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** in 1990. As of 2016, the most recent year for which data was available, that number had fallen to **39958245.9**, a loss of **1324449**, or **3.3145824351614%**. OR **(3%)**

The forest area lost over this time period is slightly more than the entire land area of **-1324449** listed for the year 2016 (which is **Peru**).

2. REGIONAL OUTLOOK

In 2016, the percentage 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 percentage 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**
Sub-Saharan Africa	**30.67**	**28.79**
Europe & Central Asia	**37.28**	**38.04**
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**
North America	**35.65**	**36.04**

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** (dropped from **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 the forest area from 1990 to 2016 by **527,229.06**. 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 **92,456**, much lower than the figure for **China**.

Russia and **Canada** 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 top. **Iceland's** forest area by **2.14%** 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: **China**, **Sudan** and **Ethiopia**.

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**
China	**East Asia & Pacific**	**527229.06**
Indonesia	**East Asia & Pacific**	**282193.98**
Sudan	**Sub-Saharan Africa**	**190355.29**
Ethiopia	**Sub-Saharan Africa**	**125396.00**

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
Iceland	**Europe & Central Asia**	**2.14**
French Polynesia	**East Asia & Pacific**	**1.82**
Bahrain	**Middle East & North Africa**	**1.77**
Uruguay	**Latin America & Caribbean**	**1.34**
Dominican Republic	**Latin America & Caribbean**	**0.82**

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 **Latin America & Caribbean**. The countries are **Haiti**, **Nicaragua**, **El Salvador**, and **Panama**. The 5th country on the list is**Zimbabwe**, which is in the **Sub-Saharan Africa** region. From the above analysis, we see that **Haiti** 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
Q-1	**85**
Q-2	**72**
Q-3	**38**
Q-4	**9**

The largest number of countries in 2016 were found in the **Quartile 1 (Q-1)**.

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
Bhutan	**Southern Asia**	**84.34**
Finland	**Northern Europe**	**76.47**
Gabon	**Middle Africa**	**88.18**
Guyana	**South America**	**84.45**
Laos	**South-East Asia**	**77.67**
Suriname	**South America**	**91.92**
Sweden	**Northern Europe**	**76.87**
Vanuatu	**Melanesia**	**89.03**
Zambia	**Eastern Africa**	**76.38**

4. RECOMMENDATIONS

Based on the report, it is clear that deforestation continues to be a major problem around the world, with a significant decrease in forest area over the past few years. In terms of recommendations, it is important for respective country's governments around the world to take steps to encounter deforestation like promoting reforestation, implementing new policies, education and awareness of forest and its impact.

Analyzed reports show that countries such as Brazil, Indonesia have lost significant forest area over the years. Therefore, it is essential to address countries which have lost the highest forest area to understand the factors and develop interventions. Also, there are a handful of countries which have seen steady increase in forest loss like Madagascar, Nigeria and Bolivia. The Forest Team should closely monitor those countries to address the situations causing the steady loss.

<u>Below are few recommendations to be considered:</u>

- *Low Forest Management*
- *Poverty*
- *Social/Economic Interventions*
- *Global Collaboration*

Overall, The report highlights that It is crucial to coordinate on a country-level as well as globally to address deforestation, protect forest to save the environment and promote sustainability of forest land.

5. APPENDIX: SQL Queries Used

CREATE VIEW

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

Answer - A – Global Situation

Result : 41282694.9

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

**** * Total world sqkm based world measurements of forest is 41,282,694.9 however data collected in our database for countries actually listed give us 40,733,777.136028***

```
SELECT Sum(forest_area_sqkm)
 FROM   forestation
 WHERE  year = '1990'
     AND country_name <> 'World';
```

Answer - B – Global Situation

Result : 39958245.9

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

Answer - C – Global Situation

Result : 1324449

```
WITH year2016
   AS (SELECT Sum(forest_area_sqkm) AS year_2016_Data
      FROM   forestation
      WHERE  year = '2016'
          AND country_name = 'World'
      GROUP  BY year),
   year1990
   AS (SELECT Sum(forest_area_sqkm) AS year_1990_Data
      FROM   forestation
      WHERE  year = '1990'
          AND country_name = 'World'
      GROUP  BY year)
 SELECT year_2016_data,
     year_1990_data,
     ( year_1990_data - year_2016_data ) AS "Difference"
 FROM   year1990
     CROSS JOIN year2016;
```

