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 41282694.90 km^2 in 1990. As of 2016, the most recent year for which data was available, that number had fallen to 39958245.90 km^2, a loss of 1324449 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 1279999.99 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
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 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 Unites States, but it only saw an increase of 79200 km^2, much lower than the figure for China.

China and the 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: Brazil, Indonesia, and Myanmar.

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 km^2
Indonesia	East Asia & Pacific	282193.9844 km^2
Myanmar	East Asia & Pacific	107234.0039 km^2
Nigeria	Sub-Saharan Africa	106506.00098 km^2
Tanzania	Sub-Saharan Africa	102320 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	75.45%
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
1	85
2	72
3	38
4	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
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	Sub-Saharan Africa	87.61%

4. RECOMMENDATIONS

The World Bank data provided an excellent data on deforestation though there were some missing values. A complete picture of deforestation around the world since 1990 to 2016 has been obtained from the data set. Within 26 years the world has lost its forest area which is above of the total land area of a country like Peru. We could imagine the devastating scenario after the next 30 years.

By anlyzing the data set we have found certain regions and countries which should be focused on over others. There are two regions in the world that decreased in percent forest area from 1990 to 2016. The first one is the Latin America & Caribbean which lost its relative forestation around 5% and the second one is the Sub-Saharan Africa which lost around 2% within this two and a half decades. Among top five countries (Brazil, Indonesia, Myanmar, Nigeria, Tanzania) those had a decrease in forest area from 1990 to 2016, Brazil faced highly destructive scenario of deforestation. This giant forest oriented land lost 541510 km^2 of forest area which is greater than the total land area of Spain. The second largest concern is Indonesia which lost more than half of the losses of Brazil. Another concern Nigeria which is also listed in the top 5 countries (Togo, Nigeria, Uganda, Mauritania, Honduras) those had percentage decrease in forest area from 1990 to 2016 had a decline around 61.80%. Another African country, Togo should be focused as well which faced highest decline in terms of percentage of the forest area.

Among top two countries those has increase in forest area from 1990 to 2016, China put an extremely impressive landmark to the world. It gained in total 527229.062 km^2 forest area within this two and half decades. On the othe hand, the United State added a total of 79200 km^2 forest area. Another extremely effective example of a small country which has a surprising increase in terms of percentage in forest area is Iceland. The forest area increased by 213.66% from 1990 to 2016. Therefore, China, United States, and Iceland could be the examples for the other countries those lost their forest area.

5. APPENDIX: SQL Queries Used

Preparing the dataset: A view has been created by given tables.

```
DROP VIEW IF EXISTS forestation;

CREATE VIEW forestation AS (
  SELECT f.country_code,
         f.country_name,
         f.year,
         f.forest_area_sqkm,
         l.total_area_sq_mi * 2.59 AS total_area_sqkm,
         ( f.forest_area_sqkm / ( l.total_area_sq_mi * 2.59 ) ) *
100
          AS forest_percentage,
         r.region,
         r.income_group
   FROM   forest_area AS f
   JOIN land_area AS l
        ON f.country_code = l.country_code
           AND f.year = l.year
   JOIN regions AS r
        ON l.country_code = r.country_code);
```

1. Global Situation:
   a) Total forest area (in sq km) of the world in 1990:

```
SELECT forest_area_sqkm
FROM   forestation
WHERE  year = 1990
       AND country_name = 'World';
```

   b) The total forest area (in sq km) of the world in 2016:

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

   c) The change (in sq km) in the forest area of the world from 1990 to 2016

```
SELECT (SELECT forest_area_sqkm
        FROM   forestation
        WHERE  year = 1990
               AND country_name = 'World')
       - (SELECT forest_area_sqkm
```

```
                FROM   forestation
                WHERE  year = 2016
                    AND country_name = 'World')
            AS change;
```

d) The percent change in forest area of the world between 1990 and 2016

```
WITH year_1990
     AS (SELECT forest_area_sqkm
         FROM   forestation
         WHERE  year = 1990
                AND country_name = 'World'),
     year_2016
     AS (SELECT forest_area_sqkm
         FROM   forestation
         WHERE  year = 2016
                AND country_name = 'World')
SELECT ( Abs((SELECT forest_area_sqkm
              FROM   year_2016)
             - (SELECT forest_area_sqkm
                FROM   year_1990)) ) * 100
             / (SELECT forest_area_sqkm
                FROM year_1990)
       AS percent_forest;
```

e) The amount of forest area lost between 1990 and 2016, to which country's total area in 2016 is it closest to:

```
SELECT country_name,
       total_area_sqkm
FROM   forestation
WHERE  total_area_sqkm BETWEEN 1200000 AND 1400000
       AND year = 2016
ORDER  BY 2 DESC;
```

