

Evaluating climate vulnerability using the World Bank's Climate Change Knowledge Portal- Stepwise exercise

Suggested Reading

- How to use the World Bank's Climate Change Portal
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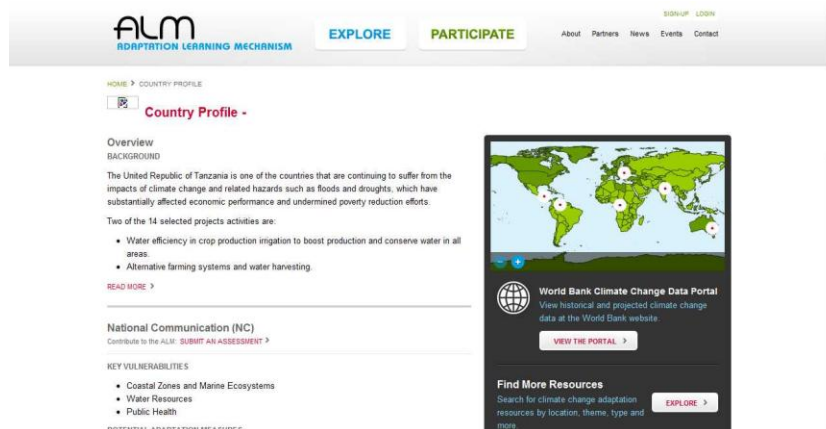
In this overview we will use the World Bank's Climate Change Portal to

- a) review the historical, current, and projected trends for a country of choice; and
- b) identify and evaluate a broad range of potential impacts within different sectors

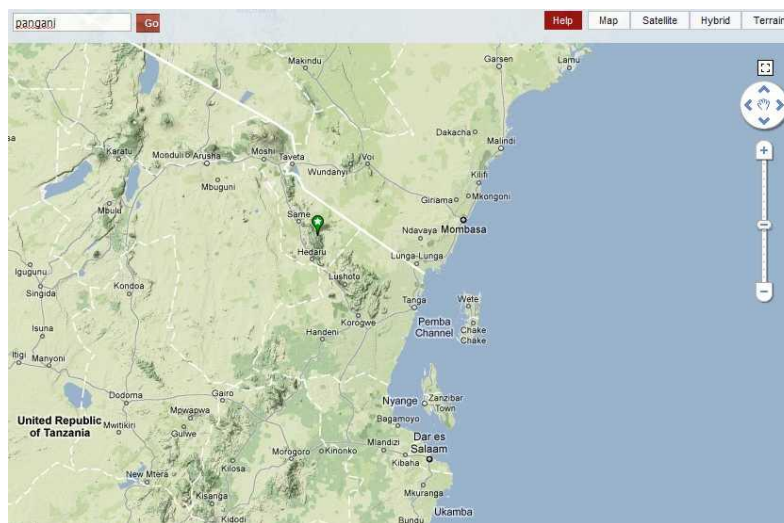
The overview will provide some building steps for you to create a vulnerability matrix during Exercise 1.

Step 1: What are the major climate (e.g. maximum temperature) and climate-related factors (e.g. Drought frequency) of importance on sectors such as water and natural resource management?

1. Open the World Bank's Climate Change Portal using your internet browser by going to <http://sdwebx.worldbank.org/climateportal>. The portal is meant to provide rapid access to information regarding climate change and relevant information. As a true portal, it is meant to provide ready and intelligent access to a wealth of information, not necessarily restricted to that available within the World Bank.
2. We are going to begin by exploring a bird's eye view of the major risks for **Tanzania** but please note that you can do the same for other country of interest. To do this, click on the **Tools Option** on the bottom of the left hand options. Select **UNDP-ALM tool**. A new page will open showing information from UNDP's Adaptation Learning Mechanism (ALM).
3. In the Choose your Location box on the right hand side of the interface, **type Tanzania** and press the enter button on your keyboard. Then **click on the View Country Profile** button that appears. A new page will open, showing you information on climate change risks and adaptation. This page (shown below) contains synthesized information for Tanzania, including Key Vulnerabilities within different key economic sectors, Ongoing Projects by different organizations, and an Overview Profile that describes the reasons for vulnerability and risks for Tanzania as a whole from National Communications, NAPA's, etc. *Make note of the key findings from this overview before continuing.*

