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 1,279,999.99 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**
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. 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, but it only saw an increase of 79200 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	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 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	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

5. RECOMMENDATIONS

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

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

a) The forest area has been decreased.
b) Though most of the countries have increased their forest area, decrease in some major countries caused the total forest area to decrease over the span of about 26 years (1990 to 2016).
c) The impact of these decrease can be seen on the region-wise forest area. Latin America & Caribbean region suffered the heavy forest loss.
d) Another 2 regions that came out at the top of forest area loss in terms of sq km and percent of total land are Sub-Saharan Africa , and East Asia & Pacific region.

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

a) The country that lost the biggest forest area is Brazil. Brazil contains a significant portion of world forest area. Our primary focus has to be this country.
b) If we focus on forest area decrease by percentage and by land loss, Nigeria comes out at the top.
c) China is a bright star that has increased the forest area by huge amount. So, a close study of China's forest policy will definitely shed light in solving the problem of decreasing forest in countries.
d) Another country, who also has increased the percentage of forest most, is Iceland. A thorough study will surely reveal many secrets of increasing forestation.

Appendix: SQL queries

1. "**forestation" view creation:**

```
CREATE VIEW forestation AS
SELECT fa.country_code
        ,fa.country_name
        ,fa.year
        ,forest_area_sqkm
        ,total_area_sq_mi
        ,region
       ,income_group
      ,(forest_area_sqkm/(total_area_sq_mi*2.59))*100 AS forest_percentage
FROM  forest_area fa
INNER JOIN land_area la ON la.country_code = fa.country_code AND fa.year =la.year
INNER JOIN regions re ON re.country_code = fa.country_code
```

2. **GLOBAL SITUATION:**

a) **the total forest area of the world in 1990**

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

b) **the total forest area of the world in 2016**

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

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

```
WITH cte_1990 AS (SELECT country_name
                         ,forest_area_sqkm
                  FROM forest_area
                   WHERE year = '1990' AND country_name ='World'),
cte_2016 AS (SELECT country_name
                    ,forest_area_sqkm
             FROM forest_area
             WHERE year = '2016' AND country_name ='World')
SELECT (cte_1990.forest_area_sqkm - cte_2016.forest_area_sqkm) AS forest_area_loss
FROM cte_1990
INNER JOIN cte_2016 ON cte_2016.country_name = cte_1990.country_name
```

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

```
WITH cte_1990 AS (SELECT country_name
                         ,forest_area_sqkm
                  FROM forest_area
                   WHERE year = '1990' AND country_name ='World'),
cte_2016 AS (SELECT country_name
                    ,forest_area_sqkm
             FROM forest_area
             WHERE year = '2016' AND country_name ='World')
SELECT ((cte_2016.forest_area_sqkm -
cte_1990.forest_area_sqkm)/cte_1990.forest_area_sqkm)*100 AS forest_percentage_change
FROM cte_1990
INNER JOIN cte_2016 ON cte_2016.country_name = cte_1990.country_name
```

The answer is negative (- 3.21%). So, the percentage of forest has been decreased by 3.21%.

e) The forest area lost over this time period is slightly more than the entire land area of Peru listed for the year 2016:

```
WITH cte AS (SELECT country_name
                    ,(total_area_sq_mi*2.59) AS total_area_sq_km
             FROM land_area
             WHERE year = '2016'
             ORDER BY ABS ((total_area_sq_mi*2.59) - 1324449) )
SELECT *
FROM cte
LIMIT 1
```

3. REGIONAL OUTLOOK

a) In 2016, the percent of the total land area of the world designated as forest:

```
WITH cte AS (SELECT DISTINCT f1.country_name
                    ,f1.forest_area_sqkm
                    ,f2.country_name
                    ,f2.total_area_sq_mi
             FROM forestation AS f1
             INNER JOIN forestation AS f2 ON f2.country_name = f1.country_name
             WHERE f1.year = '2016' AND f2.year = '2016' AND f1.country_name = 'World')
SELECT (forest_area_sqkm/(total_area_sq_mi*2.59))*100 AS forest_percentage
FROM cte
```

b) The region with the highest relative forestation(2016):

```
WITH cte AS (SELECT f1.region AS f1_region
                    ,f2.region AS f2_region
                    ,SUM(f1.forest_area_sqkm) AS region_forest_area
                    ,SUM((f2.total_area_sq_mi)*2.59) AS region_land_area
             FROM forestation AS f1
             INNER JOIN forestation AS f2 ON f2.region = f1.region
             WHERE f1.region !='World' AND f2.region !='World' AND f1.year='2016' AND
f2.year='2016'
GROUP BY 1,2)
SELECT cte.f1_region
       ,(region_forest_area/region_land_area)*100 AS region_forest_percentage
FROM cte
ORDER BY 2 DESC
LIMIT 1
```