2. Regional Outlook:

```
WITH forest_precentage_1990
AS (SELECT region,
           ( SUM(forest_area_sqkm) * 100 ) /
SUM(total_area_sqkm)
           AS percent_forest
    FROM   forestation
    WHERE  year = 1990
```

```
          GROUP  BY 1
          ORDER  BY 2 DESC),
     forest_precentage_2016
     AS (SELECT region,
                ( SUM(forest_area_sqkm) * 100 ) /
SUM(total_area_sqkm)
                AS percent_forest
          FROM   forestation
          WHERE  year = 2016
          GROUP  BY 1
          ORDER  BY 2 DESC),
     joined_1990_2016
     AS (SELECT f1.region,
                Round(f1.percent_forest :: NUMERIC, 2)
                     AS percent_1990,
                Round(f2.percent_forest :: NUMERIC, 2) AS
percent_2016
          FROM   forest_precentage_1990 AS f1
          JOIN   forest_precentage_2016 AS f2
                 ON f1.region = f2.region)
    SELECT *
    FROM   joined_1990_2016;
```

Based on the table above created (**joined_1990_2016**), all the other queries from this section (Regional Outlook) will be run.

a) Percent forest of the entire world in 2016:

```
SELECT region,
       percent_2016
FROM   joined_1990_2016
WHERE  region = 'World';
```

Region which had the HIGHEST percent forest in 2016:

```
SELECT region,
       percent_2016 AS highest_percent
FROM   joined_1990_2016
ORDER  BY 2 DESC
LIMIT  1;
```

Region which had the LOWEST percent forest in 2016:

```
SELECT region,
       percent_2016 AS lowest_percent
FROM   joined_1990_2016
```

```
ORDER  BY 2
LIMIT  1;
```

b) Percent forest of the entire world in 1990:

```
SELECT region,
       percent_1990
FROM   joined_1990_2016
WHERE  region = 'World';
```

Region which had the HIGHEST percent forest in 1990:

```
SELECT region,
       percent_1990 AS highest_percent
FROM   joined_1990_2016
ORDER  BY 2 DESC
LIMIT  1;
```

Region which had the LOWEST percent forest in 1990:

```
SELECT region,
       percent_1990 AS highest_percent
FROM   joined_1990_2016
ORDER  BY 2
LIMIT  1;
```

c) Regions those DECREASED in forest area from 1990 to 2016:

```
SELECT *
FROM   joined_1990_2016
WHERE  percent_1990 > percent_2016;
```

3. Country-Level Detail:

a) 5 countries those saw the largest amount decrease in forest area from 1990 to 2016, and the difference in forest area for each:

```
WITH forest_area_1990
AS (SELECT country_name, region, forest_area_sqkm
    FROM   forestation
    WHERE  year = 1990
           AND forest_area_sqkm IS NOT NULL),
forest_area_2016
AS (SELECT country_name, region, forest_area_sqkm
    FROM   forestation
    WHERE  year = 2016
           AND forest_area_sqkm IS NOT NULL),
joined_1990_2016
AS (SELECT f1.country_name, f1.region,
```

```
            f1.forest_area_sqkm AS forest_1990_sqkm,
            f2.forest_area_sqkm AS forest_2016_sqkm
    FROM    forest_area_1990 AS f1
    JOIN    forest_area_2016 AS f2
            ON f1.country_name = f2.country_name)

SELECT   country_name, region, forest_1990_sqkm,
         forest_2016_sqkm,
         Abs(forest_2016_sqkm - forest_1990_sqkm)
         AS difference_sqkm
FROM     joined_1990_2016
WHERE    forest_1990_sqkm > forest_2016_sqkm
AND      country_name <> 'World'
ORDER BY difference_sqkm DESC
LIMIT 5;
```

