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 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 1,279,999.9891 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
World	32.42%	31.38%
Latin America & Caribbean	51.03%	46.16%
Middle East & North Africa	1.78%	2.07%
Europe & Central Asia	37.29%	38.04%
North America	35.65%	36.04%
Sub-Saharan Africa	30.67%	28.79%
East Asia & Pacific	25.78%	26.36%
South Asia	16.51%	17.51%

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**

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 527,229.062 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.

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 kilometer 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	541,510 sq km
Indonesia	East Asia & Pacific	282,193.9844 sq km
Myanmar	East Asia & Pacific	107,234.0039 sq km
Nigeria	Sub-Saharan Africa	106,506.00098 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	61.80%
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.

C. 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 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
American Samoa	East Asia & Pacific	87.50%
Micronesia, Fed. Sts.	East Asia & Pacific	91.86%
Gabon	Sub-Saharan Africa	90.04%
Guyana	Latin America & Caribbean	83.90%
Lao PDR	East Asia & Pacific	82.11%
Palau	East Asia & Pacific	87.61%
Solomon Islands	East Asia & Pacific	77.86%
Suriname	Latin America & Caribbean	98.26%

Seychelles	Sub-Saharan Africa	88.41%

5. RECOMMENDATIONS

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

- *What have you learned from the World Bank data?*
- *Which countries should we focus on over others?*

The data showing that most countries fall into the total forest percentage of 0-25% is very concerning, more efforts must be concentrated in educating the world population about the dangers and damages caused to the ecosystem due to deforestation. Two regions should be paid special attention to when creating our message: Latin America & Caribbean and Sub-Saharan Africa. Brazil should be our main concern in Latin America since a great deal of deforestation has taken place over the years, ranking Brazil as the top country with the most forest area lost. When dealing with the Sub-Saharan Africa region focus on Nigeria, Not only was the country one of the highest ranking of forest area lost but they were one of the highest ranking of total percentage of forest area lost as well. While we could make our message full of doom and gloom we must end on a positive note, I recommend talking about how the Middle East & North Africa region has increased in percentage of forest and maintaining an optimistic tone when telling the world we believe that we can curb the rate of deforestation. Mention how small countries like Vietnam can compete with larger countries when it comes to restoring forest area, explain how it was able to increase its forest area at a rate rivaling China and the United States. By hitting all these points in future presentations, I believe this will help enlighten the world about forestation restoration being an obtainable goal to work towards.