c) The region with the lowest relative forestation(2016):

```
WITH cte AS (SELECT region
                    ,SUM(forest_area_sqkm) AS region_forest_area
                    ,SUM((total_area_sq_mi)*2.59) AS region_land_area
             FROM forestation
             WHERE region!='World' AND year='2016'
             GROUP BY region)
SELECT cte.region
      ,(region_forest_area/region_land_area)*100 AS region_forest_percentage
FROM cte
ORDER BY 2 ASC
LIMIT 1
```

d) In 1990, the percent of the total land area of the world designated as forest:

```
WITH cte_forest_area AS (SELECT country_name
                                ,forest_area_sqkm
                         FROM forest_area
                         WHERE year = '1990' AND country_name = 'World'),
cte_land_area AS (SELECT country_name
                         ,total_area_sq_mi
                  FROM land_area
                  WHERE year = '1990' AND country_name = 'World')
SELECT (forest_area_sqkm/(total_area_sq_mi*2.59))*100 AS forest_percentage
FROM cte_forest_area
INNER JOIN cte_land_area ON cte_land_area.country_name = cte_forest_area.country_name
```

e) The region with the highest relative forestation(1990):

```
WITH cte AS (SELECT region
                    ,SUM(forest_area_sqkm) AS region_forest_area
                    ,SUM((total_area_sq_mi)*2.59) AS region_land_area
             FROM forestation
             WHERE region!='World' AND year = '1990'
             GROUP BY region)
SELECT cte.region
      ,(region_forest_area/region_land_area)*100 AS region_forest_percentage
FROM cte
ORDER BY 2 DESC
LIMIT 1
```

f) The region with the lowest relative forestation(1990):

```
WITH cte AS (SELECT region
                    ,SUM(forest_area_sqkm) AS region_forest_area
                    ,SUM((total_area_sq_mi)*2.59) AS region_land_area
             FROM forestation
             WHERE region!='World' AND year = '1990'
             GROUP BY region)
SELECT cte.region
      ,(region_forest_area/region_land_area)*100 AS region_forest_percentage
FROM cte
ORDER BY 2 ASC
LIMIT 1
```

g) 2016 Forest Percentage by region:

```
WITH cte AS (SELECT region
                    ,SUM(forest_area_sqkm) AS region_forest_area
                    ,SUM((total_area_sq_mi)*2.59) AS region_land_area
             FROM forestation
             WHERE region!='World' AND year='2016'
             GROUP BY region)
SELECT cte.region
      ,(region_forest_area/region_land_area)*100 AS region_forest_percentage
FROM cte
ORDER BY 2 DESC
```

h) 1990 Forest Percentage by region:

```
WITH cte AS (SELECT region
                    ,SUM(forest_area_sqkm) AS region_forest_area
                    ,SUM((total_area_sq_mi)*2.59) AS region_land_area
             FROM forestation
             WHERE region!='World' AND year='1990'
             GROUP BY region)
SELECT cte.region
      ,(region_forest_area/region_land_area)*100 AS region_forest_percentage
FROM cte
ORDER BY 2 DESC
```

4. **COUNTRY-LEVEL DETAIL**
   A. **SUCCESS STORIES**
      1. **The country that increased in forest area MOST from 1990 to 2016**

```
WITH cte_1990 AS (SELECT country_name
                                ,forest_area_sqkm
                  FROM forestation
                  WHERE year = '1990' AND country_name != 'World' and forest_area_sqkm IS
NOT NULL),

cte_2016 AS (SELECT country_name
                           ,forest_area_sqkm
             FROM forestation
             WHERE year = '2016' AND country_name != 'World' and forest_area_sqkm IS  NOT
NULL)
SELECT cte_1990.country_name
      ,(cte_2016.forest_area_sqkm - cte_1990.forest_area_sqkm) AS forest_gain
FROM cte_1990
INNER JOIN cte_2016 ON cte_2016.country_name = cte_1990.country_name
WHERE (cte_2016.forest_area_sqkm - cte_1990.forest_area_sqkm) > 0
ORDER BY 2 DESC
LIMIT 1
```

      2. **The country that increased in forest area 2nd MOST from 1990 to 2016:**

```
WITH cte_1990 AS (SELECT country_name
                                ,forest_area_sqkm
                  FROM forestation
                  WHERE year = '1990' AND country_name != 'World' and
forest_area_sqkm IS  NOT NULL),

cte_2016 AS (SELECT country_name
                           ,forest_area_sqkm
             FROM forestation
             WHERE year = '2016' AND country_name != 'World' and forest_area_sqkm IS
NOT NULL)
SELECT cte_1990.country_name
      ,(cte_2016.forest_area_sqkm - cte_1990.forest_area_sqkm) AS forest_gain
FROM cte_1990
JOIN cte_2016 ON cte_2016.country_name = cte_1990.country_name
WHERE (cte_2016.forest_area_sqkm - cte_1990.forest_area_sqkm) > 0
ORDER BY 2 DESC
LIMIT 2
```

From here, I entered the value from the 2nd one.