b) 5 countries those saw the largest percent decrease in forest area from 1990 to 2016, and the percent change for each:
By using the above table (**joined_1990_2016**), the solution of this query stated below:

```
SELECT country_name, region, forest_1990_sqkm,
       forest_2016_sqkm,
       Round(( Abs(forest_2016_sqkm - forest_1990_sqkm)
            * 100 / forest_1990_sqkm) :: NUMERIC, 2)
           AS difference_percent
FROM   joined_1990_2016
WHERE  forest_1990_sqkm > forest_2016_sqkm
ORDER  BY difference_percent DESC
LIMIT  5;
```

c) If countries were grouped by percent forestation in quartiles, the group that had the most countries in it in 2016:

```
WITH forest_percent_quartile
     AS (SELECT country_name, forest_percentage,
                CASE
                  WHEN forest_percentage > 75 THEN 4
                  WHEN forest_percentage > 50 THEN 3
                  WHEN forest_percentage > 25 THEN 2
                  ELSE 1
                END AS quartile_number
         FROM   forestation
         WHERE  year = 2016
                AND country_name <> 'World'
```

```
                AND forest_percentage IS NOT NULL)

SELECT quartile_number,
       Count(*) AS count_country
FROM   forest_percent_quartile
GROUP  BY quartile_number
ORDER  BY count_country DESC;
```

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

```
WITH forest_percent_quartile
     AS (SELECT country_name, region, forest_percentage,
                CASE
                  WHEN forest_percentage > 75 THEN 4
                  WHEN forest_percentage > 50 THEN 3
                  WHEN forest_percentage > 25 THEN 2
                  ELSE 1
                END AS quartile_number
         FROM   forestation
         WHERE  year = 2016
                AND country_name <> 'World'
                AND forest_percentage IS NOT NULL)

SELECT country_name, region,
       Round(forest_percentage :: NUMERIC, 2)
            AS forest_percentage
FROM   forest_percent_quartile
WHERE  quartile_number = 4
ORDER  BY forest_percentage DESC;
```

e) Countries those had a percent forestation higher than the United States in 2016:

```
WITH forest_pct_2016
     AS (SELECT country_name, forest_percentage
         FROM   forestation
         WHERE  year = 2016
                AND forest_percentage IS NOT NULL),
     us_forest_pct_2016
     AS (SELECT forest_percentage
         FROM   forestation
         WHERE  year = 2016
                AND country_name <> 'World'
```

```
                AND country_name = 'United States')

SELECT Count(*) AS total_countries
FROM   forest_pct_2016
WHERE  forest_percentage > (SELECT *
                            FROM   us_forest_pct_2016);
```

Success Stories:

Top 5 countries those saw the largest amount increase in forest area from 1990 to 2016, and the difference in forest area for each:

```
WITH forest_area_1990
AS (SELECT country_name, region, forest_area_sqkm
    FROM   forestation
    WHERE  year = 1990
           AND forest_area_sqkm IS NOT NULL),
forest_area_2016
AS (SELECT country_name, region, forest_area_sqkm
    FROM   forestation
    WHERE  year = 2016
           AND forest_area_sqkm IS NOT NULL),
joined_1990_2016
AS (SELECT f1.country_name, f1.region,
           f1.forest_area_sqkm AS forest_1990_sqkm,
           f2.forest_area_sqkm AS forest_2016_sqkm
    FROM   forest_area_1990 AS f1
    JOIN   forest_area_2016 AS f2
           ON f1.country_name = f2.country_name)

SELECT   country_name, region, forest_1990_sqkm,
         forest_2016_sqkm,
         Abs(forest_2016_sqkm - forest_1990_sqkm)
         AS difference_sqkm
FROM     joined_1990_2016
WHERE    forest_2016_sqkm > forest_1990_sqkm
AND      country_name <> 'World'
ORDER BY difference_sqkm DESC
Limit 5;
```

Top 5 countries those saw the largest percent increase in forest area from 1990 to 2016, and the percent change for each:

By using the above table (**joined_1990_2016**), the solution of this query stated below:

```
SELECT country_name, region, forest_1990_sqkm,
```

```
        forest_2016_sqkm,
        Round(( Abs(forest_2016_sqkm - forest_1990_sqkm)
             * 100 / forest_1990_sqkm) :: NUMERIC, 2)
             AS difference_percent
FROM    joined_1990_2016
WHERE   forest_2016_sqkm > forest_1990_sqkm
ORDER   BY difference_percent DESC
LIMIT   5;
```