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 **41282694.9 km^2** in 1990. As of 2016, the most recent year for which data was available, that number had fallen to **39958245.9 km^2**, a loss of **1324449 km^2**, or **3.2082**%.

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 **1279999.9891 km^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
East Asia & Pacific	25.78	26.36
Europe & Central Asia	37.28	38.04
Latin America & Caribbean	51.03	46.16
Middle East & North Africa	1.78	2.07
North America	35.65	36.04
South Asia	16.51	17.51
Sub-Saharan Africa	30.67	28.79
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** (**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 **527229.062 km^2**. 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 **79200 km^2**, much lower than the figure for **China**.

United States 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 **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	541510.00
Indonesia	East Asia & Pacific	282193.98
Myanmar	East Asia & Pacific	107234.00
Nigeria	Sub-Saharan Africa	106506.00
Tanzania	Sub-Saharan Africa	102320.00

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 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
1	85
2	72
3	38
4	9

The largest number of countries in 2016 were found in the **First** 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

4. RECOMMENDATIONS

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

From this data, we infer that the world has lost a concerning amount of total forest area, amounting to a decrease of 3.2 % over the last 16 years. The forest area lost over this period is slightly larger than the entire land area of Peru.
Middle East and Africa has faced the largest amount of deforestation, in terms of %, with the 2.07 %.
There are a few countries that have managed to not only sustain, but increase their forest area coverage. China and United States of America have managed to increase their total forest area, by 527229.062 km^2 and 79200^2 respectively.

In terms of relative percentage, Iceland is a clear winner by increasing its forest cover by 213.66 %.

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

Countries whose deforestation is concerning

Almost all of the countries whose forest coverage decreased the most fall under the region of Sub-Saharan Africa. Nigeria is the country whose fall in forest area is the most concerning, as it has lost forest area, both in terms of forest area as well as percentage relative to its land area.

The countries of Togo, Uganda, Mauritania and Honduras are also vulnerable, being in the top quartile of percentage forest decrease. Deforestation in Brazil is also quite high, which should be a cause for surprise as Brazil is part of the Latin America & Caribbean region, which is well known for being rich in their forest coverage.

Forests are entire ecosystems, housing flora and fauna. The loss of forest is hastening the impact of catastrophic climate change, and will prove devastating in the long run. The effects of climate change have already been felt this year, with natural forest fires occurring in several regions of the world, as well as heat waves in otherwise cool climates.

Countries should not prioritize economic development at the cost of their green cover, as this method is unsustainable in the long term.

5. APPENDIX: SQL queries used

Create Forestation View

```
CREATE OR REPLACE 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 * 100 / (2.59 * la.total_area_sq_mi) AS
pct_area_forest
FROM forest_area fa
JOIN land_area la
ON fa.country_code = la.country_code AND fa.year = la.year
JOIN regions r
ON fa.country_code = r.country_code;
```

1. Global Situation

a. What was the total forest area (in sq km) of the world in 1990? Please keep in mind that you can use the country record denoted as “World" in the region table.

```
-- World Forest Area (1990)
SELECT forest_area_sqkm  AS total_forest_area_1990
FROM forestation
WHERE country_name = 'World'
AND year = 1990;
```

b. What was the total forest area (in sq km) of the world in 2016? Please keep in mind that you can use the country record in the table is denoted as “World.”

```
SELECT forest_area_sqkm AS total_forest_area_2016
FROM forestation
WHERE country_name = 'World'
AND year = 2016;
```

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

```
SELECT previous.forest_area_sqkm - current.forest_area_sqkm AS
deforest_area_sq_km
      FROM (SELECT f.country_code, f.forest_area_sqkm
            FROM forest_area f
              WHERE f.country_name = 'World'
                AND f.year = 1990) AS previous
      JOIN (SELECT f.country_code,f.forest_area_sqkm
            FROM forest_area f
              WHERE f.country_name = 'World'
                AND f.year = 2016) AS current
      ON previous.country_code = current.country_code;
```

