Report for ForestQuery into Global Deforestation, 1990 to 2016

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ForestQuery is on a mission to combat deforestation around the world and to raise awareness about this topic and its impact on the environment. The data analysis team at ForestQuery has obtained data from the World Bank that includes forest area and total land area by country and year from 1990 to 2016, as well as a table of countries and the regions to which they belong.

The data analysis team has used SQL to bring these tables together and to query them in an effort to find areas of concern as well as areas that present an opportunity to learn from successes.

1. **GLOBAL SITUATION**

According to the World Bank, the total forest area of the world was ***41,282,694.9 sq km*** in 1990. As of 2016, the most recent year for which data was available, that number had fallen to ***39,958,245.9 sq km***, a loss of ***1,324,449 sq km***, or ***3.21%***.

The forest area lost over this time period is slightly more than the entire land area of ***Peru*** listed for the year 2016 (which is ***1,279,999.99 sq km***).

2. **REGIONAL OUTLOOK**

In 2016, the percent of the total land area of the world designated as forest was ***31.38%***. The region with the highest relative forestation was ***Latin America & Caribbean***, with ***46.16%***, and the region with the lowest relative forestation was ***Middle East & North Africa***, with ***2.07%*** forestation.

In 1990, the percent of the total land area of the world designated as forest was ***32.42%***. The region with the highest relative forestation was ***Latin America & Caribbean***, with ***51.03%***, and the region with the lowest relative forestation was ***Middle East & North Africa***, with ***1.78%*** forestation.

Table 2.1: Percent Forest Area by Region, 1990 & 2016:

Region	1990 Forest Percentage	2016 Forest Percentage
Latin America & Caribbean	***51.03***	***46.16***
Europe & Central Asia	***37.28***	***38.04***
North America	***35.65***	***36.04***
World	***32.42***	***31.38***
Sub-Saharan Africa	***30.67***	***28.79***
East Asia & Pacific	***25.78***	***26.36***
South Asia	***16.51***	***17.51***
Middle East & North Africa	***1.78***	***2.07***

The only regions of the world that decreased in percent forest area from 1990 to 2016 were ***Latin America & Caribbean*** (dropped from ***51.03%*** to ***46.16%***) and ***Sub-Saharan Africa*** (***30.67%*** to ***28.79%***). All other regions actually increased in forest area over this time period. However, the drop in forest area in the two aforementioned regions was so large, the percent forest area of the world decreased over this time period from ***32.42%*** to ***31.38%***.

3. **COUNTRY-LEVEL DETAIL**

1. SUCCESS STORIES

There is one particularly bright spot in the data at the country level, ***China***. This country actually increased in forest area from 1990 to 2016 by ***527,229.06 sq km***. It would be interesting to study what has changed in this country over this time to drive this figure in the data higher. The country with the next largest increase in forest area from 1990 to 2016 was the ***United States***, but it only saw an increase of ***79,200 sq km***, much lower than the figure for ***China***.

China and ***United States*** are of course very large countries in total land area, so when we look at the largest *percent* change in forest area from 1990 to 2016, we aren't surprised to find a much smaller country listed at the top. ***Iceland*** increased in forest area by ***213.66%*** from 1990 to 2016.

2. LARGEST CONCERNS

Which countries are seeing deforestation to the largest degree? We can answer this question in two ways. First, we can look at the absolute square kilometer decrease in forest area from 1990 to 2016. The following 5 countries had the largest decrease in forest area over the time period under consideration:

Table 3.1: Top 5 Amount Decrease in Forest Area by Country, 1990 & 2016:

Country	Region	Absolute Forest Area Change
Brazil	***Latin America & Caribbean***	***541,510 sq km***
Indonesia	***East Asia & Pacific***	***282,193.98 sq km***
Myanmar	***East Asia & Pacific***	***107,234 sq km***
Nigeria	***Sub-Saharan Africa***	***106,506 sq km***
Tanzania	***Sub-Saharan Africa***	***102,320 sq km***

The second way to consider which countries are of concern is to analyze the data by percent decrease.

