acronym, not spelled out), and Balancing Area (if known)
        ii. Electricity generation (MWh)
        iii. Marginal Cost ($/MWh)
        iv. (OPTIONAL) Price (if the user has area-specific values they want to use instead of the default values contained within the module)
    d. Per Logan et al. (2021), the present monetary value of electricity generation for any given sector under conditions "j" is represented by the following equation, for an electricity sector of generation G, wholesale electricity price W, and marginal cost of electricity M

$$PV_j = G_j(W - M)$$

    e. Note: marginal cost of electricity M is derived in the module as the sum of 1) fuel costs and 2) variable operation and maintenance (O&M) costs for the given electricity sector
    f. Calculation Outline
        i. The user inputs baseline and alternative scenario inputs for the desired study area
        ii. The module converts all units into normalized units of $ and MWh, and retrieves electricity price data (if not provided by the user) for the given temporal and spatial specification

iii. The module then uses all user-provided data and internal parameters to calculate changes in value based on the provided inputs

3. Uniformly Mixed Pollutant Emissions
   a. The uniformly mixed pollutant component of the valuation suite estimates changes in value due to changes in net carbon dioxide emissions under a particular scenario.
   b. The module outputs a low, high, and middle estimate of surplus based on three different estimates of the social cost of carbon (SCC) adapted from the Biden Interagency Working Group (2021), Hansen et. al (2020), and Nordhaus (2017), respectively
   c. The user is required to provide the following inputs into the calculation for both the baseline and alternative scenario cases:
      i. Year and State (spelled out, e.g., “Illinois,” not “IL)
      ii. Carbon dioxide emissions (mass units)
      iii. Carbon sequestration (mass units)
      iv. (OPTIONAL) SCC (if the user wishes to calculate changes in value due to their own designation of the social cost of carbon)
   d. Calculation Outline
      i. The module calculates changes in value due to net carbon dioxide emissions. Carbon dioxide emissions impose some monetary cost on the populace, while each unit of soil carbon sequestered reduces this cost.
         1. Alternatively, if there is soil carbon loss, costs would increase.
      ii. The three estimates of the SCC are as follows (all estimated using a 3% discount rate):
         1. \$51/ton CO_2 – from Biden (2021)
         2. \$102/ ton CO_2 - from Nordhaus (2017)
         3. \$208/ ton CO_2 - from Hansen et. al (2020)
      iii. The module calculates monetary estimates using the following equation, which is based on the SCC, power plant carbon dioxide emissions ($CO2_{PP}$), and soil carbon sequestration ($CO2_{SQ}$)

$$TD = SCC * \left(CO2_{PP} - CO2_{SQ}\right)$$

iv. NOTE – carbon sequestration data is typically measured in mass units of carbon. Thus, to run this equation, the valuation module first converts this estimation in mass carbon dioxide units by multiplying by the ratio of the molecular weight of carbon dioxide to that of carbon (44/12)

v. This calculation is run first with the baseline scenario data for a baseline scenario estimate of TS, and then is run again with the alternative scenario data for an alternative scenario estimate. The difference between the two TS estimates is the change in surplus due to the specified scenario.

vi. NOTE – if the user decides to provide their own SCC, the results will generate values from this specification. Otherwise, the default SCC used in the module is that of the Biden Working Group (\$51/ton CO_2)

4. Localized Pollutant Emissions
    a. Unlike uniformly mixed pollutants like carbon dioxide, localized pollutants have non-uniform effects on the populace depending on spatial location, local populace, and meteorological conditions (among other factors)
    b. The local pollutant component of the Valuation Suite thus estimates changes in marginal damages due to changes in local air pollutant emissions from power plants resulting under a particular scenario.
    c. The module uses the AP3 integrated assessment model (IAM) adapted from Muller (2007, 2011) to convert emissions into these monetary estimates.
    d. NOTE: this component of the Valuation Suite must be run outside the main body of the suite with separate inputs and requires the user to have the software program MATLAB. The "How-To" section of this guide details how to operate the model in MATLAB
    e. The AP3 IAM can estimate marginal damages associated with 6 criteria air pollutants, but for the C-FEWS project, only the following air pollutants will be considered:
        i. Nitrous Oxide (NO_x)
        ii. Sulfur Dioxide (SO_2)
    f. The user is required to provide the following inputs into the AP3 IAM for both the baseline and alternative scenario cases:
        i. Air Pollutant of interest (provided as either "NOX" or "SO2)
        ii. Year, State (2-letter acronym, NOT spelled out), and Balancing Area (if known)
        iii. **County-level** NO_x emissions from electricity-producing power plants
        iv. **County-level** SO_x emissions from electricity-producing power plants
        v. (OPTIONAL) Value of Statistical Life estimate ($), if the user decides to estimate marginal damages with a value different than the default number used in the IAM
        vi. (OPTIONAL) Total population by age group **per county**. The AP3 IAM uses 2014 population numbers as a default, so if the user desires the most accurate measure of the populace, these inputs must be updated