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

```
--  Change in forest cover %
SELECT ROUND((((previous.forest_area_sqkm - current.forest_area_sqkm)
/ previous.forest_area_sqkm )*100)::numeric, 4)  AS pct_change_fa
      FROM (SELECT f.country_code, f.forest_area_sqkm
            FROM forest_area f
              WHERE f.country_name = 'World'
                AND f.year = 1990) AS previous
      JOIN (SELECT f.country_code,f.forest_area_sqkm
            FROM forest_area f
              WHERE f.country_name = 'World'
                AND f.year = 2016) AS current
      ON previous.country_code = current.country_code;
```

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?

```
-- Similar to country (Peru)
SELECT country_name, ABS((total_area_sq_mi * 2.59) - 1324449) AS
diff_fa_loss
FROM forestation
WHERE year = 2016
ORDER BY 2
LIMIT 1;
```

2. Regional Outlook

```
-- Regional Outlook
CREATE OR REPLACE VIEW region_forest_area
AS
WITH forest_area_2016 AS
    (SELECT region, SUM(fa.forest_area_sqkm) AS
total_forest_area_sqkm_2016,
       SUM(la.total_area_sq_mi * 2.59) AS total_area_sqkm_2016,
       SUM(fa.forest_area_sqkm) * 100 / SUM(la.total_area_sq_mi *
2.59) AS percent_fa_region_2016
       FROM forest_area fa
       JOIN land_area la
       ON fa.country_code = la.country_code AND fa.year = la.year
       JOIN regions r
       ON la.country_code = r.country_code
       WHERE fa.year = 2016
       GROUP BY 1
       ORDER BY 1
       ),
       forest_area_1990 AS
```

```
      (SELECT region, SUM(fa.forest_area_sqkm) AS
total_forest_area_sqkm_1990,
       SUM(la.total_area_sq_mi * 2.59) AS total_area_sqkm_1990,
       SUM(fa.forest_area_sqkm) * 100 / SUM(la.total_area_sq_mi *
2.59) AS percent_fa_region_1990
       FROM forest_area fa
       JOIN land_area la
       ON fa.country_code = la.country_code AND fa.year = la.year
       JOIN regions r
       ON la.country_code = r.country_code
       WHERE fa.year = 1990
       GROUP BY 1
       ORDER BY 1
       )
       SELECT fa2016.region, total_forest_area_sqkm_2016,
total_area_sqkm_2016, percent_fa_region_2016,
       total_forest_area_sqkm_1990, total_area_sqkm_1990,
percent_fa_region_1990
       FROM forest_area_2016 fa2016
       JOIN forest_area_1990 fa1990
       ON fa1990.region = fa2016.region;
```

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?

```
-- World
SELECT ROUND(percent_fa_region_2016::numeric, 2)
       FROM region_forest_area
     WHERE region = 'World';

-- Highest forest cover 2016
SELECT region,
       ROUND(total_area_sqkm_2016::numeric, 2) AS total_area_sqkm,
       ROUND(percent_fa_region_2016::numeric, 2) AS percent_fa_region
       FROM region_forest_area
       WHERE region != 'World'
       ORDER BY 3 DESC
       LIMIT 1;

-- Lowest forest cover 2016
SELECT region,
       ROUND(total_area_sqkm_2016::numeric, 2) AS total_area_sqkm,
       ROUND(percent_fa_region_2016::numeric, 2) AS percent_fa_region
       FROM region_forest_area
       WHERE region != 'World'
       ORDER BY 3 ASC
       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?

