Report for ForestQuery into Global Deforestation, 1990 to 2016

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 15,727,327.14 mi^2 in 1990. As of 2016, the most recent year for which data was available, that number had fallen to 15,392,736.71 mi^2, a loss of 334,590.43 mi^2, or 2.13%.

The forest area lost over this time period is slightly more than the entire land area of Venezuela, listed for the year 2016 (which is 340,559.85 mi^2)!

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	37.27%	38.06%
North America	35.65%	36.04%
Sub-Saharan Africa	32.19%	27.56%
East Asia & Pacific	25.77%	26.36%
South Asia	16.51%	17.51%
Middle East & North Africa	1.78%	2.07%
Total World	32.42%	31.38%

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 (32.19% to 27.56%). 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**

A. 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 203,563.34 mi², or 25.12%! 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 2.55%, much lower than the figure for China.

Russia and China 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 68.12% from 1990 to 2016.

B. 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 mile decrease in forest area from 1990 to 2016. The following 3 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	-209,077.22 mi²
Indonesia	East Asia & Pacific	-108,955.20 mi²
Myanmar	East Asia & Pacific	-41,403.09 mi²
Nigeria	Sub-Saharan Africa	-41,122.01 mi²
Tanzania	Sub-Saharan Africa	-39,505.80 mi²

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	-61.80 %
Uganda	Sub-Saharan Africa	-59.13 %
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 mile 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.

C. QUARTILES

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

Quartile	Number of Countries
First	98
Second	73
Third	38
Fourth	9

The largest number of countries in 2016 were found in the First quartile.

There were 98 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 %

5. RECOMMENDATIONS

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

- *Sub-Saharan Africa and Latin America & Caribbean* are the only regions with a *net negative* on forest coverage per square mile from 1990 to 2016
    - All other regions *gained* square miles of forest within same time span

- Countries which lost the *most forest area by percentage* of country's total area
    - Togo, Nigeria, Uganda, and Mauritania
        - All within *Sub Saharan Africa*

- Focus resources on *Nigeria* to help stop the rapid deforestation already underway
    - Ranks top 5 in both *total percent forest loss* and *total square miles of forest loss*

Appendix:

SQL queries used for analysis

```
--DROP VIEW to fix Udacity workspace error
DROP VIEW IF EXISTS forestation;

--forestation VIEW used for further analysis
CREATE VIEW forestation
AS (
SELECT f.country_code c_code
    , f.country_name
    , r.region
    , r.income_group
    , f.year
    , ROUND(f.forest_area_sqkm::numeric, 2) forest_area_sqkm
    , ROUND((f.forest_area_sqkm / 2.59)::numeric, 2) AS
forest_area_sq_mi
    , ROUND(l.total_area_sq_mi::numeric, 2) total_area_sq_mi
    , ROUND((((f.forest_area_sqkm / 2.59) / total_area_sq_mi) *
100)::numeric, 2) AS total_percent_forest
FROM forest_area f
JOIN land_area l
    ON f.year = l.year AND  f.country_code = l.country_code
JOIN regions r
ON r.country_code = l.country_code
);

-------------------------------------------------

--subqueries
    --find total forest area of world in 1990
WITH world_forest_area_1990 AS (
            SELECT SUM(forest_area_sq_mi) total
            FROM forestation
            WHERE year = '1990'
            )
    --find total forest area of world in 2016
```

```
    , world_forest_area_2016 AS (
            SELECT SUM(f.forest_area_sq_mi) total
            FROM forestation f
            WHERE year = '2016'
            )
    --find total area of world in 2016
    , world_area_2016 AS (
            SELECT l.total_area_sq_mi total
            FROM land_area l
            WHERE country_name = 'World' AND year = '2016'
            )
    --find total percent of world designated as forest in 1990
    , percent_forest_1990 AS (
            SELECT f.region
                , ROUND((SUM(f.forest_area_sq_mi) /
SUM(f.total_area_sq_mi)*100)::numeric, 2) percent_forest_1990
            FROM forestation f
            WHERE 1=1
                AND f.total_percent_forest IS NOT NULL
                AND year = '1990'
                AND region LIKE 'World'
            GROUP BY 1
            ORDER BY 2 DESC
            )
    --find total percent of world designated as forest in 2016
    , percent_forest_2016 AS (
            SELECT f.region
                , ROUND((SUM(f.forest_area_sq_mi) /
SUM(f.total_area_sq_mi)*100)::numeric, 2) percent_forest_2016
            FROM forestation f
            WHERE 1=1
                AND f.total_percent_forest IS NOT NULL
                AND year = '2016'
                AND region LIKE 'World'
            GROUP BY 1
            ORDER BY 2 DESC
            )
    --finds 1990 forest area totals by country
    , forest_percent_1990 AS (
```

```
            SELECT f.country_name
                , ROUND((SUM(f.forest_area_sq_mi) /
SUM(f.total_area_sq_mi)*100)::numeric, 2) percent_total_1990
            FROM forestation f
            WHERE 1=1
                AND f.total_percent_forest IS NOT NULL
                AND year = '1990'
                AND region NOT LIKE 'World'
            GROUP BY 1
            ORDER BY 2 DESC
            )
    --finds 2016 forest area totals by country
    , forest_percent_2016 AS (
                SELECT f.country_name
                , ROUND((SUM(f.forest_area_sq_mi) /
SUM(f.total_area_sq_mi)*100)::numeric, 2) percent_total_2016
            FROM forestation f
            WHERE 1=1
                AND f.total_percent_forest IS NOT NULL
                AND year = '2016'
                AND region NOT LIKE 'World'
            GROUP BY 1
            ORDER BY 2 DESC
            )

    --finds 1990 forest area totals by country
    ,  forest_area_1990 AS (
            SELECT f.country_name
                , f.forest_area_sq_mi f_area_1990
            FROM forestation f
            WHERE 1=1
                AND f.total_percent_forest IS NOT NULL
                AND year = '1990'
                AND country_name NOT LIKE 'World'
            ORDER BY 2 DESC
            )
    --finds 2016 forest area totals by country
    , forest_area_2016 AS (
            SELECT f.country_name
```

```
            , f.forest_area_sq_mi f_area_2016
        FROM forestation f
        WHERE 1=1
            AND f.total_percent_forest IS NOT NULL
            AND year = '2016'
            AND country_name NOT LIKE 'World'
        ORDER BY 2 DESC
        )


/* 1. Global Situtaion */

--main query to find total loss from 1990 to 2016
SELECT forest_area_1990
    , forest_area_2016
    , forest_area_1990.total - forest_area_2016.total total_loss
    , round(((forest_area_1990.total - forest_area_2016.total) /
forest_area_1990.total)*100::numeric, 2) total_loss_percent
FROM forest_area_1990, forest_area_2016
;

--find country whose total_area_sq_mi roughly equals the total area of