vii. (OPTIONAL) Mortality rates by age group **per county**. The AP3 IAM uses 2014 adult mortality rates as a default, so if the user desires the most accurate measure of the populace, these inputs must be updated

g. Calculation Outline

i. The economic framework used by Muller and Mendelsohn (2007) depicts the relationship between emissions and marginal disutility because of each increasing emission. The following equation represents the marginal damage from a set of pollutants "m" that power plant "k" emits:

$$MD(e_{mk}) = \sum_{j=1}^{J}\sum_{l=1}^{L}\left(\lambda_j \frac{\partial u_j}{\partial z_{lj}}\right)\left(\frac{\partial z_{lj}}{\partial e_{mk}}\right)$$

Where the consumer "j" is exposed to a list of pollutant concentrations "l"

ii. With this representation, the IAM was developed as follows. A baseline estimate of marginal damages from each criteria pollutant was estimated using 10,000 sources, obtained through USEPA emission inventories. Within the IAM are separate air quality models that simulate emissions transport, chemical transformation, and deposition to accurately represent the pathway from emissions to marginal damage inflicted upon the populace

iii. To represent the varying nature of the impact of these pollutants, the IAM takes in both population and mortality inputs to link age-specific damages associated with emissions from each criteria pollutant.

iv. To convert these damage estimates to monetary measures, the model uses the following equation to calculate the value of statistical life (VSL), which is dependent on a risk premium R (how much working individuals require in extra pay in order to assume an incremental risk of death) and change in the probability of death $\Delta\gamma$

$$VSL = \frac{R}{\Delta\gamma}$$

v. While in the baseline case the model considers age differentiated VSL, the user can choose to have a uniform VSL across all age groups

vi. Using these two parameters (VSL and marginal damage of pollutant emissions), the IAM outputs measures of monetary mortality damages associated with the input emissions level of each criteria pollutant.

vii. Outputs are presented per county (for those counties with power plants) for each of the criteria pollutants. With metadata indicating the spatial location of each plant, the user can aggregate these marginal damage estimates to the spatial state of their choosing

viii. NOTE: The AP3 IAM only accepts county-level inputs. If the user has emissions inputs in other spatial configurations, they can use the marginal damage estimates generated from 2014 and match the spatial resolution outside the model. It is important to note that if the emissions inputs are from post-2014, the resulting monetary estimates will be based on incorrect vitals (as the MD-estimates were generated from 2014 population and mortality statistics in the contiguous United States)

1. For example, ReEDS produces air pollutant emissions data by balancing area. Thus, for current simulations, this method is employed

5. Water Quality
    a. The water quality component of the Valuation Suite estimates changes in value due to changes in water quality in a freshwater water body resulting from a scenario. The calculation module considers changes in water quality to be any non-zero change in water pollutant concentrations.
    b. The module uses a benefit transfer methodology adapted from Johnston and Bauer (2020) to calculate these monetary values. This methodology translates measures of water pollutant concentrations into a Water Quality Index (WQI) estimate, which is then applied with other socio-economic variables for the area in question to measure consumer willingness-to-pay (WTP) for a certain level of WQI
    c. The methodology considers the following water pollutants:
        i. Dissolved Oxygen (DO)
        ii. Fecal coliform (FC)
        iii. Total Nitrogen (TN)
        iv. Total Phosphorus (TP)
        v. Total Suspended Solids (TSS)
        vi. Biochemical Oxygen Demand
    d. The user is required to provide the following inputs into the calculation module:
        i. Year, County, and State
            1. County name must be spelled out, and the state input should be its numerical FIPS code (e.g., Alabama – 01)
        ii. Baseline and alternative scenario pollutant concentrations of at least one of the above water pollutants. If the user only provides concentrations for some water pollutants, the module will assign default subindex values to the other pollutants
        iii. Answers (all Yes or No) to the following scenario questions:
            1. Is the affected population only nonusers of the water body?
            2. Is the study interested in the affected population's changes in swimming usage?