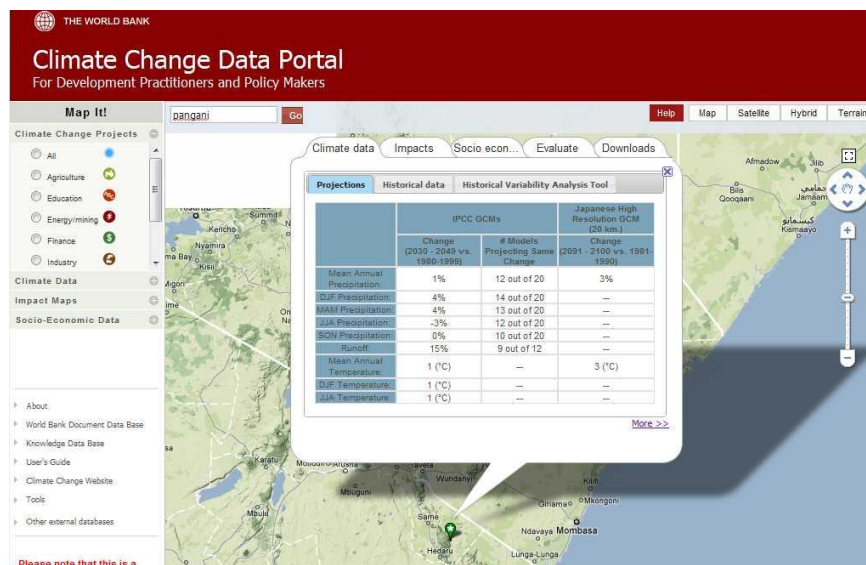


4. Now return to the World Bank’s Climate Change Portal and **use the zoom box functions to navigate to your basin of interest**. You can also alternatively search for these basins or nearby areas using *the Search for a place box*. The portal will zoom you into your desired location. In the example below, we have used the search for a place box to zoom into the Pangani river basin in Tanzania by typing in “Pangani” and clicking on the Go button. The map control will zoom into the Pangani basin.



5. **Click on a location on the map** near the Pangani basin (located on the map with a green bubble with a star) once you have zoomed in. A dialogue box will appear which has several tabs, including: *Climate Data, Impacts, Socio-Economic, Evaluate, and Downloads*. This dialogue box offers a preview of the available information within the portal, clicking on the **EXPLORE FURTHER...** link under any of these tabs will allow you to view the data in complete detail, as well as offer the possibility of downloading these for further analysis. You will be using these tabs in more detail in the exercises below.

If you have any questions or further suggestions on the Portal please contact
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6. Make sure you have the tabs displayed on your map control. Note that you may need to click on your site of interest on the map again.
7. Since the question we are seeking to answer involves defining the major climate (e.g maximum temperature) and climate-related factors (e.g. drought frequency) we will focus on the information in the **CLIMATE DATA** tab for the next few steps.
8. Under the **climate data tab** you will see several sub-tabs each of which provide different views of the available climate information for this location. This includes both data from global circulation models (GCMs) as well as processed information from global meteorological stations. A short description of these is provided below:
 - **Projections** –Model output data- offers a graphical representation of two variables: Rainfall and Temperature- both from a Historical, and Projected perspective. These projections are based on modeled outputs as well as the ensemble averages for these time periods. The time periods include Historical, 2020’s, 2040’s, 2060’s and 2080’s. The values available include the projected values as well as changes from historical to projected time periods (or the difference between the climate today and that projected into the future).
 - **Historical Data** – A graphical representation of Meteorological Station level dataset that offers information on historical values for rainfall and temperature as a yearly average, on a monthly basis, and for a user selected subset of these.
 - **Historical Variability Analysis Tool** – The tool allows users to investigate the historical variability of precipitation and temperature at various time scales (interannual, decadal, and long-term linear trend) over the 20th century near a user-selected location.¹
9. In order to understand what the major climate hazard may be for your region, it is important to begin by understanding the historical context of your selected site. Click on the **Historical data** tab.

