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 sqkm in 1990. As of 2016, the most recent year for which data was available, that number had fallen to 39958245.9 sqkm, a loss of 1324449 sqkm, 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 1279999.9 sqkm).

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 Sub-Saharan Africa (dropped from 30.67 % to 28.79 %) and Latin America & Caribbean (51.03 % to 46.16 %). 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 sqkm. 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 sqkm, 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 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 & Carribean	541510
Indonesia	East Asia & Pacific	282193.98
Myanmar	East Asia & Pacific	107234
Nigeria	Sub-Saharan Africa	106506
Tanzania	Sub-Saharan Africa	102320

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
1st (<25%)	85
2nd (25%-50%)	72
3rd (50%-75%)	38
4th (>75%)	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

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?*

As a conclusion for conducted analysis, I can say that we see the general steady tendency for the forest decrease around the globe. However, speaking locally, the tendency itself seems to be much

more uneven. Even though we face the forest decrease in global extent, the situation differs from country to country as well as from region to region. For instance, as we can see in our regional outlook, most regions in the world demonstrated forest area growth, but decrease in only two of them, Sub-Saharan Africa and Latin America & Caribbean is so huge, that it affects the bigger picture, making it look pessimistic. Obviously, those two should be focused on over others, but even on that level we can't treat both 'problematic' regions in a same way, since Latin America remains the area with highest relative forestation in the whole world, but Sub-Saharan Africa appears to be in significantly worse situation, as it is demonstrated in a country-level analysis as well. That difference appears more explicitly as we look at the percent decrease in forest area from 1990 to 2016, where four of the top 5 countries on the list are in the region of Sub-Saharan Africa and only the fifth place is occupied by country from Latin America & Caribbean region. Another perturbing fact is that the only country included in both top 5 lists in terms of absolute square kilometer decrease in forest as well as percent decrease in forest area is Nigeria, which is also in the Sub-Saharan region. Therefore, there is no doubt, that Sub-Saharan African countries, like Nigeria, mentioned above, or Togo that lost 75% of its forest area from 1990 to 2016 (!) should have the top priority in terms of all possible remedial efforts. China, that demonstrated the largest absolute increase in forest area from 1990 to 2016 in the world or Iceland, showed the largest percent change in forest area in the same period can be taken as an examples of success stories.

5. APPENDIX: SQL Queries Used

```
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,
          r.region,
          r.income_group,
          f.forest_area_sqkm / ( l.total_area_sq_mi * 2.59 ) * 100 AS
             forest_percent
   FROM   forest_area f
          INNER JOIN land_area l
            ON f.country_code = l.country_code
               AND l.year = f.year
          INNER JOIN regions r
            ON l.country_code = r.country_code);
```

Global situation

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

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

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

```
SELECT forest_area_sqkm
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 forest_area_sqkm - (SELECT forest_area_sqkm
                           FROM   forestation
                           WHERE  country_name = 'World'
                                  AND year = 2016) AS sqkm_change
FROM   forestation
WHERE  country_name = 'World'
       AND year = 1990
```

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

```
SELECT Cast(t1.sqkm_change/forest_area_sqkm * 100 AS DECIMAL (5, 2)) A
S
       percent_change
FROM   (SELECT forest_area_sqkm,
               forest_area_sqkm - (SELECT forest_area_sqkm
                                   FROM   forestation
                                   WHERE  country_name = 'World'
                                          AND year = 2016) AS sqkm_cha
nge
        FROM   forestation
        WHERE  country_name = 'World'
               AND year = 1990) t1
```

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?

```
SELECT forest_area_sqkm - (SELECT forest_area_sqkm
                           FROM   forestation
                           WHERE  country_name = 'World'
                                  AND year = 2016) AS sqkm_change
FROM   forestation
WHERE  country_name = 'World'
       AND year = 1990
```

```
SELECT country_name,
       total_area_sqkm
FROM   forestation
WHERE  year = 2016
       AND total_area_sqkm BETWEEN 1200000 AND 1600000
ORDER  BY total_area_sqkm
```

Regional outlook

a. What was the percent forest of the entire world in 2016?

```
SELECT Cast (forest_area_sqkm / total_area_sqkm * 100 AS DECIMAL(5, 2)
) AS
       percent_forest_area,
       region,
       year
FROM   forestation
WHERE  year = 2016
       AND region = 'World'
GROUP  BY 1,
          2,
          3
ORDER  BY 1
```

Which region had the HIGHEST percent forest in 2016, to 2 decimal places?

```
SELECT Cast (Sum(forest_area_sqkm)/Sum(total_area_sqkm)*100 AS DECIMAL
(25, 2))
       AS
       percent_forest_area,
       region,
       year
FROM   forestation
WHERE  year = 2016
GROUP  BY 2,
          3
ORDER  BY 1 DESC
LIMIT  1;
```

Which region had the LOWEST percent forest in 2016, to 2 decimal places?

```
SELECT Cast (Sum(forest_area_sqkm)/Sum(total_area_sqkm)*100 AS DECIMAL
(25, 2))
       AS
       percent_forest_area,
       region,
       year
FROM   forestation
WHERE  year = 2016
GROUP  BY 2,
          3
ORDER  BY 1
LIMIT  1;
```

b. What was the percent forest of the entire world in 1990?

```
SELECT Cast (forest_area_sqkm / total_area_sqkm * 100 AS DECIMAL(5, 2)
) AS
       percent_forest_area,
       region,
       year
FROM   forestation
WHERE  year = 1990
       AND region = 'World'
GROUP  BY 1,
          2,
```

```
          3
ORDER  BY 1
```

