EDA and Stakeholder Questions Notebook

In [1]:
```
# Import the required libraries
import pandas as pd
import numpy as np

import scipy.stats as scs

import matplotlib.pyplot as plt
import matplotlib.colors
import seaborn as sns

# set up pandas to display floats in a more human friendly way
pd.options.display.float_format = '{:,.2f}'.format
```

In [2]:
```
def get_percentage_summary(label, x, y):
    percentage = round(x/y, 3)
    summary = str(percentage) + '% ' + label
    return summary
```

In [3]:
```
# read in the processed data
df = pd.read_csv('../data/train_processed_labeled.csv')
print(df.shape)
df.head(3)
```

```
(57565, 44)
```

Out[3]:

	id	amount_tsh	date_recorded	funder	gps_height	installer	longitude	latitude	wpt_name	basin	...	source	source_type	so
0	69572	6,000.00	2011-03-14	roman	1390	roman	34.94	-9.86	none	lake nyasa	...	spring	spring	g
1	8776	0.00	2013-03-06	grumeti	1399	grumeti	34.70	-2.15	zahanati	lake victoria	...	rainwater harvesting	rainwater harvesting	
2	34310	25.00	2013-02-25	lottery club	686	world vision	37.46	-3.82	kwa mahundi	pangani	...	dam	dam	

3 rows × 44 columns

Processed Data Column Descriptions

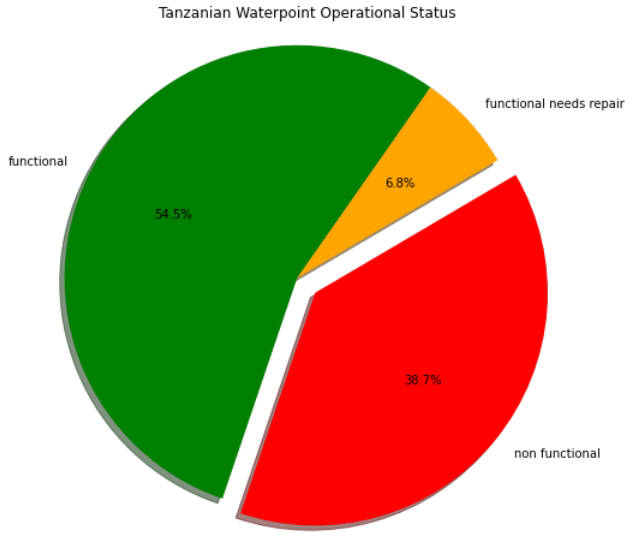
- id - Numeric identifer for the waterpoint
- amount_tsh - Total static head (amount water available to waterpoint)
- date_recorded - The date the row was entered
- funder - Who funded the well
- gps_height - Altitude of the well
- installer - Organization that installed the well
- longitude - GPS coordinate
- latitude - GPS coordinate
- wpt_name - Name of the waterpoint if there is one
- basin - Geographic water basin
- subvillage - Geographic location
- region - Geographic location, NOTE: Hierarchy is Region > LGA > Ward
- region_code - Geographic location (coded)
- district_code - Geographic location (coded)
- lga - Geographic location
- ward - Geographic location
- population - Population around the well
- public_meeting - True/False
- recorded_by - Group entering this row of data
- scheme_management - Who operates the waterpoint
- scheme_name - Who operates the waterpoint
- permit - If the waterpoint is permitted
- construction_year - Year the waterpoint was constructed
- extraction_type - The kind of extraction the waterpoint uses
- extraction_type_group - The kind of extraction the waterpoint uses
- extraction_type_class - The kind of extraction the waterpoint uses
- management - How the waterpoint is managed
- management_group - How the waterpoint is managed
- payment - What the water costs
- payment_type - What the water costs
- water_quality - The quality of the water
- quality_group - The quality of the water
- quantity - The quantity of water
- quantity_group - The quantity of water
- source - The source of the water
- source_type - The source of the water
- source_class - The source of the water
- waterpoint_type - The kind of waterpoint
- waterpoint_type_group - The kind of waterpoint
- recorded_year - Pulling out the year from date_recorded
- waterpoint_age - Calculate as recorded_year - construction_year
- region_with_code - Combine region and region_code. There are more region_code values than region values
- recorded_good_quality - True if quality_group == 'good', False if anything other than 'good'
- recorded_good_quantity - True if quanity_group == 'sufficient', False if anythign other than 'sufficient'
- status_group - Operational status (these are the 3 classes we will attempt to predict on Test data)

Question 1: What is the operational status of waterpoints in Tanzania?