Table 3.2: Top 5 Percent Decrease in Forest Area by Country, 1990 & 2016:

Country	Region	Pct Forest Area Change
Togo	***Sub-Saharan Africa***	***75.45***
Nigeria	***Sub-Saharan Africa***	***61.8***
Uganda	***Sub-Saharan Africa***	***59.27***
Mauritania	***Sub-Saharan Africa***	***46.75***
Honduras	***Latin America & Caribbean***	***45.03***

When we consider countries that decreased in forest area the most between 1990 and 2016, we find that four of the top 5 countries on the list are in the region of ***Sub-Saharan Africa***. The countries are ***Togo***, ***Nigeria***, ***Uganda***, and ***Mauritania***. The 5th country on the list is ***Honduras***, which is in the ***Latin America & Caribbean*** region.

From the above analysis, we see that ***Nigeria*** is the only country that ranks in the top 5 both in terms of absolute square kilometer decrease in forest as well as percent decrease in forest area from 1990 to 2016. Therefore, this country has a significant opportunity ahead to stop the decline and hopefully spearhead remedial efforts.

3. QUARTILES

Table 3.3: Count of Countries Grouped by Forestation Percent Quartiles, 2016:

Quartile	Number of Countries
0-25	***85***
25-50	***72***
50-75	***38***
75-100	***9***

The largest number of countries in 2016 were found in the ***1st (0-25)*** quartile.

There were ***9*** countries in the top quartile in 2016. These are countries with a very high percentage of their land area designated as forest. The following is a list of countries and their respective forest land, denoted as a percentage.

Table 3.4: Top Quartile Countries, 2016:

Country	Region	Pct Designated as Forest
Suriname	***Latin America & Caribbean***	***98.26***
Micronesia, Fed. Sts.	***East Asia & Pacific***	***91.86***
Gabon	***Sub-Saharan Africa***	***90.04***
Seychelles	***Sub-Saharan Africa***	***88.41***
Palau	***East Asia & Pacific***	***87.61***
American Samoa	***East Asia & Pacific***	***87.50***
Guyana	***Latin America & Caribbean***	***83.90***
Lao PDR	***East Asia & Pacific***	***82.11***
Solomon Islands	***East Asia & Pacific***	***77.86***

4. RECOMMENDATIONS

Write out a set of recommendations as an analyst on the ForestQuery team.

- *What have you learned from the World Bank data?*

As we can see from table 2.1, the share of forested areas in the whole world in 2016 compared to 1990 has decreased from 32.42% to 31.38%. This is quite a serious problem, it requires attention, otherwise, it can lead to ecological disasters. If considered in absolute value, the loss of forested areas can be compared to the area of Peru – from 41,282,694.9 sq km in 1990, that number had fallen to 39,958,245.9 sq km, a loss of 1,324,449 sq km, or 3.21%. Brazil is the country with the most forest area loss in absolute terms – the loss is

more than 541 thousand sq km. From Table 3.2, we can see that 4 out of the top 5 countries that have lost the most forest area in percentage terms are in the Sub-Saharan Africa region. By the way, this region along with the Latin America & Caribbean region - are the only 2 regions where the share of forested areas has decreased (see table 2.1 for more details). From table 3.3, we can also see that the vast majority of countries in the world have less than 50 percent of forestation, which is also a concern.

- *Which countries should we focus on over others?*

I think that more attention should be paid to the countries mentioned in Tables 3.1 and 3.2. Especially those mentioned in 3.1, because the absolute loss of forested areas is more important for the whole world at the global level. From this point of view, Nigeria is present in both tables. But of course, Brazil, Indonesia, and other countries should also be the focus.
I think that it is also very important to study the experience of China and Iceland as the best examples for big and small countries respectively.

5. APPENDIX

-- Create a View called “forestation” by joining all three tables - forest_area, land_area and regions

```
DROP VIEW IF EXISTS forestation;

CREATE VIEW forestation
AS
  SELECT f.country_code,
         f.country_name,
         f.year,
         f.forest_area_sqkm,
         l.total_area_sq_mi * 2.59
            land_area_sqkm,
         r.region,
         r.income_group,
         ( f.forest_area_sqkm / ( l. total_area_sq_mi * 2.59 ) ) * 100
            forest_area_pct
  FROM   forest_area f
         JOIN land_area l
           ON f.country_code = l.country_code
              AND f.year = l.year
         JOIN regions r
           ON f.country_code = r.country_code;
```

