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 **-1324449 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 **1,280,000 sq. km.**).

2. **REGIONAL OUTLOOK**

In 2016, the percent of the total land area of the world designated as forest was **31.34%**. The region with the highest relative forestation was **Latin America & Caribbean**, with **46.16%**, and the region with the lowest relative forestation was the **Middle East & North Africa**, with **2.07%** forestation.

In 1990, the percent of the total land area of the world designated as forest was **32.21%**. The region with the highest relative forestation was **Latin America & Caribbean**, with **51.03%**, and the region with the lowest relative forestation was the **Middle East & 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
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
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 **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 of America**, but it only saw an increase of **79,200 sq. km.**, much lower than the figure for China.

China and the **United States of America** 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 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	282,194 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	61.80%
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 percentage 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 **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?*
- *Which countries should we focus on over others?*

A note on World Bank data:
The analysis performed is strictly based on World Bank data and is missing contextual information such as population (changes), economic development, domestic and/or international conflict information, etc. These contextual elements will have an impact on growth or reduction of forest land.

Focus areas:
The countries most in need of focus include those that have most decreased in forest land, both by absolute sq. km. and by percentage of forest land. These include **Brazil**, **Indonesia**, **Myanmar**, **Nigeria**, **Tanzania**, **St. Martin**, **Togo**, **Uganda**, and **Mauritania**. It is important to look at the context of the forest reductions in the time between 1990 and 2016 to identify ways to reduce any further forest land loss or to begin re-establishing forest land. The areas most impacted have been likely to see conflict but are also more likely to be rich in biodiversity and natural resources that should be protected.

5. APPENDIX: SQL Queries Used

Create View

```sql
-- Create a view called "forestation"
-- Joins forest_area, land_area, and regions tables
DROP VIEW IF EXISTS forestation;

CREATE VIEW forestation
AS SELECT
    fa.country_code,
    fa.country_name,
    fa.year,
```

```
    fa.forest_area_sqkm,
    la.total_area_sq_mi * 2.59 AS total_area_sqkm,
    -- Calculate the percent of total land that is forest area
    (fa.forest_area_sqkm/(la.total_area_sq_mi * 2.59) * 100) AS
perc_land_is_forest,
    r.region,
    r.income_group
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;
```

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. */
-- Total area forest (in square km) of the world in 1990
SELECT
    country_name,
    forest_area_sqkm,
    year
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." */
-- Total area forest (in square km) of the world in 2016
SELECT
    country_name,
    forest_area_sqkm,
    year
FROM forestation
WHERE country_name = 'World'
AND year = 2016;
```

```sql
/* c. What was the change (in sq km) in the forest area of the world from
1990 to 2016? */
-- Change (in square km) of forest area of the world as of 2016 since 1990
SELECT (f1.forest_area_sqkm - f2.forest_area_sqkm) AS
forest_area_change_sq_km
FROM
    forestation AS f1,
    forestation AS f2
WHERE f1.year = '2016'
AND f1.country_name = 'World'
AND f2.year = '1990'
AND f2.country_name = 'World';


/* d. What was the percent change in forest area of the world between 1990
and 2016? */
-- Percent change in forest area around the world from 1990 to 2016
SELECT
    (f1.forest_area_sqkm - f2.forest_area_sqkm) AS
forest_area_change_sq_km,
    ((f1.forest_area_sqkm - f2.forest_area_sqkm) / f2.forest_area_sqkm) *
100 AS forest_area_percent_change
FROM forestation AS f1, forestation AS f2
WHERE f1.year = '2016'
AND f1.country_name = 'World'
AND f2.year = '1990'
AND f2.country_name = 'World';


/* 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? */
-- Country with closest total area compared to the amount of forest area
lost between 1990 and 2016
SELECT
    country_name,
    year,
    total_area_sqkm
FROM forestation
WHERE year = 2016
AND (total_area_sqkm) < (( -- dynamically calculate difference in total
forest area
```

```
                            SELECT forest_area_sqkm
                            FROM forestation
                            WHERE country_name = 'World'
                            AND year = 1990) -
                            (SELECT forest_area_sqkm FROM forestation
                            WHERE country_name = 'World'
                            AND year = 2016))
ORDER BY total_area_sqkm DESC
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? */
-- Find the percent forest of the entire world in 2016
SELECT
    ROUND(CAST(SUM(forest_area_sqkm) / SUM(total_area_sqkm) * 100 AS
NUMERIC), 2) AS forest_area_world
FROM forestation
WHERE year = 2016;

-- Find the region with the HIGHEST percent forest in 2016
SELECT
    region,
    ROUND(CAST(SUM(forest_area_sqkm) / NULLIF(SUM(total_area_sqkm), 0) *
100 AS NUMERIC), 2) AS forest_area_world
FROM forestation
WHERE year = 2016
GROUP BY 1
ORDER BY 2 DESC;

-- Find the region with the LOWEST percent forest in 2016
SELECT
    region,
    ROUND(CAST(SUM(forest_area_sqkm) / NULLIF(SUM(total_area_sqkm), 0) *
100 AS NUMERIC), 2) AS forest_area_world
FROM forestation
WHERE year = 2016
GROUP BY 1
ORDER BY 2;
```