Historical data

¹ This tool was developed in collaboration with IRI at Columbia University.

- Again, since this is just a scoping exercise you can select all of the months. Also click on the monthly averages tick box.
- As the starting year, pick a year that would allow you to see the historical averages for the variable selected (you will do this for both Data TYPES: *temperature and rainfall*), for example 1965.
- Select 2002 as the end year.

Historical Data

Month(s): August September October November December

Starting Year: 1965

Ending Year: 2002

Monthly Average

Data Type: Precipitation

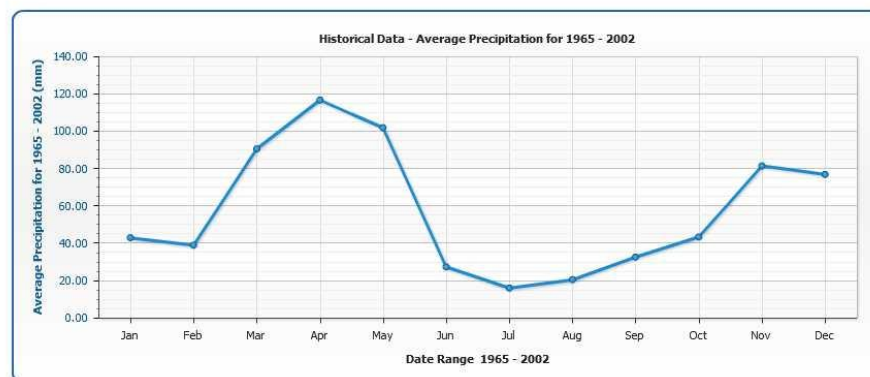
Graph Data

Source:

[CRU TS 2.1 Global Climate Dataset](#). These data has been produced by the Climatic Research Unit (CRU of University of East Anglia (UEA), and reformatted by International Water Management Institute (IWMI). The CRU TS 2.1 Global Climate Dataset is comprised of 1224 monthly time-series of climate variables, including temperature and precipitation, for the period 1901-2002, covering the global land surface, excluding Antarctica, at 0.5 degrees resolution. These data were downloaded from the CGIAR Consortium for Spatial Information (<http://cru.csi.cgiar.org/index.asp>).

[ClimateWizard Dataset\(TNC\) - Country analysis of climate data.](#)

- Once you are finished making your selections, click on the **graph data** button. A separate window will appear showing a month by month curve of historical average values for the variable (rainfall or temperature) selected.
- You may now ask yourself: What pattern of rainfall / temperature do you have? Does your rainy season occur during one or two periods out of the year? During which periods? In the example below, this site has two rainy periods, a long and a short rainy season- one beginning in August and ending in January and another beginning in February and ending in May. Note that there is a dry period from June-August.



- Now take a look at the historical temperature graph: When are the hottest periods of the year for your selected site? What does it mean for energy consumption? What does this mean for water resource management in energy and/or agriculture in the area? For example, a higher

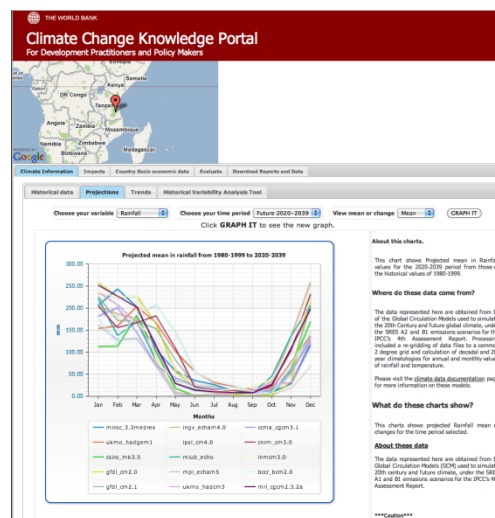
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temperature could lead to more loss of moisture from the soil, which would require longer time during the rainy period to accumulate sufficient moisture for certain kinds of crop production. What does it mean for the planting seasons? **Make a note of your observations.**


13. Explore various different time periods, especially the changes between 1965-1985 and the 1990s and 2000's – how are rainfall and temperature patterns changing, on average? – Discuss with your peers: What are the implications for these changes? Save the graph (or minimize it) in your desktop for future reference.
14. Once you have defined the critical months and relevant activities for your Basin - You are ready to begin exploring climate futures for your area.
15. Return to the **Climate Data Tab**.

