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 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 **41,282,695 km^2** in 1990. As of 2016, the most recent year for which data was available, that number had fallen to **39,958,246 km^2**, a loss of **1,324,449 km^2**, 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 **738,054 km^2**).

2. REGIONAL OUTLOOK

In 2016, the percentage of 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 percentage of 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
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

A. SUCCESS STORIES

There is one particularly bright spot in the data at the country level, **China**. The forest area in China increased from 1990 to 2016 by **527,230 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 USA, but it only saw an increase of **79,200 km^2**, much lower than the figure for China.

China and The US 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 km^2
Indonesia	East Asia & Pacific	282,194 km^2
Myanmar	East Asia & Pacific	107,234 km^2
Nigeria	Sub-Saharan Africa	106,506 km^2
Tanzania	Sub-Saharan Africa	102,320 km^2

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	75.00 %
Nigeria	Sub-Saharan Africa	62.00 %
Uganda	Sub-Saharan Africa	59.00 %
Mauritania	Sub-Saharan Africa	47.00 %
Honduras	Latin America & Caribbean	45.00 %

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
4th	**9**
3rd	**38**
2nd	**72**
1st	**85**

Quartiles:

4th: greater than 75%
3th: less than 75% - greater than 50%
2nd: less than 50% - greater than 25%
1st: less than 25%

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	% 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

There are **94 countries** with a larger forestation percentage larger than that of the United States.

5. RECOMMENDATIONS

Since 1990, the global forest area has declined by 3.21% or over 1.3 million km^2. This is roughly equal to the total area of Peru.

Not surprisingly, the area with the largest percentage of forests remains Latin America and the Caribbean, home to the Amazon forest and the forests of Central America. Sadly, this was the area with the largest deforestation measured, dropping from 51.03% in 1990 to 46.16% in 2016, with **Brazil** losing half a million km^2 of forests.
Indonesia, **Myanmar**, **Nigeria** and **Tanzania** complete the top five countries with the largest loss. The top 5 countries contain some of the world's largest rainforests, which indicates that most of the deforestation is caused by logging and exploitation of natural resources in these forests.

Sub-Saharan Africa is another area of great concern with 4 countries that have lost the most forest per total area: **Togo, Nigeria, Uganda,** and **Mauritania,** losing 75%, 62%, 59% and 47% respectively.
These numbers are catastrophic and are not global headlines because the total forested area in these countries is small compared to Brazil, Russia, China, and the US. However, looked as a whole, Sub-Saharan Africa is in the process of a catastrophic and perhaps irreversible deforestation.

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

We first must focus efforts on stopping deforestation in Latin America and the Caribbean, since it contains the largest forest area. Any percentage improvement in this area will translate to the largest net forest area saved or restored.
Additionally, countries with large rainforest areas (Indonesia, Myanmar, etc.) should be part of the top tier of protection along with Latin America. A successful conservation program in any of these countries will translate to millions of saved forest square kilometers.

Regionally, the countries of Sub-Saharan Africa will require a monumental effort as some of them have lost most of their forests. This region will require a multi-nation effort to restore forests to 1990 levels.

5. Queries

Create Deforestation View

```
DROP VIEW IF EXISTS forestation;
CREATE VIEW forestation
AS
SELECT fa.country_code AS "country_code",
        fa.country_name AS "country_name",
        fa.year AS "year",
        fa.forest_area_sqkm AS "forest_area",
        (la.total_area_sq_mi * 2.59 ) AS "total_area",
        rg.region AS "region",
        rg.income_group AS "income_group",
        ROUND((fa.forest_area_sqkm / (la.total_area_sq_mi * 2.59 ) ) * 100 , 2)
AS "percentage_forest"
FROM forest_area fa
    JOIN land_area la
        ON la.country_code = fa.country_code AND fa.year = la.year
    JOIN regions as rg
        ON rg.country_code = la.country_code;
```

Global Situation

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

```
    SELECT fa.forest_area_sqkm
    FROM forest_area fa
        JOIN regions rg
        ON rg.country_code = fa.country_code
    WHERE rg.country_name = 'World' AND fa.year = 1990
```