1a: What is the overall waterpoint Operational Status?

In [4]:
```
by_op_status = df.groupby('status_group')['id'].count()
by_op_status.sort_values(ascending=False, inplace=True)
```

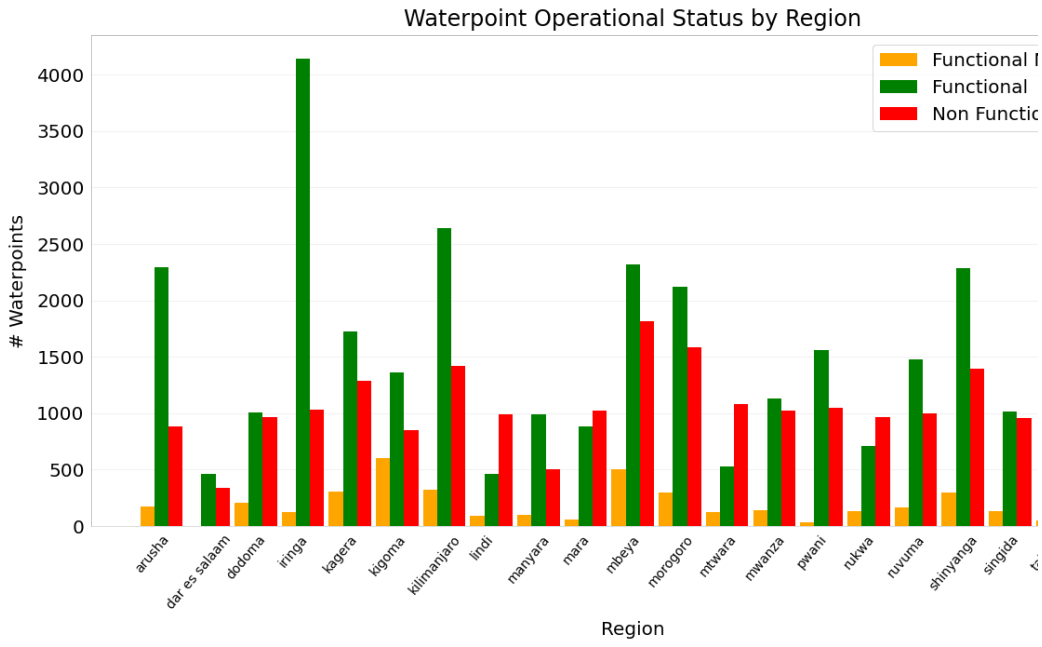
In [5]:
```
plfig = plt.figure(figsize = (8, 8))
my_explode = (0, 0.1, 0)
my_colors = ['green', 'red', 'orange']
plt.pie(by_op_status, labels=by_op_status.index, autopct='%1.1f%%', startangle=55, shadow =True, c
plt.title('Tanzanian Waterpoint Operational Status')
plt.axis('equal')
plt.rcParams.update({'font.size': 20})
plt.show()
```



1b: What is the breakdown of waterpoint operational status by Region?