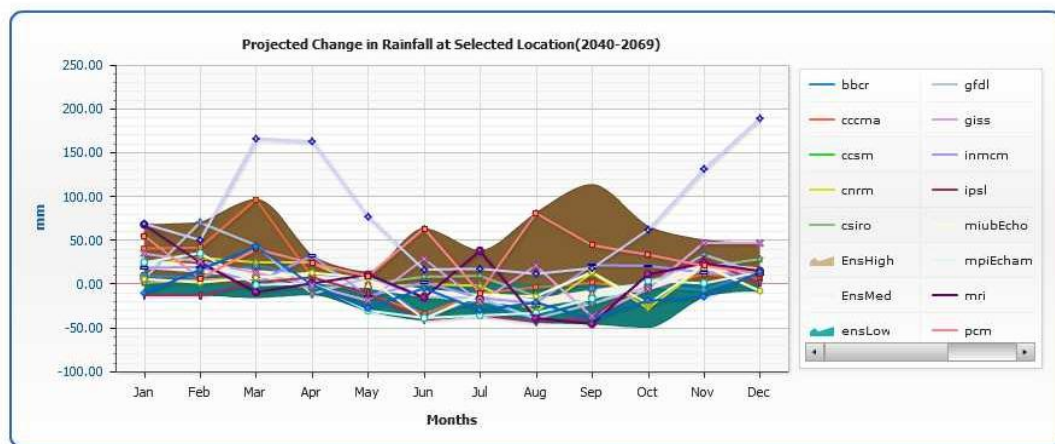


16. Now, click on the **Projections** sub-tab. Please select the **Explore Further...** link to see the table and other functionalities in full mode. This tab allows you to visualize global circulation model (GCM) output at the selected location. Note that the values for this chart come from a 50x50km grid cell, rather than being specific to the site.





17. Take a look at the selection options on the top of the window. You have the ability to graph either temperature or rainfall values from the historical record and in the future (decadal up to 2100) from 15 Global Circulation Models (GCMs). Note that you can also graph **estimated mean values** into the future or **change values** from the historical record (i.e 1965-1985 to 2045-2065).
18. Select the **rainfall** variable, the **historical** option, and **mean** option and then click on the  button. This indicates mean model values for rainfall and how well they can interpret historical data. Note the differences (if any) from the models and the historical reconstruction.

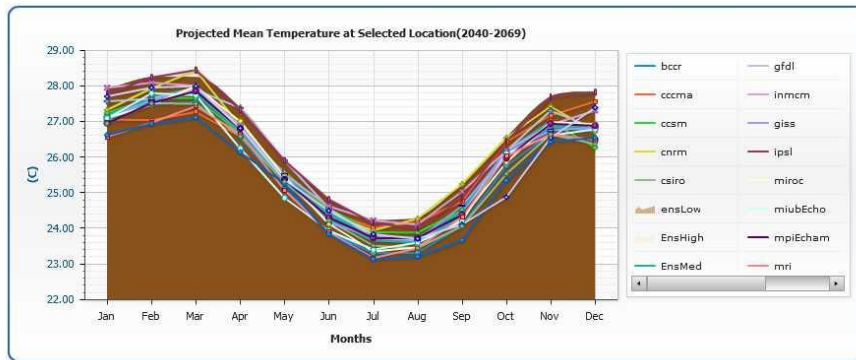
19. Now run through the process of step 18 above with the temperature variable. How has temperature changed in your area? What are the implications of the observed combined rainfall and temperature changes?
20. The steps above will help you to define the variability of temperature and rainfall in your area. Note any significant observations and the time in which they occurred. Once you have finished, you are ready to begin exploring the future climate projections.
21. Select a **Future** time period (i.e 2040-2069), the **rainfall** variable, and the **mean** option and then click on the  button. A new graph will appear showing multiple colored lines indicating the way many models project mean rainfall into the selected future period. What are the average monthly rainfall values for each model?