GLOBAL SITUATION

-- a. What was the total forest area (in sq km) of the world in 1990?

```
SELECT Sum(forest_area_sqkm) total_forest_area_1990
FROM   forestation
WHERE  region = 'World'
       AND year = 1990;
```

-- b. What was the total forest area (in sq km) of the world in 2016?

```
SELECT Sum(forest_area_sqkm) total_forest_area_2016
FROM   forestation
WHERE  region = 'World'
       AND year = 2016;
```

-- c. What was the change (in sq km) in the forest area of the world from 1990 to 2016?

```
SELECT ( Sum(f_1.forest_area_sqkm) - Sum(f_2.forest_area_sqkm) )
       forest_area_change
FROM   forestation f_1,
       forestation f_2
WHERE  f_1.region = 'World'
       AND f_2.region = 'World'
       AND f_1.year = 1990
       AND f_2.year = 2016
```

-- d. What was the percent change in forest area of the world between 1990 and 2016?

```
SELECT Round(( ( ( SUM(f_1.forest_area_sqkm) - SUM(f_2.forest_area_sqkm) ) * 100
               ) /
                           SUM(f_1.forest_area_sqkm) ) :: NUMERIC, 2)
       forest_area_pct_change
FROM   forestation f_1,
       forestation f_2
WHERE  f_1.region = 'World'
       AND f_2.region = 'World'
       AND f_1.year = 1990
       AND f_2.year = 2016
```

-- e. If you compare the amount of forest area lost between 1990 and 2016, to which country's total area in 2016 is it closest to?

```
WITH tb1 AS
(
         SELECT   country_name,
                  Sum(land_area_sqkm) total_land_area_sqkm
         FROM     forestation
         WHERE    year = 2016
         GROUP BY 1
         ORDER BY 2 DESC)
SELECT   country_name,
         Abs(1324449 - total_land_area_sqkm)    closest_area_differance,
         Round(total_land_area_sqkm::numeric,2) land_area_sqkm
FROM     tb1
ORDER BY 2 limit 1;
```

REGIONAL OUTLOOK

-- a. What was the percent forest of the entire world in 2016? Which region had the HIGHEST percent forest in 2016, and which had the LOWEST, to 2 decimal places?

-- a1. What was the percent forest of the entire world in 2016?

```
SELECT Round(( SUM(forest_area_sqkm) * 100 / SUM(land_area_sqkm) ) :: NUMERIC, 2
       )
       forest_pct_2016
FROM   forestation
WHERE  country_name = 'World'
       AND year = 2016
```

-- a2. Which region had the HIGHEST percent forest in 2016

```
SELECT region,
       Round(( Sum(forest_area_sqkm) * 100 / Sum(land_area_sqkm) ) :: NUMERIC, 2
       )
       highest_forest_pct_2016
FROM   forestation
WHERE  year = 2016
GROUP  BY 1
ORDER  BY 2 DESC
LIMIT  1;
```

-- a3. Which region had the LOWEST percent forest in 2016

```
SELECT region,
       Round(( Sum(forest_area_sqkm) * 100 / Sum(land_area_sqkm) ) :: NUMERIC, 2
       )
       lowest_forest_pct_2016
FROM   forestation
WHERE  year = 2016
GROUP  BY 1
ORDER  BY 2
LIMIT  1;
```

-- b. What was the percent forest of the entire world in 1990? Which region had the HIGHEST percent forest in 1990, and which had the LOWEST, to 2 decimal places?

-- b1. What was the percent forest of the entire world in 1990?

```
SELECT Round(( SUM(forest_area_sqkm) * 100 / SUM(land_area_sqkm) ) :: NUMERIC, 2
       )
       forest_pct_1990
FROM   forestation
WHERE  country_name = 'World'
       AND year = 1990
```

-- b2. Which region had the HIGHEST percent forest in1990

```
SELECT region,
       Round(( Sum(forest_area_sqkm) * 100 / Sum(land_area_sqkm) ) :: NUMERIC, 2
       )
       highest_forest_pct_1990
FROM   forestation
WHERE  year = 1990
```

```
GROUP  BY 1
ORDER  BY 2 DESC
LIMIT  1;
```

-- b3. Which region had the LOWEST percent forest in 1990

```
SELECT region,
       Round(( Sum(forest_area_sqkm) * 100 / Sum(land_area_sqkm) ) :: NUMERIC, 2
       )
       lowest_forest_pct_1990
FROM   forestation
WHERE  year = 1990
GROUP  BY 1
ORDER  BY 2
LIMIT  1;
```

-- c. Based on the table you created, which regions of the world DECREASED in forest area from 1990 to 2016?