3. **Largest percent increase in forest area from 1990 to 2016**

```
WITH cte_2016 AS (SELECT country_name
                        ,forest_area_sqkm AS forest_area_2016
                  FROM forestation
                  WHERE year = '2016' AND country_name != 'World' and forest_area_sqkm
IS  NOT NULL),
cte_1990 AS (SELECT country_name
                    ,forest_area_sqkm AS forest_area_1990
             FROM forestation
             WHERE year = '1990' AND country_name != 'World' and forest_area_sqkm IS
NOT NULL)
SELECT cte_2016.country_name
       ,((forest_area_2016 - forest_area_1990)/forest_area_1990)*100 AS
forest_gain_percentage
FROM cte_2016
INNER JOIN cte_1990 ON cte_1990.country_name = cte_2016.country_name
ORDER BY 2 DESC
LIMIT 1
```

B. LARGEST CONCERNS

1. **Top 5 Amount Decrease in Forest Area by Country, 1990 & 2016:**

```
WITH cte_1990 AS (SELECT country_name
                         ,region
                         ,forest_area_sqkm
                  FROM forestation
                  WHERE year = '1990' AND country_name != 'World' and
forest_area_sqkm IS  NOT NULL),
cte_2016 AS (SELECT country_name
                    ,forest_area_sqkm
             FROM forestation
             WHERE year = '2016' AND country_name != 'World' and forest_area_sqkm IS
NOT NULL)
SELECT cte_1990.country_name
      ,cte_1990.region
      ,(cte_1990.forest_area_sqkm - cte_2016.forest_area_sqkm) AS forest_loss
FROM cte_1990
INNER JOIN cte_2016 ON cte_2016.country_name = cte_1990.country_name
WHERE (cte_1990.forest_area_sqkm - cte_2016.forest_area_sqkm) > 0
ORDER BY 3 DESC
LIMIT 5
```

2. **Top 5 percent Decrease in Forest Area by Country, 1990 & 2016:**

```
WITH cte_2016 AS (SELECT country_name
                 ,region
   ,forest_area_sqkm AS forest_area_2016
FROM forestation
WHERE year = '2016' AND country_name != 'World' and forest_area_sqkm IS  NOT NULL),
cte_1990 AS (SELECT country_name
   ,forest_area_sqkm AS forest_area_1990
FROM forestation
WHERE year = '1990' AND country_name != 'World' and forest_area_sqkm IS  NOT NULL)
SELECT cte_2016.country_name
     ,region
     ,((forest_area_2016 - forest_area_1990)/forest_area_1990)*100 AS forest_loss_percentage
FROM cte_2016
INNER JOIN cte_1990 ON cte_1990.country_name = cte_2016.country_name
ORDER BY 3 ASC
LIMIT 5
```

4. **QUARTILES**
   a) **Count of Countries Grouped by Forestation Percent Quartiles, 2016**

```
WITH cte AS (SELECT
CASE WHEN ((forest_area_sqkm/(total_area_sq_mi*2.59))*100) < 25 THEN '1'
        WHEN ((forest_area_sqkm/(total_area_sq_mi*2.59))*100) BETWEEN 25 AND 50
THEN '2'
        WHEN ((forest_area_sqkm/(total_area_sq_mi*2.59))*100) BETWEEN 50 AND 75
THEN '3'
        WHEN ((forest_area_sqkm/(total_area_sq_mi*2.59))*100) > 75 THEN '4' END AS
Quartile
         ,country_name
         ,region
FROM forestation
WHERE year = '2016' AND country_name != 'World' and forest_area_sqkm IS  NOT NULL
AND total_area_sq_mi IS  NOT NULL)
SELECT Quartile
        ,COUNT(country_name) AS number_of_countries
FROM cte
GROUP BY 1
ORDER BY 1
```

b) Top Quartile Countries, 2016:

```
WITH cte AS (SELECT
CASE WHEN ((forest_area_sqkm/(total_area_sq_mi*2.59))*100) < 25 THEN '1'
        WHEN ((forest_area_sqkm/(total_area_sq_mi*2.59))*100) BETWEEN 25 AND 50
THEN '2'
        WHEN ((forest_area_sqkm/(total_area_sq_mi*2.59))*100) BETWEEN 50 AND 75
THEN '3'
        WHEN ((forest_area_sqkm/(total_area_sq_mi*2.59))*100) > 75 THEN '4' END AS
Quartile
            ,country_name
           ,region
           ,(forest_area_sqkm/(total_area_sq_mi*2.59))*100 AS forest_percentage
FROM forestation
WHERE year = '2016' AND country_name != 'World' and forest_area_sqkm IS  NOT NULL
AND total_area_sq_mi IS  NOT NULL)
SELECT country_name
     ,region
     ,forest_percentage
FROM cte
WHERE Quartile = '4'
ORDER BY 3 DESC
```