6. Appendix

```
/* Created View as forestation for further usage *//
CREATE VIEW forestation AS
SELECT fa.country_code, fa.country_name, fa.year, fa.forest_area_sqkm,
la.total_area_sq_mi, r.region, r.income_group,
(fa.forest_area_sqkm/(la.total_area_sq_mi * 2.59)) AS percentage_of_forest
FROM forest_area AS fa
JOIN land_area AS la
ON (fa.year = la.year and fa.country_code = la.country_code)
JOIN regions AS r
ON (r.country_code = fa.country_code and r.country_code = la.country_code);

/* Determines World region's forest area in 1990 */
SELECT forest_area_sqkm from forestation AS world_forest_area_1990
WHERE (region = 'World' AND year = '1990');
```

```
/* Determines World region's forest area in 2016 */
SELECT forest_area_sqkm from forestation AS world_forest_area_2016
WHERE (region = 'World' AND year = '2016');

/* Determines World region's forest area change in square kilometers
over time from 1990-2016 (subquery to be used for next upcoming query) */
WITH TABLE1 AS (SELECT country_name, region, forest_area_sqkm AS forest_area_1990
 FROM forestation
 WHERE year='1990'),
 TABLE2 AS (SELECT country_name, region,
 forest_area_sqkm AS forest_area_2016
 FROM forestation
 WHERE year='2016')

SELECT (TABLE1.forest_area_1990 - TABLE2.forest_area_2016) AS
absolute_forest_area_change
FROM TABLE1
JOIN TABLE2
ON TABLE1.country_name=TABLE2.country_name
WHERE TABLE1.country_name='World';

/* Determines World region's forest area change in percentage of forest area over time from
1990-2016 */
SELECT ((TABLE1.forest_area_1990 - TABLE2.forest_area_2016) /
TABLE1.forest_area_1990)*100 AS absolute_forest_area_percent_change
FROM TABLE1
JOIN TABLE2
ON TABLE1.country_name=TABLE2.country_name
WHERE TABLE1.country_name='World';

/* By using this subquery in conjunction with the previous subquery that created TABLE1 and
TABLE2 we can find the country in 2016 with the closest total land area to the World region's
forest area change in square kilometers. Keeping in mind we must convert the unit to square
kilometers beforehand in order to make a valid comparison. */
TABLE3 AS (SELECT (TABLE1.forest_area_1990 - TABLE2.forest_area_2016)  AS
absolute_forest_area_change
 FROM TABLE1
 JOIN TABLE2
 ON TABLE1.country_name=TABLE2.country_name
 WHERE TABLE1.country_name='World')

SELECT country_name, total_area_sq_mi * 2.59 AS total_area_sqkm
FROM forestation, TABLE3
WHERE TABLE3.absolute_forest_area_change >
forestation.total_area_sq_mi * 2.59 AND forestation.year='2016'
ORDER BY total_area_sq_mi*2.59 DESC
LIMIT 1;
```

```
/* We create a table called regional_forest_percentage in order to easily reference forest
percentages for each region during the years 1990 and 2016 */
CREATE TABLE regional_forest_percentage AS
  SELECT region, year, SUM(forest_area_sqkm) / SUM(total_area_sq_mi * 2.59)
  AS forest_percentage
  FROM forestation
  WHERE year = '2016' OR year = '1990'
  GROUP BY region, year;

/* Gets the World region's percentage of forest in the year 2016 */
SELECT region, year, forest_percentage
FROM regional_forest_percentage
WHERE region='World' AND year='2016';

/* Determines region with the highest percentage of forest rounded to two decimal places in the
year 2016 */
SELECT region, to_char(forest_percentage,'FM9.0000') AS forest_percentage
FROM regional_forest_percentage
WHERE year='2016'
GROUP BY region, forest_percentage
ORDER BY forest_percentage DESC
LIMIT 1;


/* Determines region with the least percentage of forest rounded to two decimal places in the
year 2016 */
SELECT region, to_char(forest_percentage,'FM9.0000') AS forest_percentage
FROM regional_forest_percentage
WHERE year='2016'
GROUP BY region, forest_percentage
ORDER BY forest_percentage
LIMIT 1;

/* Determines the World region's forest percentage in the year 1990 */
SELECT region, year, forest_percentage
FROM regional_forest_percentage
WHERE year='1990' AND region='World';

/* Determines the region with the highest percentage of forest area rounded to two decimal
places during the year 1990 */
SELECT region, to_char(forest_percentage,'FM9.0000') AS forest_percentage
FROM regional_forest_percentage
WHERE year='1990'
GROUP BY region, forest_percentage
ORDER BY forest_percentage DESC
LIMIT 1;

/* Determines the region with the lowest percentage of forest area rounded to two decimal places
during the year 1990 */
```

```
SELECT region, to_char(forest_percentage,'FM9.0000') AS forest_percentage
FROM regional_forest_percentage
WHERE year='1990'
GROUP BY region, forest_percentage
ORDER BY forest_percentage
LIMIT 1;

/* Determines forest area percentage of all regions during the years 1990 and 2016 in ascending
order (order doesn't matter for the associated question) */
SELECT region, year, forest_percentage
FROM regional_forest_percentage
ORDER BY region, forest_percentage ASC;