3. Is the study interested in the affected population's changes in boating?
4. Is the study interested in the affected population's changes in game fishing?
5. Does the study area include a river or multiple rivers?
6. Does the study area include multiple water body types?
7. Are the analyzed water bodies located in the USDA Northeast region?
8. Are the analyzed water bodies located in the USDA Midwest or Mountain Plains region?
9. Are the analyzed water bodies located in the USDA Southeast or Southwest region?

iv. Median household income for the study area. If this is not provided, the module will assign a default income value

v. Number of households within the study area

vi. (OPTIONAL) Geographic variables including shoreline length, region area size, water body length, and proportion of land area that is used for agricultural purposes that intersects the analyzed water body. Default values will be assigned if any or all information is not provided

e. Calculation Outline

i. The user inputs baseline and alternative scenario water pollutant concentrations for the desired area, along with answers to the module questions and any desired socio-economic and geographic characteristics

ii. The module then estimates sub-indexes for each water pollutant for both the baseline and alternative scenario cases. Seen below, the subindex is dependent on the magnitude of the water pollutant's concentration and varies with magnitude

Table 5. Water Quality Index Parameter-Subindex Equations

Parameter	Value	Subindex
DO	$DO \leq 3.3$	10
	$3.3 < DO < 10.5$	$-80.29 + 31.88*DO - 1.401*DO^2$
	$10.5 \leq DO$	100
FC	$FC \leq 50$	98
	$50 < FC \leq 1{,}600$	$98 * \exp[-0.00099178*(FC - 50)]$
	$1{,}600 < FC$	10
TN	$TN \leq 3$	$100 * \exp(-0.4605*TN)$
	$3 < TN$	10
TP	$TP \leq 0.25$	$100 - 299.5*TP - 0.1384*TP^2$
	$0.25 < TP$	10
TSS	$TSS \leq 28$	100
	$28 < TSS \leq 168$	$158.48 * \exp(-0.0164*TSS)$
	$168 < TSS$	10
BOD	$BOD \leq 8$	$100 * \exp(-0.1993*BOD)$
	$8 < BOD$	10

iii. The module then multiplies these subindex estimates with assigned index weights to obtain a measure of each water pollutant's contribution to the total WQI estimate. These weights are assigned as follows for a freshwater body:

1. DO: 0.24
2. FC: 0.22
3. TN: 0.14
4. TP: 0.14
5. TSS: 0.11
6. BOD: 0.15

iv. With these baseline and alternative scenario WQI estimates, the module then uses benefit transfer to find measures of household WTP to change the WQI from one value to the other. The module uses 1) WQI estimates calculated earlier, 2) Income inputs, and 3) Answers to the questions listed above to estimate household WTP.

v. Finally, the module uses the number of households provided by the user to provide a total region-wide WTP estimate resulting from the change in water quality in the water bodies considered in the study

6. How to use the Valuation Suite
    a. Master Valuation Module
        i. The Valuation Suite is operated using advanced-level Microsoft Excel features. To use the suite, the user should first open the file named "Valuation Suite".
        ii. The module is designed such that the user must only manually interact with one tab – the "Inputs" tab. Within this tab, there are multiple tables, each representing the region in which inputs are entered to obtain monetary values for that FEWS portfolio element
            1. Each inputs data table requests baseline and alternative scenario data with temporal and spatial designation. Data MUST be provided in the correct space; otherwise, the resulting monetary values will be incorrect.
            2. Data also must be provided in the right format. For example, some element's input tables require the state to be spelled out, while other ones require the state to be designated with its two-digit acronym. If these requirements are not followed, the valuation calculations will not operate
                a. See each FEWS portfolio element's individual section for guidance on correct input formatting
            3. If an element in an inputs table requests data in a specific unit, the user must ensure that those inputs are in the correct units before feeding them into the module
            4. Some components of the input tables are not required to be filled. Please consult the individual FEWS portfolio element sections to identify those parameters
        iii. Once inputs are provided for any or all FEWS portfolio elements, change in value results will be automatically generated. The valuation module presents results in three different formats:

1. Detailed Results – The user can access these by selecting the "Outputs – Detailed" tab, which present annual results by C-FEWS region
2. Summarized Results – The user can access these by selecting the "Outputs – Summary" tab, which presents "yearly-averaged" results by C-FEWS region. In other words, if multiple years of data was provided for a FEWS portfolio element, the values in this tab represent the average change in value from all provided years
3. Visualized Results – The user can access these by selecting the "Outputs – Visuals" tab, which currently houses two graphics for the user's convenience. One figure is a stacked bar chart showing the magnitude by C-FEWS regions of the results posted in the "Outputs-Summary" tab, and the other figure are pie charts showing the percentage breakdown of changes in value for all FEWS portfolio elements

iv. There are many other tabs in the valuation module that require no interaction. Please do NOT access these tabs and/or change any values or equations contained within these regions. If you have any questions concerning outputs, please contact Joseph Chang at josephweichang@gmail.com.