Table 2.1: Percent Forest Area by Region, 1990 & 2016:

-- c1. 1990 Forest Percentage

```
SELECT region,
       Round(( SUM(forest_area_sqkm) * 100 / SUM(land_area_sqkm) ) :: NUMERIC, 2
       )
       forest_pct_1990
FROM   forestation
WHERE  year = 1990
GROUP  BY 1
ORDER  BY 2 DESC
```

-- c2. 2016 Forest Percentage

```
SELECT region,
       Round(( SUM(forest_area_sqkm) * 100 / SUM(land_area_sqkm) ) :: NUMERIC, 2
       )
       forest_pct_2016
FROM   forestation
WHERE  year = 2016
GROUP  BY 1
ORDER  BY 2 DESC
```

COUNTRY-LEVEL DETAIL

-- a.1. SUCCESS STORIES – Big countries

```
WITH forest_area_1990 AS
(
         SELECT   country_name,
                  Sum(forest_area_sqkm) forest_area_sqkm_1990
         FROM     forestation
         WHERE    year = 1990
```

```
        GROUP BY country_name), forest_area_2016 AS
(
        SELECT   country_name,
                 Sum(forest_area_sqkm) forest_area_sqkm_2016
        FROM     forestation
        WHERE    year = 2016
        GROUP BY country_name)
SELECT   f_1990.country_name,
         f_1990.forest_area_sqkm_1990,
         f_2016.forest_area_sqkm_2016,
         Round((f_2016.forest_area_sqkm_2016 - f_1990.forest_area_sqkm_1990)::numeric,2)
forest_area_change
FROM     forest_area_1990 f_1990
JOIN     forest_area_2016 f_2016
ON       f_1990.country_name = f_2016.country_name
WHERE    (
                 f_2016.forest_area_sqkm_2016 - f_1990.forest_area_sqkm_1990) IS NOT
NULL
ORDER BY forest_area_change DESC limit 2;
```

-- a.2. SUCCESS STORIES – Small country

```
WITH forest_pct_change_1990 AS
(
        SELECT   country_name,
                 Sum(forest_area_sqkm)*100/Sum(land_area_sqkm) forest_area_pct_1990
        FROM     forestation
        WHERE    year = 1990
        GROUP BY country_name), forest_pct_change_2016 AS
(
        SELECT   country_name,
                 Sum(forest_area_sqkm)*100/Sum(land_area_sqkm) forest_area_pct_2016
        FROM     forestation
        WHERE    year = 2016
        GROUP BY country_name)
SELECT   f_1990.country_name,
         f_1990.forest_area_pct_1990,
         f_2016.forest_area_pct_2016,
         Round(((f_2016.forest_area_pct_2016 -
f_1990.forest_area_pct_1990)*100/f_1990.forest_area_pct_1990)::numeric,2)
forest_area_pct_change
FROM     forest_pct_change_1990 f_1990
JOIN     forest_pct_change_2016 f_2016
ON       f_1990.country_name = f_2016.country_name
WHERE    Round(((f_2016.forest_area_pct_2016 -
f_1990.forest_area_pct_1990)*100/f_1990.forest_area_pct_1990)::numeric,2) IS NOT NULL
ORDER BY forest_area_pct_change DESC limit 1;
```

-- b. LARGEST CONCERNS

-- b.1. Which 5 countries saw the largest amount decrease in forest area from 1990 to 2016? What was the difference in forest area for each?

