Report By: Vinit Kumar

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 1,279,999.9891 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
World	32.42	31.38
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 527229.062 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 79,200 sq km, much lower than the figure for China.

Russian Federation and China 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 sq km
Indonesia	East Asia & Pacific	282,193.98 sq km
Myanmar	East Asia & Pacific	107,234.00 sq km
Nigeria	Sub-Saharan Africa	106,506.00 sq km
Tanzania	Sub-Saharan Africa	102,320 sq km

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%
Mauritiana	Sub-Saharan Africa	46.75%
Honduras	Latin America and 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 and 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
4	9
3	38
2	72
1	85

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 & Carribean	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?*

Total forest area of the world has reduced by 3.21% from 1991-2016, which is an area of concern. The Latin America & Caribbean region dominated the world with highest relative forestation as of 2016, as well as in 1990 albeit a decease in Percentage Forest Area between the stated period by 4.87%.

At Country Level, China and United States increased in forest area from 1990 to 2016 however the increase for China was drastic by 527,229.062 sq km. On the other end, Brazil noted a largest decrease in forest area in the period stated earlier however, on a percentage basis Togo saw a largest decline.

Infact out of the top 5 countries in terms of percentage decrease in forest area, 4 are in Sub-Saharan Africa Region. Nigeria which in Sub-Saharan Africa Region is the only country in Top 5 in terms in absolute square kilometer decrease in forest as well as percent decrease in forest area from 1990 – 2016.In 2016, 77% of the Countries fell in 1st & 2nd Quartile in terms of percent forestation. Largest being in 1st Quartile. Very few countries are in 4th quartile with the top 3 being Suriname, Micronesia and Gabon with Percent Forest > 90%.

In comparison to United States, 94 countries had a percent forestation higher than the United States in 2016.

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

I would recommend focusing on the countries with the largest absolute forest area change, Brazil, Indonesia, Myanmar, Nigeria, and Tanzania. Specific research in warranted on these countries to understand the reason behind the negative absolute change. China has shown a absolutely impressive positive change

China to find best practices for increasing forest area would be very helpful, and research is warranted to understand what has China done differently and possibility of leveraging the techniques in the weaker countries.

5.APPENDIX: SQL QUERIES USED

Create View

```
CREATE VIEW forestation
AS
  SELECT fa.country_code
      AS
            Forest_Country_Code,
         fa.country_name
      AS
            Forest_Country_Name,
         fa.year
      AS
            Forest_Year,
         fa.forest_area_sqkm
      AS
            Forest_Area_Sq_km,
         la.total_area_sq_mi
      AS
            Land_Total_Area_Sq_Mi,
         r.region
      AS
            R_Region,
         r.income_group
      AS
            R_Income_Grp,
         ( ( Sum(forest_area_sqkm) / Sum(total_area_sq_mi * 2.59) ) *
100 ) AS
         Percent_AS_Forest
  FROM   forest_area fa
         INNER JOIN land_area la
           ON fa.country_code = la.country_code
              AND fa.year = la.year
         INNER JOIN regions r
           ON la.country_code = r.country_code
  GROUP  BY fa.country_code,
            fa.country_name,
            fa.year,
            fa.forest_area_sqkm,
            la.total_area_sq_mi,
            r.region,
            r.income_group;
```

1. Global Situation

a. What was the total forest area (in sq km) of the world in 1990? Please keep in mind that you can use the country record denoted as “World" in the region table.

```
SELECT forest_country_name,
       forest_year,
       forest_area_sq_km
FROM   forestation
WHERE  forest_country_name = 'World'
       AND forest_year = 1990;
```

b. What was the total forest area (in sq km) of the world in 2016? Please keep in mind that you can use the country record in the table is denoted as “World.”

```
SELECT forest_country_name,
       forest_year,
       forest_area_sq_km
FROM   forestation
WHERE  forest_country_name = 'World'
       AND forest_year = 2016;
```

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

```
WITH tb1
     AS (SELECT forest_country_name,
                forest_area_sq_km
         FROM   forestation
         WHERE  forest_country_name = 'World'
                AND forest_year = 1990),
     tb2
     AS (SELECT forest_country_name,
                forest_area_sq_km
         FROM   forestation
         WHERE  forest_country_name = 'World'
                AND forest_year = 2016)
SELECT ( tb2.forest_area_sq_km - tb1.forest_area_sq_km ) AS
       Change_In_Forest_Area
FROM   tb1
       INNER JOIN tb2
         ON tb1.forest_country_name = tb2.forest_country_name;
```