In [6]:

```
# Create a grouped bar chart, with region as the x-axis and status_group as the variable we're gro
fig, ax = plt.subplots(figsize=(18, 10))

# Our x-axis. We just want a list of numbers from zero with a value for each of the regions.
x = np.arange(len(df.region.unique()))

# Define bar width. We need this to offset the additional bars.
bar_width = 0.3

b1_series = df[df['status_group'] == 'functional needs repair'].groupby('region')['id'].count().so
b2_series = df[df['status_group'] == 'functional'].groupby('region')['id'].count().sort_index(0)
b3_series = df[df['status_group'] == 'non functional'].groupby('region')['id'].count().sort_index(


b1 = ax.bar(x, b1_series, width=bar_width, label='Functional Needs Repair', color='orange')
# Same thing, but offset the x.
b2 = ax.bar(x + bar_width, b2_series, width=bar_width, label='Functional', color='green')
 # Same thing, but offset the x again
b3 = ax.bar(x +(bar_width*2), b3_series, width=bar_width, label='Non Functional', color='red')

# Fix the x-axes.
ax.set_xticks(x + bar_width / 3)
ax.set_xticklabels(b1_series.index, fontsize=14, rotation=50)

# Add legend.
ax.legend()

# Axis styling.
ax.spines['top'].set_visible(False)
ax.spines['right'].set_visible(False)
ax.spines['left'].set_visible(False)
ax.spines['bottom'].set_color('#DDDDDD')
ax.tick_params(bottom=False, left=False)
ax.set_axisbelow(True)
ax.yaxis.grid(True, color='#EEEEEE')

# Add axis and chart labels.
ax.set_xlabel('Region', labelpad=10)
ax.set_ylabel('# Waterpoints', labelpad=10)
ax.set_title('Waterpoint Operational Status by Region', pad=10)
fig.tight_layout()

```



Insights:

- The 3 Regions with the highest number of Functional waterpoints are Iringa, Kilimanjaro, and Kagera.
- The 3 Regions with the lowest numer of Funtional waterpoints are Mtwara, Lindi, and Dar es Salaam.
- The 3 Regions with the highest number of Functional Needs Repair waterpoints are Kigoma, Mbeya, and Kilimanjaro.
- 16 of the 21 Regions have a higher number of Functional waterpoints than Non Functional waterpoints.
- 5 of the 21 Regions have a higher number of Non Functional waterpoints than Functional waterpoints. They are Lindi, Mara, Mtwara, Ru

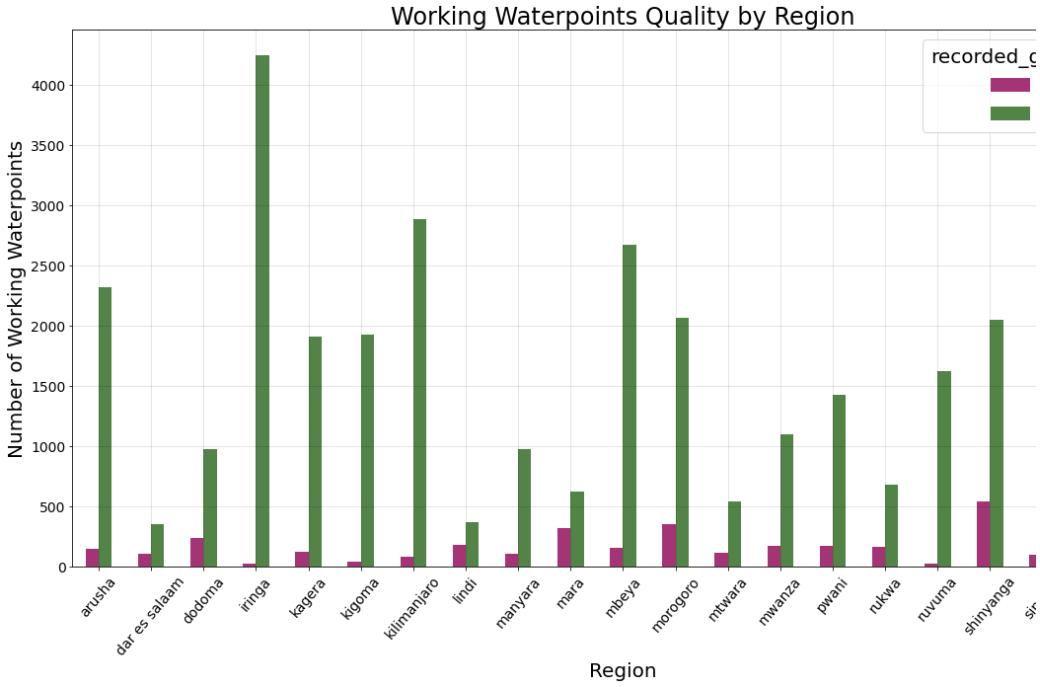
Recommendations:

- The regions of Lindi, Mara, Mtwara, Rukwa, and Tabora could potentially benefit from a water needs assessment. These regions have a Functional waterpoints than Functional waterpoints.
- Conduct future analysis into the Functional Needs Repair waterpoints in Kigoma, Mbeya, and Kilimanjaro.

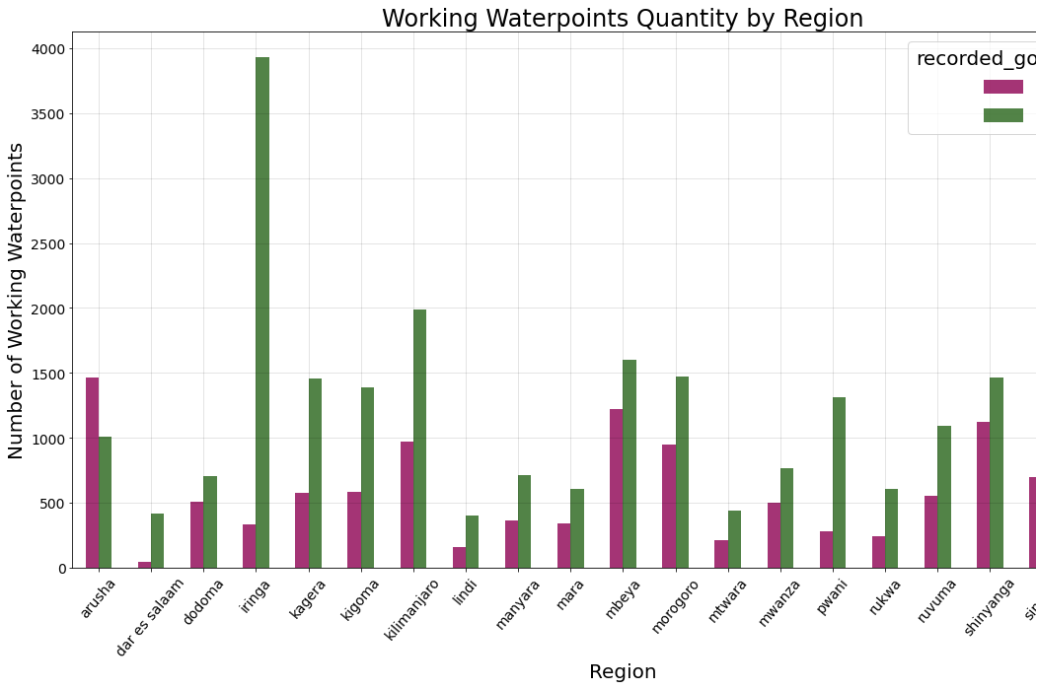
```
## Question 2: What is the reported Quality and Quantity of Working (Functioni
Functioning Needs Repair) waterpoints?
### 2a: For All Working waterpoints, what is the breakdown of water quality by Region?
### 2b: For All Working waterpoints, what is the water quantity By Region?
```

In [7]:
```
#Quality group
working_by_region_quality = df[df['status_group'] != 'non functional'].groupby(['region', 'recorde
#Quantity group
working_by_region_quantity = df[df['status_group'] != 'non functional'].groupby(['region', 'record
```

In [8]:
```
working_by_region_quality.unstack().plot.bar(fontsize=14, rot=50, alpha = 0.80, figsize=(20,10), c
plt.grid(color = 'black', alpha = 0.1, linestyle = '-', linewidth = 1)
plt.xlabel('Region')
plt.ylabel('Number of Working Waterpoints')
plt.show()
```