-- Table 3.1: Top 5 Amount Decrease in Forest Area by Country, 1990 & 2016:

```
WITH forest_area_1990 AS
(
         SELECT   country_name,
                  region,
                  Sum(forest_area_sqkm) forest_area_sqkm_1990
         FROM     forestation
         WHERE    year = 1990
         GROUP BY country_name,
                  region), forest_area_2016 AS
(
         SELECT   country_name,
                  region,
                  Sum(forest_area_sqkm) forest_area_sqkm_2016
         FROM     forestation
         WHERE    year = 2016
         GROUP BY country_name,
                  region)
SELECT   f_1990.country_name,
         f_1990.region,
         f_1990.forest_area_sqkm_1990,
         f_2016.forest_area_sqkm_2016,
         Round((f_1990.forest_area_sqkm_1990 - f_2016.forest_area_sqkm_2016)::numeric,2)
forest_area_change
FROM     forest_area_1990 f_1990
JOIN     forest_area_2016 f_2016
ON       f_1990.country_name = f_2016.country_name
WHERE    f_2016.forest_area_sqkm_2016 IS NOT NULL
AND      f_1990.forest_area_sqkm_1990 IS NOT NULL
AND      f_1990.country_name != 'World'
AND      f_2016.country_name != 'World'
ORDER BY forest_area_change DESC limit 5;
```

-- b.2. Which 5 countries saw the largest percent decrease in forest area from 1990 to 2016? What was the percent change to 2 decimal places for each?

-- Table 3.2: Top 5 Percent Decrease in Forest Area by Country, 1990 & 2016:

```
WITH forest_pct_change_1990 AS
(
         SELECT   country_name,
                  region,
                  Sum(forest_area_sqkm)*100/Sum(land_area_sqkm) forest_area_pct_1990
         FROM     forestation
         WHERE    year = 1990
         GROUP BY country_name,
                  region), forest_pct_change_2016 AS
(
         SELECT   country_name,
                  region,
                  Sum(forest_area_sqkm)*100/Sum(land_area_sqkm) forest_area_pct_2016
         FROM     forestation
         WHERE    year = 2016
         GROUP BY country_name,
```

```
                  region)
SELECT   f_1990.country_name,
         f_1990.region,
         f_1990.forest_area_pct_1990,
         f_2016.forest_area_pct_2016,
         Round(((f_1990.forest_area_pct_1990 -
f_2016.forest_area_pct_2016)*100/f_1990.forest_area_pct_1990)::numeric,2)
forest_area_pct_change
FROM     forest_pct_change_1990 f_1990
JOIN     forest_pct_change_2016 f_2016
ON       f_1990.country_name = f_2016.country_name
WHERE    f_2016.forest_area_pct_2016 IS NOT NULL
AND      f_1990.forest_area_pct_1990 IS NOT NULL
AND      f_1990.country_name != 'World'
AND      f_2016.country_name != 'World'
ORDER BY forest_area_pct_change DESC limit 5;
```

-- c. If countries were grouped by percent forestation in quartiles, which group had the most countries in it in 2016?

-- Table 3.3: Count of Countries Grouped by Forestation Percent Quartiles, 2016:

```
WITH t1
     AS (SELECT *
         FROM   forestation
         WHERE  year = 2016
                AND region != 'World'
                AND forest_area_pct IS NOT NULL),
     t2
     AS (SELECT *,
                CASE
                  WHEN forest_area_pct < 25 THEN '0-25'
                  WHEN forest_area_pct >= 25
                       AND forest_area_pct < 50 THEN '25-50'
                  WHEN forest_area_pct >= 50
                       AND forest_area_pct < 75 THEN '50-75'
                  ELSE '75-100'
                END AS quartile
         FROM   t1)
SELECT quartile,
       Count(1) number_of_countries
FROM   t2
GROUP  BY 1
ORDER  BY 1;
```

-- d. List all of the countries that were in the 4th quartile in 2016.

-- Table 3.4: Top Quartile Countries, 2016:

```
SELECT country_name,
       region,
       Round(forest_area_pct :: NUMERIC, 2) forest_pct
FROM   forestation
WHERE  forest_area_pct > 75
```

```
       AND forest_area_pct IS NOT NULL
       AND year = 2016
ORDER  BY 3 DESC
```

-- e. How many countries had a percent forestation higher than the United States in 2016?

```
SELECT Count(1)
FROM   forestation
WHERE  year = 2016
       AND forest_area_pct > (SELECT forest_area_pct
                              FROM   forestation
                              WHERE  country_name = 'United States'
                                     AND year = 2016);
```

List of Literature

Within the framework of this project, I mainly used the resources of the UDACITY e-learning platform and Slack channel.
Links to the several additional resources used are provided below:

1. https://www.devart.com/dbforge/sql/sqlcomplete/self-join-in-sql-server.html
2. https://www.w3schools.com/sql/sql_join_self.asp
3. https://www.dpriver.com/pp/sqlformat.htm