deforesation
SELECT l.country_name
    , l.total_area_sq_mi
FROM land_area l
WHERE total_area_sq_mi BETWEEN 334000 AND 350000
GROUP BY 1, 2
ORDER BY 2 DESC
;

--------------------------
/* 2. Regional Outlook */

--2016: total percent forest coverage of the world
SELECT f.region
    , ROUND((SUM(f.forest_area_sq_mi) /
SUM(f.total_area_sq_mi)*100)::numeric, 2) percent_total
FROM forestation f
```

```sql
WHERE 1=1
    AND f.total_percent_forest IS NOT NULL
    AND year = '2016'
    AND region LIKE 'World'
GROUP BY 1
ORDER BY 2 DESC
;

--2016: region with highest/lowest (remove DESC) forest percentages
SELECT f.region
    , ROUND((SUM(f.forest_area_sq_mi) /
SUM(f.total_area_sq_mi)*100)::numeric, 2) percent_total
FROM forestation f
WHERE 1=1
    AND f.total_percent_forest IS NOT NULL
    AND year = '2016'
    AND region NOT LIKE 'World'
GROUP BY 1
ORDER BY 2 DESC
LIMIT 1
;

--1990: total percent forest coverage of the world
SELECT f.region
    , ROUND((SUM(f.forest_area_sq_mi) /
SUM(f.total_area_sq_mi)*100)::numeric, 2) percent_total
FROM forestation f
WHERE 1=1
    AND f.total_percent_forest IS NOT NULL
    AND year = '1990'
    AND region LIKE 'World'
GROUP BY 1
ORDER BY 2
LIMIT 1
;

--1990: region with highest/lowest (remove DESC) forest percentages
SELECT f.region
```

```
    , ROUND((SUM(f.forest_area_sq_mi) /
SUM(f.total_area_sq_mi)*100)::numeric, 2) percent_total
FROM forestation f
WHERE 1=1
    AND f.total_percent_forest IS NOT NULL
    AND year = '1990'
    AND region NOT LIKE 'World'
GROUP BY 1
ORDER BY 2 DESC
LIMIT 1
;

--compare for only 'World' percent_forest_1990 and percent_forest_2016
SELECT *
FROM percent_forest_1990 p1990
INNER JOIN percent_forest_2016 p2016
    ON p1990.region = p2016.region
;

--------------------------
/* 3. Country Level */

--A. Success Stories
--compare total forest area change by country between 1990 and 2016
SELECT f1990.country_name
    , f1990.f_area_1990
    , f2016.f_area_2016
    , f2016.f_area_2016 - f1990.f_area_1990 area_change
    , ROUND((((f2016.f_area_2016 - f1990.f_area_1990) /
f2016.f_area_2016)*100)::numeric, 2) percent_change
FROM forest_area_1990 f1990
JOIN forest_area_2016 f2016
    ON f1990.country_name = f2016.country_name
GROUP BY 1, 2, 3
ORDER BY 4 DESC
;

--find top two countries with largest land area
SELECT country_name
```

```sql
    , total_area_sq_mi
FROM forestation f
WHERE 1=1
    AND total_area_sq_mi IS NOT NULL
    AND country_name NOT LIKE 'World'
    AND year = '2016'
GROUP BY 1, 2
ORDER BY 2 DESC
LIMIT 2
;

--compare total forest acre change between 1990 and 2016
SELECT f2016.country_name
    , round((forest_area_2016 - forest_area_1990)::numeric, 2)
area_change
    , round((((forest_area_2016 - forest_area_1990) /
f.total_area_sq_mi)*100)::numeric, 2) percent_change
 FROM forestation f, forest_area_2016 f2016
 JOIN forest_area_1990 f1990
    ON f1990.country_name = f2016.country_name
 GROUP BY 1, 2, 3
 ORDER BY 2 DESC;

--compare percent change in forest area by country between 1990 and
2016
SELECT f1990.country_name
    , f1990.percent_total_1990
    , f2016.percent_total_2016
    , (percent_total_2016 - percent_total_1990) change
FROM forest_percent_1990 f1990
JOIN forest_percent_2016 f2016
    ON f1990.country_name = f2016.country_name
GROUP BY 1, 2, 3, 4
ORDER BY change DESC;

--B. Largest Concerns
--finds percent change by country
SELECT f1990.country_name
    , r.region
```

```
    , f1990.f_area_1990
    , f2016.f_area_2016
    , f2016.f_area_2016 - f1990.f_area_1990 area_change
    , ROUND((((f2016.f_area_2016 - f1990.f_area_1990) /
f1990.f_area_1990)*100)::numeric, 2) percent_change
FROM forest_area_1990 f1990
JOIN forest_area_2016 f2016
    ON f1990.country_name = f2016.country_name
JOIN regions r
    ON f1990.country_name = r.country_name
GROUP BY 1, 2, 3, 4
ORDER BY 6
;

--count of countries grouped by total_percent_forest for 2016
SELECT
    CASE
        WHEN f.total_percent_forest > 75 THEN '4th Quartile'
        WHEN f.total_percent_forest > 50 AND f.total_percent_forest <
75 THEN '3rd Quartile'
        WHEN f.total_percent_forest > 25 AND f.total_percent_forest <
50 THEN '2nd Quartile'
        ELSE '1st Quartile' END AS quartiles
    , COUNT(*) AS count
FROM forestation f
WHERE year = '2016'
GROUP BY 1
ORDER BY 1
;

--top quartile countries 2016
SELECT f.country_name
    , f.region
    , f.total_percent_forest
FROM forestation f
WHERE 1=1
    AND f.year = '2016'
    AND f.total_percent_forest IS NOT NULL
ORDER BY 3 DESC;
```