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

```
    SELECT fa.forest_area_sqkm
    FROM forest_area fa
        JOIN regions rg
        ON rg.country_code = fa.country_code
    WHERE rg.country_name = 'World' AND fa.year = 2016
```

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

```
SELECT
    (SELECT fa.forest_area_sqkm AS total_1990
        FROM forest_area fa
            JOIN regions rg
            ON rg.country_code = fa.country_code
        WHERE rg.country_name = 'World' AND fa.year = 1990)

    - (SELECT fa.forest_area_sqkm AS total_2016
        FROM forest_area fa
            JOIN regions rg
            ON rg.country_code = fa.country_code
        WHERE rg.country_name = 'World' AND fa.year = 2016)

AS change_forest_area_sqkm
```

```
--- From View ---
SELECT
    (SELECT forest_area AS total_1990
        FROM forestation
        WHERE country_name = 'World' AND year = 1990)

    - (SELECT forest_area
        FROM forestation
        WHERE country_name = 'World' AND year = 2016)
AS change_forest_area
```

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

```
SELECT
    (
    (
        (SELECT fa.forest_area_sqkm AS total_1990
        FROM forest_area fa
            JOIN regions rg
            ON rg.country_code = fa.country_code
        WHERE rg.country_name = 'World' AND fa.year = 1990)

    - (SELECT fa.forest_area_sqkm AS total_2016
        FROM forest_area fa
            JOIN regions rg
            ON rg.country_code = fa.country_code
        WHERE rg.country_name = 'World' AND fa.year = 2016)
    )/
    (
```

```
        (SELECT fa.forest_area_sqkm AS total_1990
        FROM forest_area fa
            JOIN regions rg
            ON rg.country_code = fa.country_code
        WHERE rg.country_name = 'World' AND fa.year = 1990)

    ) )* 100
AS percentage_change_forest_area_sqkm
```

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 change_forest_area_sqkm AS
    (SELECT
     (
    (SELECT fa.forest_area_sqkm AS total_1990
        FROM forest_area fa
            JOIN regions rg
            ON rg.country_code = fa.country_code
        WHERE rg.country_name = 'World' AND fa.year = 1990)

    - (SELECT fa.forest_area_sqkm AS total_2016
        FROM forest_area fa
            JOIN regions rg
            ON rg.country_code = fa.country_code
        WHERE rg.country_name = 'World' AND fa.year = 2016)
        ) / 2.59 AS difference
    ),
    country_total_area AS
    (SELECT country_name,
        total_area_sq_mi
    FROM land_area
    WHERE year = 2016)
SELECT country_name,
        ABS(total_area_sq_mi -
    (select difference
    FROM change_forest_area_sqkm)) AS substraction
FROM country_total_area
ORDER BY  substraction
LIMIT 1
```

Regional Outlook

Create a table that shows the Regions and their percent forest area in 1990 and 2016

```
SELECT region,
        SUM(forest_percentage) AS Regional_forest_percentage,
        "year"
FROM
    (SELECT region,
            ROUND(SUM(forest_area) / SUM(total_area) * 100 , 2) AS
forest_percentage,
            "year"
    FROM forestation
    WHERE "year" IN (1990, 2016) AND region != 'World'
    GROUP BY "year", "region"
    ORDER BY "year") AS "years_regions"
GROUP BY region, year
ORDER BY region, year;
```

2016

In 2016, the percent of the total land area of the world designated as forest was

```
SELECT region,
        SUM(forest_percentage) AS Regional_forest_percentage,
        "year"
FROM
    (SELECT region,
            ROUND(SUM(forest_area) / SUM(total_area) * 100 , 2) AS
forest_percentage,
            "year"
    FROM forestation
    WHERE "year" = 2016 AND region = 'World'
    GROUP BY "year", "region"
    ORDER BY "year") AS "years_regions"
GROUP BY region, year
ORDER BY region, year;
```

The region with the highest relative forestation was , with :

```
SELECT region,
        SUM(forest_percentage) AS Regional_forest_percentage,
        "year"
FROM
    (SELECT region,
     ROUND(SUM(forest_area) / SUM(total_area) * 100 , 2) AS forest_percentage,
     "year"
```

```
    FROM forestation
    WHERE "year" = 2016
    GROUP BY "year", "region"
    ORDER BY "year") AS "years_regions"
GROUP BY region, year
ORDER BY  Regional_forest_percentage DESC
LIMIT 1;
```

And the region with the lowest relative forestation was with % forestation.