In [9]:
```
working_by_region_quantity.unstack().plot.bar(fontsize=14, rot=50, alpha = 0.80, figsize=(20,10),
plt.grid(color = 'black', alpha = 0.1, linestyle = '-', linewidth = 1)
plt.xlabel('Region')
plt.ylabel('Number of Working Waterpoints')
plt.show()
```



Insights:

- All 21 Regions have a higher number of 'good quality' waterpoints than 'insuffient quality' waterpoints.
- 19 of the 21 Regions have a higher number of 'good/suffient quantity' waterpoints than 'insuffient quantity' waterpoints.
- 2 of the 21 Regions have a higher number of 'insuffient quantity' waterpoints than 'good/suffient quantity' waterpoints.

Recommendations:

- The regions of Indi, Mara, and Singida could potentially benefit from a water needs assement. These regions have a higher ratio of "insu "good quality" waterpoints than the other Regions.
- The Arusha and Singida regions could potentally benefit from a water needs assement. These arre the only regions with a higher numb quantity' waterpoints than 'suffient quantity' waterpoints.

Question 3: Is there a difference between the average age of Waterpoints by Opera Status?

3a: Difference between average age of Working (Functional and Functional Needs Repair) and Non Fu waterpoints?

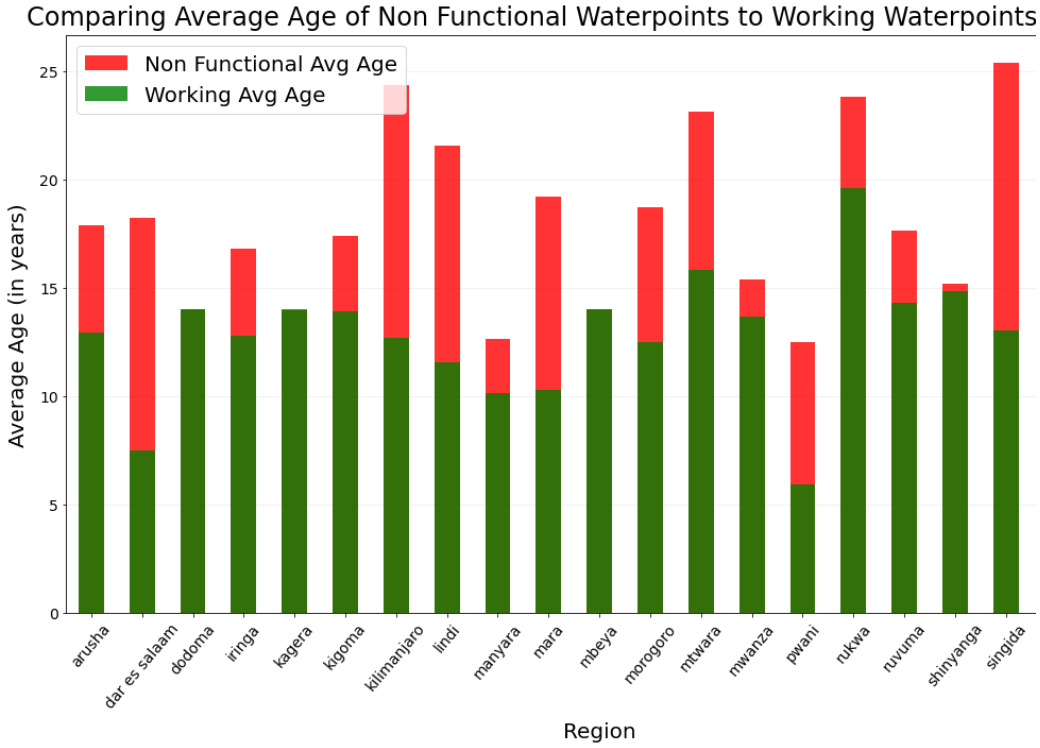
3b: Difference between average age of Functional Needs Repair and Functional waterpoints?