- Do all models agree on the projected changes in rainfall? Do some models show greater or lesser increases than others? Do they agree on changes in rainfall for a specific period of time?
- If there is agreement, how many models agree? How many disagree? How would you characterize this in terms of the certainty required in the matrix?

22. Now select the **change** option on the left hand side and then click on the  button. This chart shows the same colored lines, but instead of representing mean rainfall in the future, the chart shows projected changes in rainfall from the historical record (1965-1985 to 2040-2069). The lines above the X axis at "0" indicate a projected increase in rainfall whereas those below the x axis at "0" indicate a projected decrease in rainfall. Be very careful and observe closely the values of the Y axis. How do these compare with the mean values you noted in step 12? Are these significant changes?

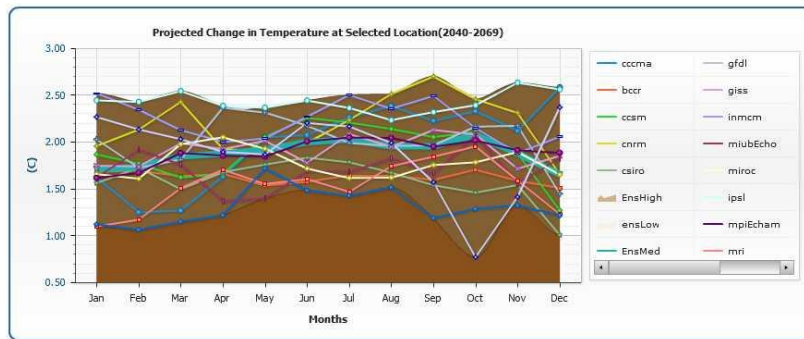
23. Now do the same as step 22 above for **temperature** and then click on  button. A new graph will appear showing multiple colored lines indicating the way many models project **mean temperature** into the future (2040-2069).



24. Select the **change** option on the left hand side of the chart and then click on the graph it

Graph It

button. This chart shows the same colored lines, but instead of representing mean temperature in the future, the chart shows projected changes in temperature from the historical record (1965-1985 to 2040-2069). The lines above the x axis at "0" indicate a projected increase in rainfall whereas those below the x axis at "0" indicate a projected decrease in rainfall. How do these compare with the mean values you noted in step 12? Are these significant changes?



- Do most models agree on the direction of change? What about the magnitude of change? If there is agreement, how many models agree? How many disagree?
- Are there months which are projected to be much hotter than normal? Which ones and by what temperature?
- You will need to discuss with your team the following questions:
 - To what extent do rainfall and temperature capture meaningful variables for your understanding of climate change risks?
 - To what extent are future changes in temperature/rainfall expected to change?
 - Is there uncertainty regarding what these changes will be?
 - Are there specific times of the year where there is more certainty on projected changes than others? If so, are these periods significant for your activities?
 - If there is a lot of uncertainty in model projections, how will you address these in the project activities?

25. Scroll down below the graph to view the summary table that appears below. This table synthesizes information across a range of Global Circulation models from the IPCC's 4th

Assessment report. This information is for the Global Circulation Model Grid cell where your point is located. Explore the information presented:

- The first column defines the variables for which information is available, including projected change in:
 - ◆ mean annual precipitation,
 - ◆ DJF (December January February) Precipitation
 - ◆ MAM (March April May) Precipitation
 - ◆ JJA (June July August) Precipitation
 - ◆ SON (September October November) Precipitation
 - ◆ Runoff
 - ◆ DJF (December January February) Temperature
 - ◆ MAM (March April May) Temperature
 - ◆ JJA (June July August) Temperature
 - ◆ SON (September October November) Temperature
- The second column shows the results (in terms of % change for each of the variables above) from one high resolution Global Circulation model for change from present to 2100.
- The third column shows the same results (on average) for the ensemble (combination) of Global Circulation Models used in the Intergovernmental Panel on Climate Change (IPCC) 4th Assessment Report -- for change from the present to 2049.
- The Fourth column indicates the number of models which project the same direction of change as noted in column 3. The reason for this column is that the change shown in terms of % in column 3 is an average across all models- meaning that some models may actually indicate a different direction of change, but when averaged, that direction may be opposite. Let's take a look at the example below to better understand this:

Climate Change Summary				
By mid-century, the coarser-resolution global climate models project that this site will become warmer, with more frequent heatwaves and fewer frost days. They disagree on whether this site will become wetter or drier. Rainfall intensity is expected to increase. Runoff (precipitation minus evapotranspiration), a measure of water availability, is projected to increase. The maximum amount of rain that falls in any 5-day period (a surrogate for an extreme storm event) is expected to increase.				
One particular higher-resolution (finer spatial scale) climate model projects that this site will become wetter by the end of the century. The maximum amount of rain that falls in any 5-day period (a surrogate for an extreme storm event) is projected to increase. The maximum period between rainy days is expected to decrease. Sometimes this higher-resolution model can be in conflict with the ensemble of coarser-resolution models, underscoring the need to consider many different climate models.				
Climate Data				
	Japanese High Resolution GCM (20 km.)	IPCC GCMs		Country Average Values
	Change (2091 - 2100 vs. 1981- 1990)	Change (2030 - 2049 vs. 1980-1999)	# Models Projecting Same Change	
Mean Annual Precipitation:	3 %	1 %	12 out of 20	1 %
DJF Precipitation:	--	4 %	14 out of 20	4 %
MAM Precipitation:	--	4 %	13 out of 20	11 %
JJA Precipitation:	--	-3 %	12 out of 20	5 %
SON Precipitation:	--	0 %	10 out of 20	-1 %

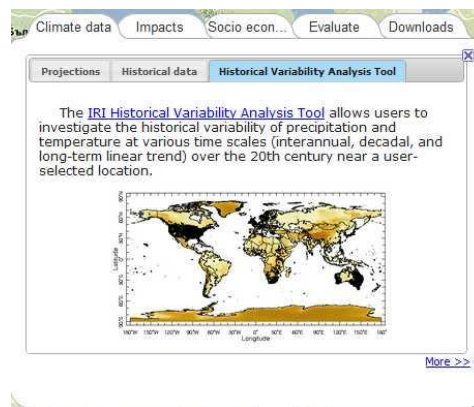
Let's begin by taking the outputs under the IPCC Models (Third Column)

- The model ensemble projects minimal (1%) in mean annual precipitation through 2049. This is an average annual value. Precipitation for December-January-February is also projected to change slightly (4%), as is March April May (MAM).

27. During June July August (JJA)- the critical months of the dry period, a 3% decrease of rainfall annually is projected. What this means, for your basin of interest, is entirely dependent upon context and sector (i.e. if farmers are already farming under marginal conditions, what does a more pronounced dry period mean?) You also need to bear in mind that 12 out of 20 GCM's project a decrease in rainfall during this time period (see column #models projecting same change). This means that there is **uncertainty** regarding the projected changes in rainfall for this time period- and that this requires **robust planning approaches** under a range of scenarios. This implies that planning should also take into account the potential for drier soil conditions at the beginning of the rainy season, with potential implications for crops. Hence, while rainfall during this period may not be critical for agriculture, the combined effects of a more intense dry season and increasing temperatures could have significant repercussions for crops.
28. Now take a look at the final data column- which shows the average change values for the same variables for the entire country. How does your site's information compare to the rest of Tanzania? Can you see any opportunities and risks particular to your site? There are also projected increases in temperature throughout the year by 3 degrees Celsius for the same time period, indicating the potential for increased evaporation from the soil leading to loss of soil moisture. How this might impact annual crop production? How might agriculture production shift under new climate patterns? *You will need to discuss with your group what these changes may mean and how they will impact your matrix.*

Step 2: What are the historical trends in the major climate (e.g. maximum temperature) and climate-related factors (e.g. Drought frequency) of importance to the agricultural water and natural resource management sector?