```
- World Forest cover 1990
SELECT ROUND(percent_fa_region_1990::numeric, 2)
       FROM region_forest_area
     WHERE region = 'World';

-- Highest forest cover 1990
SELECT region,
       ROUND(total_area_sqkm_1990::numeric, 2) AS total_area_sqkm,
       ROUND(percent_fa_region_1990::numeric, 2) AS percent_fa_region
       FROM region_forest_area
       WHERE region != 'World'
       ORDER BY 3 DESC
       LIMIT 1;

-- Lowest forest cover 1990
SELECT region,
       ROUND(total_area_sqkm_1990::numeric, 2) AS total_area_sqkm,
       ROUND(percent_fa_region_1990::numeric, 2) AS percent_fa_region
       FROM region_forest_area
       WHERE region != 'World'
       ORDER BY 3 ASC
       LIMIT 1;
```

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

```
-- Regions that declined in area
SELECT region,
    ROUND(percent_fa_region_1990::numeric, 2) AS
percent_fa_region_1990,
    ROUND(percent_fa_region_2016::numeric, 2) AS
percent_fa_region_2016,
    ROUND((percent_fa_region_1990 - percent_fa_region_2016)::numeric,
2) AS percent_fa_decrease
FROM region_forest_area
WHERE percent_fa_region_1990 > percent_fa_region_2016
ORDER BY 3 DESC
```

3. Country-level Detail

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

```sql
-- Country Outlook
CREATE OR REPLACE VIEW country_forest_area
AS
WITH forest_area_2016 AS
    (SELECT fa.country_name, region, SUM(fa.forest_area_sqkm) AS
total_forest_area_sqkm_2016,
       SUM(la.total_area_sq_mi * 2.59) AS total_area_sqkm_2016,
       SUM(fa.forest_area_sqkm) * 100 / SUM(la.total_area_sq_mi *
2.59) AS percent_fa_region_2016
       FROM forest_area fa
       JOIN land_area la
       ON fa.country_code = la.country_code AND fa.year = la.year
       JOIN regions r
       ON la.country_code = r.country_code
       WHERE fa.year = 2016
         AND fa.forest_area_sqkm IS NOT NULL
       GROUP BY 1, 2
       ORDER BY 1
       ),
       forest_area_1990 AS
      (SELECT fa.country_name, region, SUM(fa.forest_area_sqkm) AS
total_forest_area_sqkm_1990,
       SUM(la.total_area_sq_mi * 2.59) AS total_area_sqkm_1990,
       SUM(fa.forest_area_sqkm) * 100 / SUM(la.total_area_sq_mi *
2.59) AS percent_fa_region_1990
       FROM forest_area fa
       JOIN land_area la
       ON fa.country_code = la.country_code AND fa.year = la.year
       JOIN regions r
       ON la.country_code = r.country_code
       WHERE fa.year = 1990
         AND fa.forest_area_sqkm IS NOT NULL
       GROUP BY 1, 2
       ORDER BY 1
       ) SELECT fa2016.country_name "country", fa2016.region,
total_forest_area_sqkm_2016, total_area_sqkm_2016,
percent_fa_region_2016,
       total_forest_area_sqkm_1990, total_area_sqkm_1990,
percent_fa_region_1990
       FROM forest_area_2016 fa2016
       JOIN forest_area_1990 fa1990
       ON fa1990.country_name = fa2016.country_name;
```

```sql
-- Absolute decrease country
SELECT country,
      region,
      ROUND(total_forest_area_sqkm_1990 - total_forest_area_sqkm_2016,
2) "Absolute Forest Change"
FROM country_forest_area
WHERE country != 'World'
ORDER BY 3 DESC;
```

b. 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?

```sql
-- decrease by country %
SELECT country, region,
      ROUND(((total_forest_area_sqkm_1990 -
total_forest_area_sqkm_2016) * 100 /
total_forest_area_sqkm_1990)::numeric, 2)
      "Forest Change Pctage"
FROM country_forest_area
WHERE country != 'World'
ORDER BY 3 DESC;
```

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

```sql
-- Quartiles 2016
WITH country_fa_2016 AS (SELECT
                        fa.country_name,
                        fa.year,
                        fa.forest_area_sqkm,
                        la.total_area_sq_mi * 2.59 AS total_area_sqkm,
                         (fa.forest_area_sqkm *
100/(la.total_area_sq_mi * 2.59))  AS pct_fa
                         FROM forest_area fa
                         JOIN land_area la
                         ON fa.country_code = la.country_code
                         AND fa.country_name != 'World'
                         AND fa.forest_area_sqkm IS NOT NULL
                         AND la.total_area_sq_mi IS NOT NULL
                         AND fa.year = 2016
                         AND la.year = 2016
                         ORDER BY 5 DESC
                    ),
      country_fa_qtile AS (SELECT
                         country_name,
                         year,
```