Which region had the HIGHEST percent forest in 1990, to 2 decimal places?

```
SELECT Cast (Sum(forest_area_sqkm)/Sum(total_area_sqkm)*100 AS DECIMAL
(25, 2))
       AS
       percent_forest_area,
       region,
       year
FROM   forestation
WHERE  year = 1990
GROUP  BY 2,
          3
ORDER  BY 1 DESC
LIMIT  1;
```

Which region had the LOWEST percent forest in 1990, to 2 decimal places?

```
SELECT Cast (Sum(forest_area_sqkm)/Sum(total_area_sqkm)*100 AS DECIMAL
(25, 2))
       AS
       percent_forest_area,
       region,
       year
FROM   forestation
WHERE  year = 1990
GROUP  BY 2,
          3
ORDER  BY 1
LIMIT  1;
```

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

```
WITH region2016
     AS (SELECT Cast (Sum(forest_area_sqkm) / Sum(total_area_sqkm) * 1
00 AS
                       DECIMAL(5, 2)) AS
                percent_forest_area,
                region,
                year
         FROM   forestation
         WHERE  year = 2016
         GROUP  BY 2,
                   3
         ORDER  BY 3),
     region1990
     AS (SELECT Cast (Sum(forest_area_sqkm) / Sum(total_area_sqkm) * 1
00 AS
                       DECIMAL(5, 2)) AS
                percent_forest_area,
                region,
                year
         FROM   forestation
         WHERE  year = 1990
         GROUP  BY 2,
                   3
         ORDER  BY 3)
SELECT region2016.percent_forest_area AS percent2016,
       region1990.percent_forest_area AS percent1990,
       region2016.region
FROM   region1990
       INNER JOIN region2016
         ON region1990.region = region2016.region
WHERE  region1990.percent_forest_area - region2016.percent_forest_area
 > 0
       AND region1990.region != 'World';
```

Country level details

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?

```
WITH forest1990 AS
(
         SELECT   forest_area_sqkm,
                  country_name,
                  year,
                  region
         FROM     forestation
         WHERE    year=1990
         GROUP BY 1,
                  2,
                  3,
                  4),
forest2016 AS
(
         SELECT   forest_area_sqkm,
                  country_name,
                  year,
                  region
         FROM     forestation
         WHERE    year=2016
         GROUP BY 1,
                  2,
                  3,
                  4)
SELECT   forest1990.forest_area_sqkm sqkm1990,
         forest2016.forest_area_sqkm sqkm2016,
         forest1990.country_name,
         forest1990.region,
         forest1990.forest_area_sqkm-
forest2016.forest_area_sqkm AS change
FROM     forest1990
INNER JOIN     forest2016
ON       forest1990.country_name=forest2016.country_name
AND      forest1990.region=forest2016.region
WHERE    forest1990.country_name != 'World'
AND      forest1990.forest_area_sqkm-
forest2016.forest_area_sqkm IS NOT NULL
ORDER BY 5 DESC
LIMIT 5;
```

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?

```
WITH forest1990 AS
(
         SELECT   forest_area_sqkm,
                  country_name,
                  year,
                  region
         FROM     forestation
         WHERE    year=1990
         GROUP BY 1,
                  2,
                  3,
                  4),
forest2016 AS
(
         SELECT   forest_area_sqkm,
                  country_name,
                  year,
                  region
         FROM     forestation
         WHERE    year=2016
         GROUP BY 1,
                  2,
                  3,
                  4)
SELECT   Cast (change/sqkm1990 * 100 AS DECIMAL(5,2)) AS per_decrease,
         country_name,
         region
FROM     (
                  SELECT   forest1990.forest_area_sqkm sqkm1990,
                           forest2016.forest_area_sqkm sqkm2016,
                           forest1990.country_name,
                           forest1990.region,
                           forest1990.forest_area_sqkm-
forest2016.forest_area_sqkm AS change
                  FROM     forest1990
                  INNER JOIN     forest2016
                  ON       forest1990.country_name=forest2016.country_
name
                  AND      forest1990.region=forest2016.region
                  WHERE    forest1990.country_name != 'World'
```

```
                  AND      forest1990.forest_area_sqkm-
forest2016.forest_area_sqkm IS NOT NULL
                  ORDER BY 5 DESC) t1
ORDER BY 1 DESC
LIMIT 5;
```

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

```
SELECT Count(*) num_countries,
       quartiles
FROM   (SELECT forest_percent,
               country_name,
               CASE
                 WHEN forest_percent < 25 THEN 1
                 WHEN forest_percent > 25
                      AND forest_percent < 50 THEN 2
                 WHEN forest_percent > 50
                      AND forest_percent < 75 THEN 3
                 ELSE 4
               END AS quartiles
        FROM   forestation
        WHERE  country_name != 'World'
               AND year = 2016
               AND forest_percent IS NOT NULL
        ORDER  BY 1) t1
GROUP  BY 2
ORDER  BY 1 DESC;
```

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

```
SELECT country_name,
       region,
       Cast(forest_percent AS DECIMAL(5, 2))
FROM   (SELECT forest_percent,
               country_name,
               region,
               CASE
                 WHEN forest_percent < 25 THEN 1
                 WHEN forest_percent > 25
                      AND forest_percent < 50 THEN 2
                 WHEN forest_percent > 50
```

```
                    AND forest_percent < 75 THEN 3
               ELSE 4
             END AS quartiles
      FROM   forestation
      WHERE  country_name != 'World'
             AND year = 2016
             AND forest_percent IS NOT NULL
      ORDER  BY 1) t1
WHERE  quartiles = 4
ORDER  BY 3 DESC;
```

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

```
SELECT Count(*) AS forest_percentage_higher_than_us
FROM   forestation
WHERE  year = 2016
       AND forest_percent > (SELECT forest_percent
                             FROM   forestation
                             WHERE  country_name = 'United States'
                                    AND year = 2016)
```