In these steps, you are going to example historical trends in rainfall and temperature using the portal. This tool allows you to search through available met station information and examine historical variability in temperature and rainfall. To do this, select on a site on the map, then click the climate tab and then the Historical Variability Analysis Tool tab.



1. Then click again on the **historical variability analysis tool** tab and then select the IRI Historical Variability Analysis Tool link. A new window will open showing you the tool. Use the mouse to build a box around your interested area on the map and zoom into East Africa.

2. You will need to choose from the left hand options as follows:
3. Choose the **GHCN Precipitation** option under the “Select Precipitation or Temperature data” box

Select Precipitation or Temperature Data:
GHCN Precipitation

4. Select Jan as the start of the season and Dec as the end under the “Select Season” option
Select Season: Jan to Dec

5. Choose the 1951-2000 option under the “Select Year Range for Station Filtering” box using the drop down arrows on the right
Select Year Range for Station Filtering:
1951 to 2000

6. Now you are ready to select your site, click on the map near the Pangani basin or your basin of interest. A black and green pin will appear on the map, one representing your selected location and the other representing the nearest station location where information for variability analysis is available. Scroll down to see the results of your search.

7. You will see some text showing you the location you selected and the location of the nearest station from which information is drawn for the next analysis. Note the second column under “Nearest Station” and make sure that the distance from your selected site to the nearby station

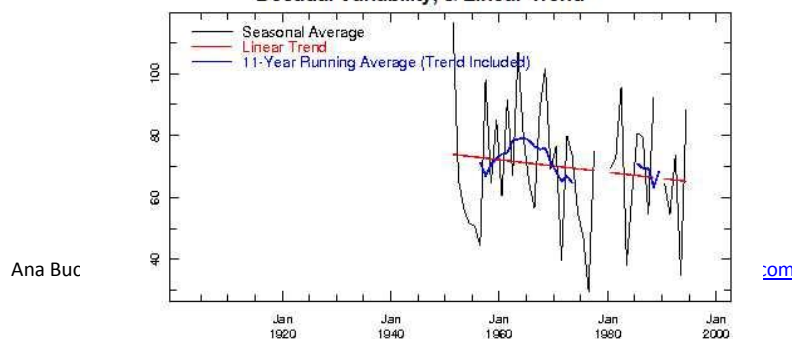
Selected Location:
Longitude: 36.19643
Latitude: -4.076414
Approximate Elevation: 1210 m

Nearest Station:
Name: MBULU BOMA TANZANIA
ID: 63789001
Longitude: 35.6E
Latitude: 3.9S
Elevation: 1737 gpm
Distance from Selected Location: 68.9556 kilometers

is not significant.

8. To the right of these data you will see a summary chart. This chart contains the rainfall values averaged on a yearly basis (black lines) from 1951 to 2000. The red line indicates the trend in annual rainfall for this time period. If it angles downward, this indicates a decreasing trend in annual rainfall. Take a look at the text values below the chart. Next to the “Trend” text, you will see an average value for the changes in rainfall over this period. You will need to decide whether or not this is a significant trend for your study area. *Note that the tool has other*

a. Jan-Dec Seasonal Average Station Precipitation Values, Decadal Variability, & Linear Trend



Station at (35.6E, 3.9S) MBULU BOMA TANZANIA; Trend: -20.1347 mm/month per cent
Seasonal average data in this graph | GIF image of this graph

functions which we encourage you to explore at a later date, but for now we are going to continue to look at the available information in the portal in terms of Impacts.

Step 3: Using the Portal to define potential impacts on your basin.

During Step 3 of building your matrix, you will need to define a list of environmental, social and economic factors of interest to the water and agriculture industry which may be impacted by the above-mentioned climate change factors (e.g. water storage capacity, water infrastructure, ecosystems, crop and land management). Which of the following steps you choose will depend on the sectors of interest selected. Click on the Impacts tab.

Climate Information **Impacts** Country Socio economic data Evaluate Download Reports and Data

Under this tab, there are several sub-tabs available, each of which offers synthesized information regarding climate change impacts for your selected site.