Answer - D – Global Situation

Result : 3.3145824351614 – ROUND (3%)

```
WITH year2016
   AS (SELECT Sum(forest_area_sqkm) AS year_2016_Data
      FROM   forestation
      WHERE  year = '2016'
          AND country_name = 'World'
      GROUP  BY year),
   year1990
   AS (SELECT Sum(forest_area_sqkm) AS year_1990_Data
      FROM   forestation
      WHERE  year = '1990'
          AND country_name = 'World'
      GROUP  BY year)
SELECT year_2016_data,
    year_1990_data,
    Round (( ( year_1990_data - year_2016_data ) / year_2016_data ) * 100) AS
    "Difference (%)"
FROM   year1990
    CROSS JOIN year2016;
```

Answer - E – Global Situation

Result : Peru – -1324449

```
SELECT l.country_name,
    ( l.total_area_sq_mi * 2.59 )            AS total_area_sq_km,
    ( l.total_area_sq_mi * 2.59 ) + (SELECT
    ( f.forest_area_sqkm -
     f1.forest_area_sqkm ) AS forest_area_lost
                        FROM   forest_area f
                            JOIN forest_area f1
                             ON ( f.country_code =
                                f1.country_code
                               AND f.year = 2016
                                        AND f1.year = 1990 )
                                ORDER  BY forest_area_lost
                                LIMIT  1) AS
      "forest_area_lost_vs_country",
```

```
      (SELECT ( f.forest_area_sqkm - f1.forest_area_sqkm ) AS forest_area_lost
       FROM   forest_area f
              JOIN forest_area f1
                ON ( f.country_code = f1.country_code
                   AND f.year = 2016
                   AND f1.year = 1990 )
       ORDER  BY forest_area_lost
       LIMIT  1)                          AS
      "forest_area_difference_world_1990_2016"
FROM   land_area l
WHERE  l.total_area_sq_mi IS NOT NULL
ORDER  BY Abs(( l.total_area_sq_mi * 2.59 ) + (SELECT
                  ( f.forest_area_sqkm -
                    f1.forest_area_sqkm ) AS forest_area_lost
                                  FROM   forest_area f
                                      JOIN forest_area f1
                                        ON (
                  f.country_code = f1.country_code
                  AND f.year = 2016
                  AND f1.year = 1990 )
                                 ORDER  BY forest_area_lost
                                   LIMIT  1))
LIMIT  1;
```

Answer - TABLE (2.1) – Regional Outlook

***** All the fill in the blank answers are based on table (2.1) created above from below Query.***

-- WITH FUNCTION

```
WITH forest_percentage
   AS (SELECT r.region,
         Sum(CASE
            WHEN f.year = 1990 THEN f.forest_area_sqkm
            ELSE 0
               END) / Sum(CASE
                  WHEN l.year = 1990 THEN
                  l.total_area_sq_mi * 2.59
                        ELSE 0
                     END) * 100 AS forest_percentage_1990,
```

```
        Sum(CASE
            WHEN f.year = 2016 THEN f.forest_area_sqkm
            ELSE 0
                END) / Sum(CASE
                  WHEN l.year = 2016 THEN
                  l.total_area_sq_mi * 2.59
                          ELSE 0
                        END) * 100 AS forest_percentage_2016
     FROM   regions r
         JOIN land_area l
          ON r.country_code = l.country_code
         JOIN forest_area f
          ON r.country_code = f.country_code
           AND l.year = f.year
     GROUP  BY r.region)
SELECT region,
  Cast(forest_percentage_1990 AS NUMERIC (10, 2)) AS forest_percentage_1990,
    Cast(forest_percentage_2016 AS NUMERIC (10, 2)) AS
    forest_percentage_2016
FROM   forest_percentage;
```

-- Another Way of Querying

```
SELECT r.region,
    Cast(Sum(CASE
          WHEN f.year = 1990 THEN f.forest_area_sqkm
          ELSE 0
             END) / Sum(CASE
                WHEN l.year = 1990 THEN l.total_area_sq_mi * 2.59
                      ELSE 0
                    END) * 100 AS NUMERIC(10, 2)) AS
    Forest_percentage_1990,
    Cast(Sum(CASE
          WHEN f.year = 2016 THEN f.forest_area_sqkm
          ELSE 0
             END) / Sum(CASE
                WHEN l.year = 2016 THEN l.total_area_sq_mi * 2.59
                      ELSE 0
                    END) * 100 AS NUMERIC(10, 2)) AS
    Forest_percentage_2016
FROM   regions r
```

```
    JOIN land_area l
      ON r.country_code = l.country_code
    JOIN forest_area f
      ON r.country_code = f.country_code
        AND l.year = f.year
GROUP  BY r.region;
```