```
SELECT region,
        SUM(forest_percentage) AS Regional_forest_percentage,
        "year"
FROM
    (SELECT region,
    ROUND(SUM(forest_area) / SUM(total_area) * 100 , 2) AS forest_percentage,
            "year"
    FROM forestation
    WHERE "year" = 2016
    GROUP BY "year", "region"
    ORDER BY "year") AS "years_regions"
GROUP BY region, year
ORDER BY  Regional_forest_percentage ASC
LIMIT 1;
```

1990

In 1990, the percent of the total land area of the world designated as forest was

```
SELECT region,
        SUM(forest_percentage) AS Regional_forest_percentage,
        "year"
FROM (SELECT region,
            ROUND(SUM(forest_area) / SUM(total_area) * 100 , 2) AS
forest_percentage,
            "year"
    FROM forestation
    WHERE "year" = 1990 AND region = 'World'
    GROUP BY "year", "region"
    ORDER BY "year") AS "years_regions"
GROUP BY region, year
ORDER BY region, year;
```

The region with the highest relative forestation was

```
SELECT region,
        SUM(forest_percentage) AS Regional_forest_percentage,
        "year"
FROM
(SELECT region,
 ROUND(SUM(forest_area) / SUM(total_area) * 100 , 2) AS forest_percentage,
            "year"
    FROM forestation
    WHERE "year" = 1990
    GROUP BY "year", "region"
    ORDER BY "year") AS "years_regions"
GROUP BY region, year
ORDER BY  Regional_forest_percentage DESC
LIMIT 1
```

and the region with the lowest relative forestation was

```
SELECT region,
        SUM(forest_percentage) AS Regional_forest_percentage,
        "year"
FROM
    (SELECT region,
            ROUND(SUM(forest_area) / SUM(total_area) * 100 , 2) AS
forest_percentage,
     "year"
    FROM forestation
    WHERE "year" = 1990
    GROUP BY "year", "region"
    ORDER BY "year") AS "years_regions"
GROUP BY region, year
ORDER BY  Regional_forest_percentage ASC
LIMIT 1
```

Country-level Details

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

```
SELECT  f1.country_code,
        f1.forest_area,
        f2.country_name,
        f2.forest_area,
        f1.forest_area - f2.forest_area as forest_area_change
FROM forestation f1
    LEFT JOIN forestation f2
        ON f1.country_code = f2.country_code
        AND f1.year = 1990
        AND f1.country_code != 'WLD'
        AND f2.year = 2016
        AND f2.country_name != 'World'
    WHERE f1.forest_area IS NOT NULL
        AND f2.forest_area IS NOT NULL
ORDER BY forest_area_change DESC
LIMIT 5
```

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?

```
SELECT f1.country_code,
        f1.percentage_forest,
        f2.percentage_forest,
        f2.country_name,
        f1.percentage_forest - f2.percentage_forest as forest_area_change
FROM forestation f1
    LEFT JOIN forestation f2
        ON f1.country_code = f2.country_code
        AND f1.year = 1990
        AND f2.year = 2016
    WHERE f1.percentage_forest IS NOT NULL
        AND f2.percentage_forest IS NOT NULL
ORDER BY forest_area_change DESC
LIMIT 5
```

Table 3.1

```
SELECT  f2.country_name,
        f1.region,
        f1.forest_area - f2.forest_area as forest_area_change
FROM forestation f1
```