```sql
/* 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? */
-- Find the percent forest of the entire world in 1990
SELECT
    SUM(forest_area_sqkm) / SUM(total_area_sqkm) * 100 AS forest_area_world
FROM forestation
WHERE year = 1990;

-- Find the region with the HIGHEST percent forest in 1990
SELECT
    region,
    ROUND(CAST(SUM(forest_area_sqkm) / NULLIF(SUM(total_area_sqkm), 0) *
100 AS NUMERIC), 2) AS forest_area_world
FROM forestation
WHERE year = 1990
GROUP BY 1
ORDER BY 2 DESC;

-- Find the region with the LOWEST percent forest in 1990
SELECT
    region,
    ROUND(CAST(SUM(forest_area_sqkm) / NULLIF(SUM(total_area_sqkm), 0) *
100 AS NUMERIC), 2) AS forest_area_world
FROM forestation
WHERE year = 1990
GROUP BY 1
ORDER BY 2;


/* c. Based on the table you created, which regions of the world DECREASED
in forest area from 1990 to 2016? */
-- Find the regions of the world that DECREASED in forest area from 1990 to
2016
SELECT
    region,
    SUM(CASE WHEN year = 1990 THEN forest_area_sqkm ELSE 0 END) AS
forest_area_1990,
    SUM(CASE WHEN year = 2016 THEN forest_area_sqkm ELSE 0 END) AS
forest_area_2016
```

```
FROM forestation
GROUP BY region
HAVING SUM(CASE WHEN year = 2016 THEN forest_area_sqkm ELSE 0 END) <
SUM(CASE WHEN year = 1990 THEN forest_area_sqkm ELSE 0 END);
```

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? */
-- Find the countries with the largest amount decrease in forest_area_sqkm
from 1990 to 2016 and the calculated difference
SELECT
    country_code,
    country_name,
    SUM(CASE WHEN year = 1990 THEN forest_area_sqkm ELSE 0 END) AS
forest_area_1990,
    SUM(CASE WHEN year = 2016 THEN forest_area_sqkm ELSE 0 END) AS
forest_area_2016,
    (SUM(CASE WHEN year = 2016 THEN forest_area_sqkm ELSE 0 END) - SUM(CASE
WHEN year = 1990 THEN forest_area_sqkm ELSE 0 END)) AS forest_area_change
FROM forestation
WHERE country_name <> 'World'
GROUP BY
    country_code,
    country_name
ORDER BY forest_area_change ASC -- ASC because it starts from negative
values
LIMIT 6;

/* 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? */
-- Find the countries with the largest percent decrease in forest area from
1990 to 2016 and round to 2 decimals
SELECT
    country_code,
    country_name,
    SUM(CASE WHEN year = 1990 THEN forest_area_sqkm ELSE 0 END) AS
forest_area_1990,
    SUM(CASE WHEN year = 2016 THEN forest_area_sqkm ELSE 0 END) AS
forest_area_2016,
```

```sql
    ROUND(CAST((SUM(CASE WHEN year = 2016 THEN forest_area_sqkm ELSE 0 END)
- SUM(CASE WHEN year = 1990 THEN forest_area_sqkm ELSE 0 END)) / SUM(CASE
WHEN year = 1990 THEN forest_area_sqkm ELSE 0 END) * 100 AS NUMERIC), 2) AS
percent_change
FROM forestation
GROUP BY
    country_code,
    country_name
HAVING SUM(CASE WHEN year = 1990 THEN forest_area_sqkm ELSE 0 END) > 0 --
Ensure we don't divide by zero
ORDER BY percent_change ASC
LIMIT 6;

/* c. If countries were grouped by percent forestation in quartiles, which
group had the most countries in it in 2016? */
-- Create quartiles of perc_land_is_forest and determine which quartile has
the highest number of countries
SELECT
    DISTINCT(quartiles),
    COUNT(country_name) OVER (PARTITION BY quartiles) AS countries
    FROM (SELECT country_name,
          CASE WHEN perc_land_is_forest <= 25 THEN '0-25%'
              WHEN perc_land_is_forest <= 75 AND perc_land_is_forest > 50
THEN '50-75%'
              WHEN perc_land_is_forest <= 50 AND perc_land_is_forest > 25
THEN '25-50%'
              ELSE '75-100%'
          END AS quartiles
FROM forestation
WHERE (perc_land_is_forest IS NOT NULL AND year = 2016)
AND country_name <> 'World') quart;

/* d. List all of the countries that were in the 4th quartile (percent
forest > 75%) in 2016. */
-- List all countries in the 4th quartile (>75%) in 2016
SELECT
    country_name,
    region,
    perc_land_is_forest
FROM forestation
WHERE year = 2016
AND country_name <> 'World'
```

```sql
AND perc_land_is_forest > 75
ORDER BY 3 DESC;

/* e. How many countries had a percent forestation higher than the United
States in 2016? */
-- Find number of countries with higher percent of forest than the United
States in 2016
WITH us_forest_percentage AS (
    SELECT perc_land_is_forest
    FROM forestation
    WHERE country_code = 'USA'
    AND year = 2016
)
SELECT COUNT(*) AS countries_higher_than_us
FROM forestation
WHERE year = 2016
AND perc_land_is_forest > (SELECT perc_land_is_forest
                           FROM us_forest_percentage);
```