Answer - A – Country Level Detail

Result : Top 5 Amount Decrease in Forest

```
SELECT country_name
    AS
    country,
    region,
    Round(Abs(forest_area_sqkm_2016 - forest_area_sqkm_1990) :: NUMERIC,
2)
    AS
    absolute_forest_area_change
FROM   (SELECT f.country_code,
        f.country_name,
        r.region,
        Sum(CASE
            WHEN f.year = 1990 THEN f.forest_area_sqkm
            ELSE 0
                end) AS forest_area_sqkm_1990,
        Sum(CASE
            WHEN f.year = 2016 THEN f.forest_area_sqkm
            ELSE 0
                end) AS forest_area_sqkm_2016
    FROM   forestation f
        JOIN regions r
          ON f.country_code = r.country_code
    WHERE  f.country_code != 'WLD'
    GROUP  BY f.country_code,
          f.country_name,
          r.region) AS sub
ORDER  BY absolute_forest_area_change DESC
LIMIT  5;
```

Answer - B – Country Level Detail

Result : Top 5 Percent Decrease in Forest

```
SELECT   f.country_name AS country,
      r.region,
      CASE
           WHEN Sum(
                CASE
                     WHEN f.year = 1990 THEN f.forest_area_sqkm
                     ELSE 0
                       END) = 0 THEN NULL
           ELSE Round(((Sum(
                CASE
                     WHEN f.year = 2016 THEN f.forest_area_sqkm
                     ELSE 0
                       END) - Sum(
                CASE
                     WHEN f.year = 1990 THEN f.forest_area_sqkm
                     ELSE 0
                       END)) / Sum(
                CASE
                     WHEN f.year = 1990 THEN f.forest_area_sqkm
                     ELSE 0
                       END))::numeric, 2)
      END AS percentage_forest_area_change
FROM     forestation f
JOIN     regions r
ON       f.country_code = r.country_code
WHERE    f.year IN (1990,
           2016)
GROUP BY f.country_name,
      r.region
ORDER BY percentage_forest_area_change DESC nulls last limit 5;
```

Answer - C – Country Level Detail

Result : Q1-85, Q2-72, Q3-38, Q4-9

```
WITH percent_quartiles
   AS (SELECT country_code,
```

```
        country_name,
        forest_area_over_land_area_percentage,
        CASE
         WHEN forest_area_over_land_area_percentage >= 75 THEN
         'Quartile-4'
         WHEN forest_area_over_land_area_percentage >= 50 THEN
         'Quartile-3'
         WHEN forest_area_over_land_area_percentage >= 25 THEN
         'Quartile-2'
         ELSE 'Quartile-1'
        END AS quartile
    FROM   forestation
    WHERE  year = 2016
           AND forest_area_over_land_area_percentage IS NOT NULL
        AND country_name <> 'World')
SELECT Count(quartile) AS countries,
    quartile
FROM   percent_quartiles
GROUP  BY quartile;
```

***** To find the answers for the fill in the blanks (After table 3.3) – Add 2 lines in existing SQL***

```
ORDER BY countries DESC
Limit 1;
```

The largest number of countries in 2016 were found in the **Quartile 1 (Q-1)**

Answer - D – Country Level Detail

Result : 9 countries

```
SELECT f.country_name,
    Round(( f.forest_area_sqkm :: NUMERIC / l.total_area_sq_mi :: NUMERIC ) *
       100.0,
    2) AS percentage_designated_forest,
    r.region
FROM   forestation f
```

```
    join land_area l
      ON f.country_code = l.country_code
        AND f.year = l.year
    join regions r
      ON f.country_code = r.country_code
WHERE  f.year = 2016
       AND f.forest_area_over_land_area_percentage > 0.75
ORDER  BY percentage_designated_forest DESC;
```

Answer - E – Country Level Detail

Result : 4

```
SELECT Count(*) AS higher_united_states_2016
FROM   forestation f
    JOIN land_area l
      ON f.country_code = l.country_code
        AND f.year = l.year
WHERE  f.year = 2016
       AND f.forest_area_over_land_area_percentage > (SELECT
       f2.forest_area_sqkm / l2.total_area_sq_mi
                          FROM forestation f2
                                  JOIN land_area l2
                                    ON f2.country_code = l2.country_code
             AND f2.year = l2.year
               WHERE f2.country_code = 'USA'
               AND f2.year = 2016);
```