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

```
WITH tb1
     AS (SELECT forest_country_name,
                forest_area_sq_km
         FROM   forestation
         WHERE  forest_country_name = 'World'
                AND forest_year = 1990),
     tb2
     AS (SELECT forest_country_name,
                forest_area_sq_km
         FROM   forestation
         WHERE  forest_country_name = 'World'
                AND forest_year = 2016)
SELECT ( tb2.forest_area_sq_km / tb1.forest_area_sq_km - 1 ) * 1
00 AS
       Per_Change_In_Forest_Area
FROM   tb1
       INNER JOIN tb2
         ON tb1.forest_country_name = tb2.forest_country_name;
```

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_country_name,
       ( land_total_area_sq_mi * 2.59 ) AS Tot_Land_Area_SqKM
FROM   forestation
WHERE  forest_year = 2016
       AND ( land_total_area_sq_mi * 2.59 ) <= 1324449
ORDER  BY tot_land_area_sqkm DESC;
```

2. Regional Outlook

```
CREATE VIEW forestation
AS
  SELECT fa.country_code
      AS
            Forest_Country_Code,
         fa.country_name
      AS
            Forest_Country_Name,
         fa.year
      AS
            Forest_Year,
         fa.forest_area_sqkm
      AS
            Forest_Area_Sq_km,
         la.total_area_sq_mi
      AS
            Land_Total_Area_Sq_Mi,
         r.region
      AS
            R_Region,
         r.income_group
      AS
            R_Income_Grp,
         ( ( Sum(forest_area_sqkm) / Sum(total_area_sq_mi * 2.59) ) *
100 ) AS
         Percent_AS_Forest
  FROM   forest_area fa
         INNER JOIN land_area la
           ON fa.country_code = la.country_code
              AND fa.year = la.year
         INNER JOIN regions r
           ON la.country_code = r.country_code
  GROUP  BY fa.country_code,
            fa.country_name,
            fa.year,
            fa.forest_area_sqkm,
            la.total_area_sq_mi,
            r.region,
            r.income_group;
```

a. What was the percent forest of the entire world in 2016? Which region had the HIGHEST percent forest in 2016, and which had the LOWEST, to 2 decimal places?

```sql
/*Query gives the Percent Forest of the entire world in 2016*/
SELECT forest_country_name,
       forest_year,
       Round(Cast(percent_as_forest AS NUMERIC), 2) AS Percent_As_Fo
rest
FROM   forestation
WHERE  forest_country_name = 'World'
       AND forest_year = 2016;

/*Query gives the Region with Highest % Forest in 2016*/
SELECT   r_region,
         forest_year,
         Round(Cast((( Sum(forest_area_sq_km) / Sum(land_total_area_
sq_mi * 2.59)) * 100)AS NUMERIC),2) AS percent_as_forest
FROM     forestation
WHERE    forest_year = 2016
GROUP BY 1,
         2
ORDER BY 3 DESC limit 1;

/*Query gives the Region with Lowest % Forest in 2016*/
SELECT   r_region,
         forest_year,
         Round(Cast((( Sum(forest_area_sq_km) / Sum(land_total_area_
sq_mi * 2.59)) * 100)AS NUMERIC),2) AS percent_as_forest
FROM     forestation
WHERE    forest_year = 2016
GROUP BY 1,
         2
ORDER BY 3 limit 1;

/*forest area*/
SELECT forest_country_name,
       land_total_area_sq_mi * 2.59 AS land_area_sq_km
FROM   forestation
WHERE  forest_year = '2016'
       AND land_total_area_sq_mi IS NOT NULL
ORDER  BY 2 DESC;
```

b. What was the percent forest of the entire world in 1990? Which region had the HIGHEST percent forest in 1990, and which had the LOWEST, to 2 decimal places?