- Agriculture – provides access to projections of the changes due to climate change to major cereal crops for your selected site at a 50x 50 km resolution.
- Disasters – offers a bird’s eye view of the sensitivity to major disasters (including floods, droughts) for your selected site.
- Water Resources – is forthcoming, and will offer information on runoff and water availability for the selected location.

Disasters

1. Click on the **Disasters sub-Tab**. The portal will query all of the available disasters data from M. Diley et al. 2005, Natural Disaster Hotspots study and offer a summary view of the relative risk and impact of Floods, Droughts, Landslides and Cyclones for this site. The higher the value, the higher the relative risk at each site. An example is provided below.
2. Take a look at this table, and make note of the climate hazards that are relevant for your area. How do they impact your area? Loss of life? Economic loss? Etc. Add this information to your risk matrix. You will use this in subsequent steps.

Natural Disaster - Relative Risk				
	Frequency	Mortality	Economic Loss	Economic Loss/ GDP
Flood:	10	8	3	4
Drought:	0	9	5	7
Landslide:	0	0	0	0
Cyclone:	0	0	0	0

The number refers to the decile of the global distribution for each variable. The higher the value, the higher the relative risk. The value is for this particular location, not the country as a whole.

Source:
Dilley, M., R.S. Chen, U. Deichmann, A.L. Lerner-Lam, M. Arnold, J. Agwe, P. Buys, O. Kjekstad, B. Lyon, and G. Yemman. 2005. Natural Disaster Hotspots: A Global Risk Analysis. Disaster Risk Management Series, Issue No. 5. The World Bank, Washington, D.C.

Agriculture

1. Click on the **Agriculture sub-tab**. Since this is a scoping exercise to look at what projected changes might be, you want to select all of the crops available in the Crops selection box by clicking and dragging along all of the names. Then select both conditions (high input and low input)- these are agricultural practices for crops, including the use of fertilizers and other inputs).

- Select both options for carbon fertilization, and both options for water use and time periods. Once you have everything selected, click on the Get Data button. The portal will query all of the available model information for the crops and conditions selected. This may take a few minutes as several layers of data are being queried. Once the information is available, it will appear in a table at the bottom of this bubble (as below).

Crop	Baseline Yield (1961 - 1990)	Future Projected Yield	Change %	Options
Wheat	0	0	NaN	High Input, Rainfed Carbon, 2020s
Wheat	0	0	NaN	High Input, Rainfed Carbon, 2050s
Rice	0	0	NaN	High Input, Rainfed Carbon, 2020s
Rice	0	0	NaN	High Input, Rainfed Carbon, 2050s
Maize	3670	3715	1.23	High Input, Rainfed Carbon, 2020s
Maize	3670	3727	1.55	High Input, Rainfed Carbon, 2050s
Sorghum	3038	3089	1.68	High Input, Rainfed Carbon, 2020s
Sorghum	3038	2935	-3.39	High Input, Rainfed Carbon, 2050s
Pearl Millet	1483	1488	0.34	High Input, Rainfed Carbon, 2020s
Pearl Millet	1483	1351	-8.9	High Input, Rainfed Carbon, 2050s
Best Cereal	3671	3715	1.2	High Input, Rainfed Carbon, 2020s
Best Cereal	3671	3727	1.53	High Input, Rainfed Carbon, 2050s

2. You can scroll within this window using the scrolling functions on the right of the table, looking for projected changes (Change %) in the yields of major crops. Write down the significant values that you see and add these to your impacts matrix where appropriate. In the screen capture above, for example, you can see that Maize yields are projected to decrease in some cases by nearly 19% for this location. The significance of these changes can be weighed using your knowledge and experience of the area. At any time, clicking on the Explore Further... option will open a new window from where you can view the complete information set.

The answers and discussions to your questions above should offer guidance on building your vulnerability matrix during Exercise 1. Time permitting, you might also feel free to explore some of the other tabs and resources available in the Climate Change Knowledge Portal. Most of the data you have explored through this exercise can be visualized under the left tab "Map it" sections. You can also try other regions and source of data.

If you have any questions or further suggestions on the Portal please contact
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