```
    LEFT JOIN forestation f2
        ON f1.country_code = f2.country_code
        AND f1.year = 1990
        AND f1.country_code != 'WLD'
        AND f2.year = 2016
        AND f2.country_name != 'World'
    WHERE f1.forest_area IS NOT NULL
        AND f2.forest_area IS NOT NULL
ORDER BY forest_area_change DESC
LIMIT 5
```

Table 3.2

```
SELECT  f2.country_name,
        f1.region,
        ((f2.forest_area - f1.forest_area) / f1.forest_area) * 100 as
forest_area_change
FROM forestation f1
    LEFT JOIN forestation f2
        ON f1.country_code = f2.country_code
        AND f1.year = 1990
        AND f1.country_code != 'WLD'
        AND f2.year = 2016
        AND f2.country_name != 'World'
    WHERE f1.forest_area IS NOT NULL
        AND f2.forest_area IS NOT NULL
ORDER BY forest_area_change ASC
LIMIT 5
```

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

```
WITH
    forest1 AS
    (SELECT *
    FROM forestation
    WHERE year = 2016
        AND percentage_forest IS NOT NULL
        AND region != 'World'),

    quartile AS
    (SELECT *,
     CASE
        WHEN percentage_forest > 75
            THEN '4th'
```

```
        WHEN percentage_forest <= 75 AND percentage_forest > 50
            THEN '3rd'
        WHEN percentage_forest <= 50 AND percentage_forest > 25
            THEN '2nd'
        ELSE '1st'
        END AS quarter
    FROM forest1 )

SELECT quarter,
        COUNT(*)
FROM quartile
GROUP BY quarter
ORDER BY 2 DESC;
```

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

```
WITH
    forest1 AS
    (SELECT *
    FROM forestation
    WHERE year = 2016
        AND percentage_forest IS NOT NULL
        AND region != 'World'),

    quartile AS
    (SELECT *,
     CASE
        WHEN percentage_forest > 75
            THEN '4th'
        WHEN percentage_forest <= 75 AND percentage_forest > 50
            THEN '3rd'
        WHEN percentage_forest <= 50 AND percentage_forest > 25
            THEN '2nd'
        ELSE '1st'
        END AS quarter
    FROM forest1 )

SELECT country_name,
        region,
        percentage_forest
FROM quartile
    WHERE quarter = '4th'
    ORDER BY percentage_forest DESC
```

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

```
SELECT count(*)
FROM forestation
WHERE percentage_forest >
        (SELECT percentage_forest
        FROM forestation
        WHERE year = 2016
            AND country_code = 'USA')
    AND year = 2016
```

Table 3.3

```
WITH
    forest1 AS
    (SELECT *
    FROM forestation
    WHERE year = 2016
        AND percentage_forest IS NOT NULL
        AND region != 'World'),

    quartile AS
    (SELECT *,
     CASE
        WHEN percentage_forest > 75
            THEN '4th'
        WHEN percentage_forest <= 75 AND percentage_forest > 50
            THEN '3rd'
        WHEN percentage_forest <= 50 AND percentage_forest > 25
            THEN '2nd'
        ELSE '1st'
        END AS quarter
    FROM forest1 )

SELECT quarter,
        COUNT(*)
FROM quartile
GROUP BY quarter
ORDER BY quarter;
```

Table 3.4

```
WITH
    forest1 AS
    (SELECT *
    FROM forestation
  WHERE year = 2016
```

```
        AND percentage_forest IS NOT NULL
        AND region != 'World'),

    quartile AS
    (SELECT *,
     CASE
        WHEN percentage_forest > 75
            THEN '4th'
        WHEN percentage_forest <= 75 AND percentage_forest > 50
            THEN '3rd'
        WHEN percentage_forest <= 50 AND percentage_forest > 25
            THEN '2nd'
        ELSE '1st'
        END AS quarter
    FROM forest1 )

SELECT country_name,
        region,
        percentage_forest
FROM quartile
    WHERE quarter = '4th'
    ORDER BY percentage_forest DESC
```