In [13]:
```
#df.groupby('region')['construction_year'].max().sort_values()
```

In [14]:
```
working_by_region_mean_age = df[df['status_group'] != 'non functional'].groupby('region')['waterpo
non_functional_by_region_mean_age = df[df['status_group'] == 'non functional'].groupby('region')['
```

In [15]:
```
ax = non_functional_by_region_mean_age.plot(fontsize=14, kind='bar', alpha=.8, rot=50, color='red'
working_by_region_mean_age.plot(kind='bar', rot=50, alpha=.8, ax=ax, color="green")

ax.set_axisbelow(True)
ax.yaxis.grid(True, color='#EEEEEE')

# Add axis and chart labels.
ax.set_xlabel('Region', labelpad=10)
ax.set_ylabel('Average Age (in years)', labelpad=10)
ax.set_title('Comparing Average Age of Non Functional Waterpoints to Working Waterpoints by Region
ax.legend(['Non Functional Avg Age', 'Working Avg Age'])

```

Out[15]: <matplotlib.legend.Legend at 0x7f2671cd2048>



In [16]:
```
# Get the difference between the average age of all working (functional and functional needs repai
# and non functional waterpoints by Region
means_zipped = zip(non_functional_by_region_mean_age.values, working_by_region_mean_age.values)
age_diffs = []

for item in means_zipped:
    diff_non_to_functional = round(item[0] - item[1], 3)
    age_diffs.append(diff_non_to_functional)

labled_age_diffs = zip(working_by_region_mean_age.index, age_diffs)

for tup in labled_age_diffs:
    print(tup[0].capitalize(), ': Diff between average Working and Non-Functional waterpoints: ',
```

```
Arusha : Diff between average Working and Non-Functional waterpoints:  4.945 years
Dar es salaam : Diff between average Working and Non-Functional waterpoints:  10.753 years
Dodoma : Diff between average Working and Non-Functional waterpoints:  0.0 years
Iringa : Diff between average Working and Non-Functional waterpoints:  4.004 years
Kagera : Diff between average Working and Non-Functional waterpoints:  -0.013 years
Kigoma : Diff between average Working and Non-Functional waterpoints:  3.436 years
Kilimanjaro : Diff between average Working and Non-Functional waterpoints:  11.698 years
Lindi : Diff between average Working and Non-Functional waterpoints:  10.02 years
Manyara : Diff between average Working and Non-Functional waterpoints:  2.467 years
Mara : Diff between average Working and Non-Functional waterpoints:  8.913 years
Mbeya : Diff between average Working and Non-Functional waterpoints:  -0.001 years
Morogoro : Diff between average Working and Non-Functional waterpoints:  6.227 years
Mtwara : Diff between average Working and Non-Functional waterpoints:  7.275 years
Mwanza : Diff between average Working and Non-Functional waterpoints:  1.732 years
Pwani : Diff between average Working and Non-Functional waterpoints:  6.551 years
Rukwa : Diff between average Working and Non-Functional waterpoints:  4.22 years
Ruvuma : Diff between average Working and Non-Functional waterpoints:  3.319 years
Shinyanga : Diff between average Working and Non-Functional waterpoints:  0.37 years
Singida : Diff between average Working and Non-Functional waterpoints:  12.359 years
Tabora : Diff between average Working and Non-Functional waterpoints:  -0.125 years
Tanga : Diff between average Working and Non-Functional waterpoints:  2.492 years
```

Insights (Funcional vs Non Functional):

The average age of Non Functional waterpoints is greater than the average age of Working waterpoints in 17 out of 21 Regions. Average ag
same in 4 out of 21 Regions. This measurement supports intuition that older waterpoints are more likely to be non functional.