b. Inputs Example

i. For this example, we will input a few values for each FEWS portfolio element. The following pictures show the input tables with said values in proper format:

FOOD PRODUCTION											
Baseline Scenario					Alternative Scenario		Constants				
Commodity	Year	State	Yield (MT/hectare)	Harvested Area (hectares)	Yield (MT/hectare)	Harvested Area (hectares)	Domestic Price Elasticity of Demand	Domestic Price Elasticity of Supply	ROW Price Elasticity of Demand	ROW Price Elasticity of Supply	Commodity Price ($/BU)
CORN	2002	Illinois	5	20	4						
CORN	2002	Illinois	4	20	5						

ELECTRICITY GENERATION														
Baseline Scenario								Alternative Scenario						
Technology	Year	Balancing Area	State	Time-Slice	Marginal Cost ($/MWh)	Price ($/MWh)	Generation (MWh)	Year	Balancing Area	State	Time-Slice	Marginal Cost ($/MWh)	Price ($/MWh)	Generation (MWh)
	2010	42	MN		5	10	10	2010	42	MN		4	10	10

NET CARBON DIOXIDE EMISSIONS									
Emissions					Sequestration				
Technology	Year	State	Baseline (metric tons)	Alt Scenario (metric tons)	Year	State	Baseline (grams C)	Alt Scenario (grams C)	Social Cost of Carbon ($/ton)
Coal	2009	Illinois	10	15					

LOCALIZED POLLUTANT EMISSIONS										
Baseline Scenario						Alternative Scenario				
Technology	Air Pollutant	Year	Balancing Area	State	Emissions (metric tons)	Year	Balancing Area	State	Emissions (metric tons)
Coal	NOX	2010	132	CT	1	2010	132	CT	3

Baseline Scenario									
Year	Reach Number	County	State FIPS	Dissolved Oxygen (mg/L)	Fecal Coliform (col/100mL)	Total Nitrogen (mg/L)	Total Phosphorus (mg/L)	Total Suspended Solids (mg/L)	Biochemical Oxygen Demand (mg/L)
2009	1	Aroostook	23			0.1	0.1		

Alternative Scenario									
Year	Reach Number	County	State FIPS	Dissolved Oxygen (mg/L)	Fecal Coliform (col/100mL)	Total Nitrogen (mg/L)	Total Phosphorus (mg/L)	Total Suspended Solids (mg/L)	Oxygen Demand (mg/L)
	1	Aroostook	23			0.11	0.11		

ii. For water quality, the user must also answer questions about the water body of interest's characteristics.

WATER QUALITY	
Study Questionnaire	
Question	Answer (Yes or No)
Is the affected population only nonusers of the water body/bodies?	No
Are the affected population's changes in swimming usage considered?	No
Are the affected population's changes in boating considered?	No
Are the affected population's changes in game fishing considered?	No
Is the focal water body a river or multiple rivers?	Yes
Does the focal water body include multiple water body types?	Yes
Are the analyzed water bodies located in the USDA Northeast Region?	Yes
Are the analyzed water bodies located in the USDA Midwest or Mountain Plains Region?	Yes
Are the analyzed water bodies located in the USDA Southeast or Southwest Region?	No

iii. Once all inputs have been provided, the module automatically generates results, accessible in three forms as specified in Section 6.a.iii.

c. AP3 Integrated Assessment Model (IAM)

i. NOTE: the model can only be used with county-level emissions inputs. If the user does not have such capability, they can still generate monetary estimates from the master valuation module, though they may be based off incorrect vitals (2014 population and mortality statistics). See Section 6(a) for how to generate surplus estimates from localized pollutant emissions for this case.