/* Creates subquery consisting of two tables composed of the forest area in square kilometers of
countries in the years 1990 and 2016 to be used temporarily in future queries */
WITH TABLE1 AS (SELECT country_name, region, forest_area_sqkm AS forest_area_1990
                FROM forestation
                WHERE year='1990'),
     TABLE2 AS (SELECT country_name, region,
                       forest_area_sqkm AS forest_area_2016
                FROM forestation
                WHERE year='2016')


/* Used with previous subquery to obtain the top 5 countries from each of their respective
regions with the greatest amount of forest area lost in square kilometers from 1990 to 2016 */
SELECT TABLE1.country_name Country, TABLE1.region,
(TABLE1.forest_area_1990 - TABLE2.forest_area_2016) AS absolute_forest_area_change
FROM TABLE1
JOIN TABLE2
ON TABLE1.country_name = TABLE2.country_name
WHERE TABLE1.forest_area_1990 IS NOT NULL AND TABLE2.forest_area_2016 IS NOT
NULL
AND TABLE1.country_name != 'World'
ORDER BY absolute_forest_area_change DESC
LIMIT 5;

/* Uses previous subquery to obtain top 5 countries with the greatest amount of forest area
gained in square kilometer from 1990 to 2016 */
SELECT TABLE1.country_name, TABLE1.forest_1990, TABLE2.forest_2016,
( TABLE2.forest_2016 - TABLE1.forest_1990 ) AS forest_increase
FROM (SELECT country_name, forest_area_sqkm AS forest_1990
      FROM forestation
      WHERE year='1990'
      GROUP BY 1,2)
  TABLE1
  JOIN (SELECT country_name, forest_area_sqkm AS forest_2016
        FROM forestation
        WHERE year='2016'
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        GROUP BY 1,2) TABLE2
    ON TABLE1.country_name = TABLE2.country_name
    WHERE TABLE2.forest_2016 > TABLE1.forest_1990
    ORDER BY 4 DESC
    LIMIT 5;

/* Uses previous subquery to obtain top country with greatest amount of forest area percentage
gain from 1990 to 2016 */
SELECT TABLE1.country_name, TABLE1.forest_1990, TABLE2.forest_2016,
((TABLE2.forest_2016 - TABLE1.forest_1990) / (Table1.forest_1990)) * 100
forest_percent_change
FROM (SELECT country_name,
                    forest_area_sqkm AS forest_1990
          FROM forestation
          WHERE year='1990'
          GROUP BY 1,2)
   TABLE1
   JOIN (SELECT country_name,
                     forest_area_sqkm AS forest_2016
           FROM forestation
           WHERE year='2016'
           GROUP BY 1,2) TABLE2
     ON TABLE1.country_name = TABLE2.country_name
     WHERE TABLE2.forest_2016 > TABLE1.forest_1990
     ORDER BY 4 DESC
     LIMIT 1;

/* Uses previous subquery to determine top 5 countries from each of their respective region with
the highest percentage of forest area lost from 1990 to 2016 */
SELECT TABLE1.country_name, TABLE1.region,
TABLE1.percentage_of_forest_1990,TABLE2.percentage_of_forest_2016,
ROUND(CAST(((TABLE1.percentage_of_forest_1990 - TABLE2.percentage_of_forest_2016) /
TABLE1.percentage_of_forest_1990) * 100 AS NUMERIC),2)percentage_of_forest_dec
FROM (
  SELECT country_name, region, percentage_of_forest AS percentage_of_forest_1990
  FROM forestation
  WHERE year='1990' AND forest_area_sqkm IS NOT NULL AND total_area_sq_mi IS NOT
NULL
  GROUP BY 1,2,3)TABLE1
JOIN
(
 SELECT country_name, region, percentage_of_forest AS percentage_of_forest_2016
  FROM forestation
  WHERE year='2016'
  AND forest_area_sqkm IS NOT NULL AND total_area_sq_mi IS NOT NULL
  GROUP BY 1,2,3)TABLE2
ON TABLE1.country_name=TABLE2.country_name
WHERE TABLE1.percentage_of_forest_1990 > TABLE2.percentage_of_forest_2016
```

```
ORDER BY 5 DESC
LIMIT 5;

/* Counts all countries and partitions each into 4 quartiles based on each country's percentage
of forest area in 2016 */
SELECT DISTINCT( quartiles ), count(country_name) OVER (PARTITION BY quartiles) AS
number_of_countries
FROM
(SELECT country_name,
 CASE WHEN percentage_of_forest <= .25 THEN '0-25%'
          WHEN percentage_of_forest > .25 AND percentage_of_forest <= .50 THEN '25%-50%'
          WHEN percentage_of_forest > .50 AND percentage_of_forest <= .75 THEN '50%-75%'
 ELSE '75%-100%'
 END AS quartiles
 FROM forestation
 WHERE year='2016' AND percentage_of_forest IS NOT NULL AND region!='World') TABLE1
 ORDER BY quartiles;

/* Finds all countries in the top quartile from the previous query */
SELECT country_name
FROM forestation
WHERE percentage_of_forest > .75 AND percentage_of_forest <= 1 AND year='2016';


/* Subquery grabs percentage of forest for the United States, then counts all countries with a
higher forest area percentage than the United States in 2016 */
WITH TABLE1 AS (SELECT percentage_of_forest AS us_percentage_of_forest
FROM forestation
WHERE year='2016' AND country_name='United States')

SELECT COUNT(country_name) AS number_of_countries
FROM forestation, TABLE1
WHERE percentage_of_forest > TABLE1.us_percentage_of_forest AND year='2016' AND
country_name!='World';
```