```sql
/*Query gives the Percent Forest of the entire world in 1990*/
SELECT forest_country_name,
       forest_year,
       Round(Cast(percent_as_forest AS NUMERIC), 2) AS Percent_As_Fore
st
FROM   forestation
WHERE  forest_country_name = 'World'
       AND forest_year = 1990;
```

```
/*Query gives the Region with Highest % Forest in 1990*/
SELECT   r_region,
         forest_year,
         Round(Cast(((  Sum(forest_area_sq_km)  /  Sum(land_total_area_sq
_mi  *  2.59))  *  100)AS  NUMERIC),2)  AS  percent_as_forest
FROM     forestation
WHERE    forest_year = 1990
GROUP BY 1,
         2
ORDER BY 3 DESC limit 1;

/*Query gives the Region with Lowest % Forest in 1990*/
SELECT   r_region,
         forest_year,
         Round(Cast(((  Sum(forest_area_sq_km)  /  Sum(land_total_area_sq
_mi  *  2.59))  *  100)AS  NUMERIC),2)  AS  percent_as_forest
FROM     forestation
WHERE    forest_year = 1990
GROUP BY 1,
         2
ORDER BY 3 limit 1;
```

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

Table 2.1: Percent Forest Area by Region, 1990 & 2016:

```
/*Query gives the Region with % Forest in 1990*/
SELECT r_region,
       forest_year,
       Round(Cast(( ( Sum(forest_area_sq_km) / Sum(land_total_area_sq_
mi * 2.59)
                    ) *
                    100 )AS
                        NUMERIC), 2) AS percent_as_forest
FROM   forestation
WHERE  forest_year = 1990
GROUP  BY 1,
          2
ORDER  BY 3 DESC;

/*Query gives the Region with % Forest in 2016*/
SELECT r_region,
       forest_year,
       Round(Cast(( ( Sum(forest_area_sq_km) / Sum(land_total_area_sq_
mi * 2.59)
                    ) *
                    100 )AS
```

```
                        NUMERIC), 2) AS percent_as_forest
FROM   forestation
WHERE  forest_year = 2016
GROUP  BY 1,
          2
ORDER  BY 3 DESC;
```

3. Country-Level Detail

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?

```
/*Top Amount Decrease in Forest Area by Country, 1990 & 2016*/
WITH tb1
     AS (SELECT forest_country_name    AS country,
                r_region,
                Sum(forest_area_sq_km) AS Forest_Area_2016
         FROM   forestation
         WHERE  forest_year = '2016'
                AND forest_area_sq_km IS NOT NULL
         GROUP  BY 1,
                   2),
     tb2
     AS (SELECT forest_country_name    AS country2,
                r_region               AS region,
                Sum(forest_area_sq_km) AS Forest_Area_1990
         FROM   forestation
         WHERE  forest_year = '1990'
                AND forest_area_sq_km IS NOT NULL
         GROUP  BY 1,
                   2)
SELECT country,
       r_region,
       ( tb1.forest_area_2016 - tb2.forest_area_1990 ) AS ABS_FOREST_A
REA_CHG
FROM   tb1
       INNER JOIN tb2
         ON tb1.country = tb2.country2
            AND tb1.r_region = tb2.region
ORDER  BY abs_forest_area_chg;

/*Top Amount Increase in Forest Area by Country, 1990 & 2016*/
WITH tb1
     AS (SELECT forest_country_name    AS country,
                r_region,
                Sum(forest_area_sq_km) AS Forest_Area_2016
         FROM   forestation
         WHERE  forest_year = '2016'
                AND forest_area_sq_km IS NOT NULL
         GROUP  BY 1,
                   2),
     tb2
     AS (SELECT forest_country_name    AS country2,
                r_region               AS region,
                Sum(forest_area_sq_km) AS Forest_Area_1990
         FROM   forestation
         WHERE  forest_year = '1990'
                AND forest_area_sq_km IS NOT NULL
         GROUP  BY 1,
```

```
                  2)
SELECT country,
       r_region,
       ( tb1.forest_area_2016 - tb2.forest_area_1990 ) AS ABS_FOREST_A
REA_CHG
FROM   tb1
       INNER JOIN tb2
         ON tb1.country = tb2.country2
            AND tb1.r_region = tb2.region
ORDER  BY abs_forest_area_chg DESC;