1. For example, the C-FEWS project only has the capability of generating emissions data per balancing area. However, since these balancing areas are 1) contained within each state and 2) were formed by combining counties within each state, monetary values can be calculated by multiplying emissions in a balancing area by the average marginal damage value out of all counties that comprise the associated balancing area

ii. If the user has such capability, the user can generate their own marginal-damage estimates per local air pollutant using the following steps:

    1. Access the AP3 IAM (requires account creation) and download all model files https://public.tepper.cmu.edu/nmuller/APModel.aspx
    2. Create a local directory where the user desires outputs to be deposited to and copy the following model files to the folder:
        a. 2011_PM_Worksheet_Area_Low_Western_Adj .mat file
        b. 2011_PM_Worksheet_Med_Tall_Western_Adj .mat file
        c. All files in the "Input Files" folder
            i. NOTE: all input files are required for the model to operate. The varying input files represent air pollutant sources of varying height (e.g. area sources, low, etc.). For the C-FEWS project, the only input file that will be altered are emissions at the power plant level, which are all contained within the "Tall" categorization
        d. All files in the "AP3 Scripts" folder
    3. Input the following into the newly created directory user-specific files in Microsoft Excel Comma-Separated-Values (CSV) file format. For the IAM to run successfully, the following files are required:
        a. Pollutant emissions per power plant for each criteria pollutant

        i. Replace the "Tall_2014" file with the desired emissions input CSV

    b. Population numbers per age group per county

        i. NOTE: the model does have 2014 population values per county, so if the user does not access to updated population values, the user can still obtain marginal damage estimates, but based on incorrect vitals

    c. Mortality estimates per age group per county

        i. NOTE: the model does have 2014 mortality estimates per county per criteria pollutant, so if the user does not access to updated population values, the user can still obtain marginal damage estimates, but based on incorrect vitals

    d. The age groups represented in the input files are as follows:

        i. Bin 1: <1
        ii. Bin 2: 1-4
        iii. Bin 3: 5-9
        iv. Bin 4: 10-14
        v. Bin 5: 15-19
        vi. Bin 6: 20-24
        vii. Bin 7: 25-29
        viii. Bin 8: 30-34
        ix. Bin 9: 35-39
        x. Bin 10: 40-44
        xi. Bin 11: 45-49
        xii. Bin 12: 50-54
        xiii. Bin 13: 55-59
        xiv. Bin 14: 60-64
        xv. Bin 15: 65-69
        xvi. Bin 16: 70-74
        xvii. Bin 17: 75-79

        xviii. Bin 18: 80-84
        xix. Bin 19: 85+
    e. Within the working directory, open the “PM_Setup” file in MATLAB
    f. Within the “PM_Setup” file, change the working directory to the new folder path created in Step 2, and update 1) “Tall Stack” file name, 2) file path of the 2 .mat files, 3) Population file name (if considered), 4) Mortality file name (if considered) and 5) “WTP_Mort” (VSL) value (if considered), as seen in the below screenshot
        i. NOTE: all other default values must be kept the same

```
%% (* ::Package:: *)
clear all
cd 'P:\Muller AP2 IAM\JWC_TEST'

%% These files contain AP3's core data such as SR matrices
load 'P:\Muller AP2 IAM\JWC_TEST_2_1\2011_PM_Worksheet_Area_Low_Western_Adj'
load 'P:\Muller AP2 IAM\JWC_TEST_2_1\2011_PM_Worksheet_Med_Tall_Western_Adj'

%% Change Emission files depending on NEI year
Area_Source{4,1}=csvread('area_sources_2014.csv');
Low_Stack{4,1}=csvread('low_2014.csv');
Med_Stack{4,1}=csvread('medium_2014.csv');
Tall_Stack{4,1}=csvread('tall_test.csv');
New_Tall{4,1}=csvread('tall2_2014.csv');

%% Change Population and Mortality for all years
Mortality{6,1}=csvread('pop_2014.csv');
Mortality{3,1}=csvread('mort_2014.csv');

%% Set Parameters for VRMR, DR-Functions
WTP_Mort = 9186210;
DoseResponseAdult= 0.005826891; % Krewski
DoseResponseInfant=0.006765865; % Woodruff 2006
```

4. Open the “AP3_Outputs” file and change the file name of “Tall_Stack” to whatever the user desires the output file to be named, as seen in the below screenshot

```
% Take marginal damages generated and write to .csv files, change years

dlmwrite('md_A_2014.csv', Mort_D_A, 'precision', 12) %%%
dlmwrite('md_L_2014.csv', Mort_D_L, 'precision', 12) %%%
dlmwrite('md_M_2014.csv', Mort_D_M, 'precision', 12) %%%
dlmwrite('md_powerplant_test.csv', Mort_D_T, 'precision', 12) %%%
dlmwrite('md_T2_2014.csv', Mort_D_T2, 'precision', 12) %%%
```

5. Execute the Model by running the "PM_CRDM_Marginal" script, which will return CSV files with marginal damages for NH3, NOx, PM2.5, SO2 and VOC (in that order) at the county level. For the C-FEWS project, the only results file that should be considered is the "Tall" file that was renamed in the previous step