```
                        pct_fa,
                        CASE WHEN pct_fa >= 75 THEN 4
                             WHEN pct_fa < 75 AND pct_fa >= 50 THEN 3
                             WHEN pct_fa < 50 AND pct_fa >=25 THEN 2
                             ELSE 1
                        END AS percentile
                        FROM country_fa_2016 ORDER BY 4 DESC
                    )
SELECT percentile,
       COUNT(percentile)
       FROM country_fa_qtile
       GROUP BY 1
       ORDER BY 2 DESC;
```

d. List all of the countries that were in the 4th quartile (percent forest > 75%) in 2016.

```
-- Countries in top Quartile
WITH country_fa_2016 AS (SELECT
                        fa.country_name,
                        r.region,
                        fa.year,
                        fa.forest_area_sqkm,
                        la.total_area_sq_mi * 2.59 AS total_area_sqkm,
                         (fa.forest_area_sqkm *
100/(la.total_area_sq_mi * 2.59))  AS pct_fa
                        FROM forest_area fa
                        JOIN land_area la
                        ON fa.country_code = la.country_code
                        JOIN regions r
                        ON fa.country_code = r.country_code
                        AND fa.country_name != 'World'
                        AND fa.forest_area_sqkm IS NOT NULL
                        AND la.total_area_sq_mi IS NOT NULL
                        AND fa.year = 2016
                        AND la.year = 2016
                        ORDER BY 5 DESC
                    ),
      country_fa_qtile AS (SELECT
                        country_name,
                        region,
                        year,
                        pct_fa,
                         CASE WHEN pct_fa >= 75 THEN 4
                              WHEN pct_fa < 75 AND pct_fa >= 50 THEN 3
                              WHEN pct_fa < 50 AND pct_fa >=25 THEN 2
                              ELSE 1
                         END AS percentile
```

```
                        FROM country_fa_2016 ORDER BY 4 DESC
                )
SELECT country_name "Country",
       region "Region",
       pct_fa "Pct Designated As Forest"
       FROM country_fa_qtile
       WHERE percentile = 4
       ORDER BY 3 DESC;
```

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

```
-- No. of Countries with % greater than the United States
WITH country_fa_2016 AS (SELECT
                       fa.country_name,
                       r.region,
                       fa.year,
                       fa.forest_area_sqkm,
                       la.total_area_sq_mi * 2.59 AS total_area_sqkm,
                        (fa.forest_area_sqkm *
100/(la.total_area_sq_mi * 2.59))  AS pct_fa
                        FROM forest_area fa
                        JOIN land_area la
                        ON fa.country_code = la.country_code
                        JOIN regions r
                        ON fa.country_code = r.country_code
                        AND fa.country_name != 'World'
                        AND fa.forest_area_sqkm IS NOT NULL
                        AND la.total_area_sq_mi IS NOT NULL
                        AND fa.year = 2016
                        AND la.year = 2016
                        ORDER BY 5 DESC
                ),
      country_fa_qtile AS (SELECT
                        country_name,
                        region,
                        year,
                        pct_fa,
                         CASE WHEN pct_fa >= 75 THEN 4
                              WHEN pct_fa < 75 AND pct_fa >= 50 THEN 3
                              WHEN pct_fa < 50 AND pct_fa >=25 THEN 2
                              ELSE 1
                         END AS percentile
                         FROM country_fa_2016 ORDER BY 4 DESC
                )
SELECT COUNT(country_name)
       FROM country_fa_qtile
       WHERE pct_fa > (SELECT pct_fa FROM country_fa_qtile WHERE
country_name = 'United States');
```