/*Countries with largest percent increase in forest area from 1990 - 2
016*/
WITH tb1 AS
(
         SELECT   forest_country_name AS country,
                  r_region,
                  Sum(forest_area_sq_km) AS forest_area_2016
         FROM     forestation
         WHERE    forest_year = '2016'
         AND      forest_area_sq_km IS NOT NULL
         GROUP BY 1,
                  2), tb2 AS
(
         SELECT   forest_country_name    AS country2,
                  r_region               AS region,
                  Sum(forest_area_sq_km) AS forest_area_1990
         FROM     forestation
         WHERE    forest_year = '1990'
         AND      forest_area_sq_km IS NOT NULL
         GROUP BY 1,
                  2)
SELECT   country,
         r_region,
         tb2.forest_area_1990,
         forest_area_2016,
         Round( Cast((((tb1.forest_area_2016 - tb2.forest_area_1990)/t
b2.forest_area_1990)*100) AS NUMERIC),2) AS percentage_forest_change
FROM     tb1
INNER JOIN     tb2
ON       tb1.country = tb2.country2
AND      tb1.r_region = tb2.region
ORDER BY percentage_forest_change 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?

```
  /*Countries with largest percent decrease in forest area from 1990 -
   2016*/
  WITH tb1 AS
  (
```

```
          SELECT    forest_country_name AS country,
                    r_region,
                    Sum(forest_area_sq_km) AS forest_area_2016
          FROM      forestation
          WHERE     forest_year = '2016'
          AND       forest_area_sq_km IS NOT NULL
          GROUP BY 1,
                    2), tb2 AS
(
          SELECT    forest_country_name    AS country2,
                    r_region               AS region,
                    Sum(forest_area_sq_km) AS forest_area_1990
          FROM      forestation
          WHERE     forest_year = '1990'
          AND       forest_area_sq_km IS NOT NULL
          GROUP BY 1,
                    2)
SELECT    country,
          r_region,
          tb2.forest_area_1990,
          forest_area_2016,
          Round( Cast((((tb1.forest_area_2016 - tb2.forest_area_1990)
/tb2.forest_area_1990)*100) AS NUMERIC),2) AS percentage_forest_chan
ge
FROM      tb1
INNER JOIN     tb2
ON        tb1.country = tb2.country2
AND       tb1.r_region = tb2.region
ORDER BY percentage_forest_change limit 5;
```

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

```
/*PERCENT FORESTATION GROUPED IN QUARTILES FOR 2016*/
WITH tb1
     AS (SELECT forest_country_name,
                r_region,
                forest_year,
                ( ( Sum(forest_area_sq_km) / Sum(land_total_area_sq_
mi * 2.59) )
                  *
                  100 )
                   AS
                PERCENT_FORESTATION
          FROM   forestation
          WHERE  forest_year = '2016'
                 AND forest_country_name != 'World'
          GROUP  BY 1,
                    2,
                    3)
SELECT quartiles,
```

```
        Count(quart)
  FROM   (SELECT forest_country_name,
                 r_region,
                 forest_year,
                 percent_forestation,
                 CASE
                   WHEN percent_forestation >= 75 THEN 4
                   WHEN percent_forestation < 75
                        AND percent_forestation >= 50 THEN 3
                   WHEN percent_forestation < 50
                        AND percent_forestation >= 25 THEN 2
                   ELSE 1
                 END AS QUARTILES
          FROM   tb1
          WHERE  percent_forestation IS NOT NULL) AS QUART
  GROUP  BY 1
  ORDER  BY 1 DESC;
```

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

```
/*PERCENT FORESTATION GROUPED IN QUARTILES FOR 2016*/
WITH tb1
     AS (SELECT forest_country_name,
                r_region,
                forest_year,
                ( ( Sum(forest_area_sq_km) / Sum(land_total_area_sq_mi
 * 2.59) )
                  *
                  100 )
                   AS
                PERCENT_FORESTATION
         FROM   forestation
         WHERE  forest_year = '2016'
                AND forest_country_name != 'World'
         GROUP  BY 1,
                   2,
                   3)
SELECT forest_country_name,
       r_region,
       forest_year,
       Round(Cast(percent_forestation AS NUMERIC), 2) AS PERCENT_FORES
TATION,
       CASE
         WHEN percent_forestation >= 75 THEN 4
         WHEN percent_forestation < 75
              AND percent_forestation >= 50 THEN 3
         WHEN percent_forestation < 50
              AND percent_forestation >= 25 THEN 2
         ELSE 1
       END                                              AS QUARTILES
```

```
FROM   tb1
WHERE  percent_forestation IS NOT NULL
       AND percent_forestation >= 75
ORDER  BY 4 DESC;
```

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

```
/*% forestation higher than the United States in 2016*/
SELECT Count(percent_as_forest)
FROM   forestation
WHERE  forest_year = '2016'
       AND percent_as_forest > (SELECT percent_as_forest
                                FROM   forestation
                                WHERE  forest_country_name = 'United S
tates'
                                       AND forest_year = '2016')
```