Recommendation:

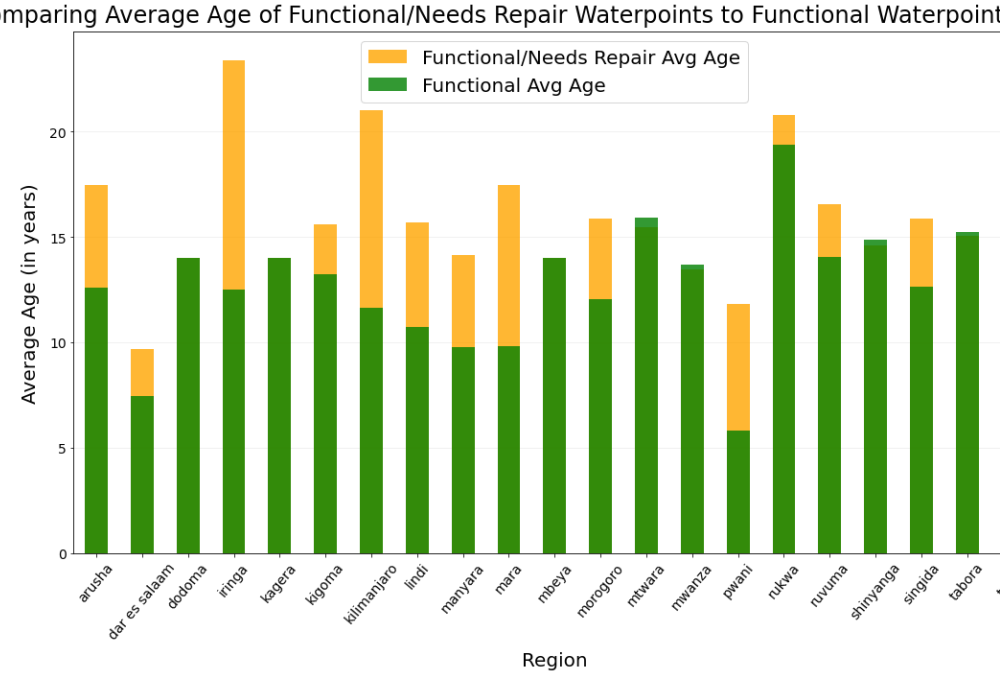
Regions that have Working waterpoints with average age close to the average age of Non Functional waterpoints should consider increasing
monitoring/maintenance of Working waterpoints and/or new waterpoint installation.

Q3b: Difference between average age of Functional Needs Repair and Functional waterpoints?

In [17]:
```
functional_by_region_mean_age = df[df['status_group'] == 'functional'].groupby('region')['waterpoi
functional_needs_repair_by_region_mean_age = df[df['status_group'] == 'functional needs repair'].g
```

In [18]:
```
ax = functional_needs_repair_by_region_mean_age.plot(fontsize=14, kind='bar', alpha=.8, rot=50, co
functional_by_region_mean_age.plot(kind='bar', rot=50, alpha=.8, ax=ax, color="green")

ax.set_axisbelow(True)
ax.yaxis.grid(True, color='#EEEEEE')

# Add axis and chart labels.
ax.set_xlabel('Region', labelpad=10)
ax.set_ylabel('Average Age (in years)', labelpad=10)
ax.set_title('Comparing Average Age of Functional/Needs Repair Waterpoints to Functional Waterpoin
ax.legend(['Functional/Needs Repair Avg Age', 'Functional Avg Age'])
```

Out[18]: <matplotlib.legend.Legend at 0x7f2671bd84e0>



In [19]:
```
# Get the difference between the average age of all Functional needs repair and Functional waterpo
means_zipped = zip(functional_needs_repair_by_region_mean_age.values, functional_by_region_mean_ag
age_diffs = []

for item in means_zipped:
    diff_non_to_functional = round(item[0] - item[1], 2)
    age_diffs.append(diff_non_to_functional)

functioning_labled_age_diffs = zip(functional_needs_repair_by_region_mean_age.index, age_diffs)

for tup in functioning_labled_age_diffs:
    print(tup[0].capitalize(), ': Diff between average age of Functional Needs Repair and Function
```

```
Arusha : Diff between average age of Functional Needs Repair and Functional waterpoints:  4.9 years
Dar es salaam : Diff between average age of Functional Needs Repair and Functional waterpoints:  2.2 y
Dodoma : Diff between average age of Functional Needs Repair and Functional waterpoints:  0.0 years
Iringa : Diff between average age of Functional Needs Repair and Functional waterpoints:  10.88 years
Kagera : Diff between average age of Functional Needs Repair and Functional waterpoints:  0.0 years
Kigoma : Diff between average age of Functional Needs Repair and Functional waterpoints:  2.37 years
Kilimanjaro : Diff between average age of Functional Needs Repair and Functional waterpoints:  9.36 ye
Lindi : Diff between average age of Functional Needs Repair and Functional waterpoints:  4.97 years
Manyara : Diff between average age of Functional Needs Repair and Functional waterpoints:  4.37 years
Mara : Diff between average age of Functional Needs Repair and Functional waterpoints:  7.64 years
Mbeya : Diff between average age of Functional Needs Repair and Functional waterpoints:  0.0 years
Morogoro : Diff between average age of Functional Needs Repair and Functional waterpoints:  3.83 years
Mtwara : Diff between average age of Functional Needs Repair and Functional waterpoints:  -0.46 years
Mwanza : Diff between average age of Functional Needs Repair and Functional waterpoints:  -0.26 years
Pwani : Diff between average age of Functional Needs Repair and Functional waterpoints:  6.03 years
Rukwa : Diff between average age of Functional Needs Repair and Functional waterpoints:  1.41 years
Ruvuma : Diff between average age of Functional Needs Repair and Functional waterpoints:  2.5 years
Shinyanga : Diff between average age of Functional Needs Repair and Functional waterpoints:  -0.26 yea
Singida : Diff between average age of Functional Needs Repair and Functional waterpoints:  3.19 years
Tabora : Diff between average age of Functional Needs Repair and Functional waterpoints:  -0.17 years
Tanga : Diff between average age of Functional Needs Repair and Functional waterpoints:  6.68 years
```

Insights (Functional Needs Repair/Functional):

The average age of Functional Needs Repair waterpoints is greater than Functional waterpoints in 14 out of 21 Regions. The avera the same in 7 out of 21 Regions. This measurement supports intuition that waterpoints in need of repair would tend to be older.

Recommendation:

Regions that have Functional waterpoints with average age approaching to average age of waterpoints that Need Repair should consider inc monitoring/preventative maintenance of waterpoints.

Future Work questions

For All Working waterpoints (Functioning and Functioning Needs Repair):

- what are payment types by Region?
- what are the recorded populations served by Region?
- what are the source_classes or source_type?
- who are the installers?
- who are the management groups?

For ALL waterpoints

- who are the management groups Grouped By Region, then Status?
- who are the installers Grouped By Region, then Status?

For Non Functioning waterpoints:

- who are the installers?
- who are the management groups?

Additional questions:

How many people use waterpoints? Entire country sum, breakdown by region, water basin.

For lower QUALITY waterpoints, Defined as quality_group anything other than 'good' and/or quantity_group listed as 'insufficient, what is the Where are they located (region, waterbasin, lat/long)

For lower QUANTITY waterpoints, Defined as quantity_group listed as 'insufficient', what is the population count, where are they located (reg lat/long)

What do we know about the payment types for waterpoints? Breakdown by country, region water basin, population bins

What do we know about waterpoint age? Country wide, water basin wide, region wide? Min, Max, Median, Mean, Dist?

How up-to-date is the data for waterpoints by region? Are there trends in missing values? Are some regions missing more data than others?

What do we know about waterpoints of unknown age? What is the population served by waterpoints of unknown age? How many, where are waterbasin, lat/long)

What do we know about the waterpoint_type_group? Breakdown by country, region, water basin, bin by population. (communal standpipe' 'h 'improved spring''cattle trough' 'dam')

What is the breakdown of Orgs that perform management for the waterpoints? Any managed that don't have a permit or permit status unkno management column not scheme_management (scheme indicates the funding mechanism, I think) Is there a difference between scheme_n management entities for waterpoints? If so, what does that look like? 13 total: 'vwc' 'wug' 'other' 'private operator' 'water board' 'wua' 'compan 'parastatal' 'unknown' 'other - school' 'trust'

What is the breakdown of extraction type /extraction type class by country, region, water basin.

In [ ]:
```
1
```