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 sq km in 1990. As of 2016, the most recent year for which data was available, that number had fallen to 39958245.9 sq km, a loss of 1324449 sq km, or 3.21%.

The forest area lost over this time period is slightly more than the entire land area of Peru(PER) listed for the year 2016 (which is 1279999.99 sq km).

2. **REGIONAL OUTLOOK**

In 2016, the percent of the total land area of the world designated as forest was 31.34%. The region with the highest relative forestation was East Asia & Pacific
, with 50.09%, and the region with the lowest relative forestation was Middle East & North Africa, with 3.19% forestation.

In 1990, the percent of the total land area of the world designated as forest was 32.21%. 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.

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	37.27%	38.06%
North America	35.65%	36.03%
Sub-Saharan Africa	32.19%	27.56%
East Asia & Pacific	25.77%	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 (32.19% to 27.56%). 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 US, 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
Indonesia	East Asia & Pacific	282193.98
Myanmar	East Asia & Pacific	107234.004
Nigeria	Sub-Saharan Africa	106506.00098
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	-75.44
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
4	9
3	38
2	73
1	85

The largest number of countries in 2016 were found in the 1 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

Based on the detailed analysis from the World Bank data, here is our data-driven recommendations and conclusions to improve forestation:

- From 1990 until 2016, we've seen the percentage of forest designated area in the entire world to have been reduced by 3.20% which seems small but this reduction is more than the entire Land area of a country like Peru
- Sub Saharan Africa, and Latin America and Caribbean are the three regions where our most focus should be on as these regions primarily contributed maximum towards reduction in designated forest area.
- Brazil which houses the biggest forest in the world which is the amazon forest needs to immediately take measures towards forestation and avoid forest fires as it lost 541510 sq. km in forest area.
- In Sub-Saharan African region, country-wise Nigeria was severely deforested losing 106506 sq km of forest land between 1990 and 2016. The Sub-Saharan African region in total lost 3.98% of its forest area and four of it's countries were resent in the top 5 country list in Percentage decrease in forest area. These countries were Togo, Uganda, Nigeria and Mauritania.
- East Asia and Pacific region are doing well on the subject as they show an increase in forest area by 2.71% in the period of 27 years(1990 to 2016). Although the overall is high as the countries with larger area are doing well, concentration needs to be focused towards Indonesia and Myanmar as they're ranked in the top 3 respectively in "Absolute Forest Area Change" list. Although very little can be done by the respective governments, as these countries are known for facing regular climate disasters which could be one of the reasons for the country's deforestation.
- China, India and the USA are leading by example when it comes to afforestation as they've performed extremely well in increasing the forest area. China being at the forefront amongst the three increasing it's forest area by 527229 sq km. The three countries can provide recommendations and guideline tool-kit to countries struggling with the crisis of deforestation.
- Our approach should also we focused on countries lying in 4th quartile of the ratio of forest to land area shown in 'Top quartiles countries' list such as Suriname and Micronesia Fed. Sts.

5. APPENDIX

Question list gathered from Udacity(https://classroom.udacity.com/paid-courses/cd12071/lessons/16cde215-7e51-44d5-9521-7b4d625467ee/concepts/c86eda9e-5acd-4638-8cd5-08bd28d78ee7) and the queries developed and executed to get the required answers:

```
-- checking for exiting view and dropping it for ease and repeated usage

DROP VIEW IF EXISTS forestation;

-- Creating view called 'forestation'

CREATE VIEW forestation AS

SELECT f.country_code AS country_code,

    f.country_name AS country_name,

    f.year,

    f.forest_area_sqkm AS forest_area_sq_km,

    l.total_area_sq_mi*2.59 AS land_area_sq_km,

    r.region,

    r.income_group,

    (f.forest_area_sqkm*100)/(l.total_area_sq_mi*2.59) AS per_forest_area_sqkm

FROM forest_area f

JOIN land_area l ON f.country_code = l.country_code

AND f.year = l.year

JOIN regions r ON r.country_code = f.country_code;


-----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 SUM(forest_table.forest_area_sq_km)
FROM forestation forest_table
WHERE forest_table.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 SUM(forest_table.forest_area_sq_km)
FROM forestation forest_table
WHERE forest_table.year = 2016;

/*c) What was the change (in sq km) in the forest area of the world from 1990 to
2016?*/
SELECT MIN(
        (SELECT SUM(forest_area_sq_km)
         FROM forestation
         WHERE YEAR = 1990) -
        (SELECT SUM(forest_area_sq_km)
         FROM forestation
         WHERE YEAR = 2016)) AS per_of_change_in_area
FROM forestation;

/*d) What was the percent change in forest area of the world between 1990 and 2016?*/
```

```
WITH forest_area_1990 AS
  (SELECT SUM(forest_table.forest_area_sq_km)
   FROM forestation forest_table
   WHERE forest_table.year = 1990),
                                          change_in_forest_area AS
  (SELECT MIN(
              (SELECT SUM(forest_area_sq_km)
               FROM forestation
               WHERE YEAR = 1990) -
              (SELECT SUM(forest_area_sq_km)
               FROM forestation
               WHERE YEAR = 2016)) AS per_of_change_in_area
   FROM forestation)
SELECT MIN(
           (SELECT *
            FROM change_in_forest_area)*100/
           (SELECT *
            FROM forest_area_1990)) AS per_of_change_in_area
FROM forestation;


/*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?*/
WITH change_in_forest_area AS
```

```
 (SELECT MIN(
            (SELECT SUM(forest_area_sq_km)
             FROM forestation
             WHERE YEAR = 1990) -
            (SELECT SUM(forest_area_sq_km)
             FROM forestation
             WHERE YEAR = 2016)) AS per_of_change_in_area
  FROM forestation)
SELECT *
FROM forestation f
WHERE YEAR = 2016
ORDER BY ABS(f.land_area_sq_km -
            (SELECT *
             FROM change_in_forest_area))
LIMIT 1;
------ 2) REGIONAL OUTLOOK----------
/*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?*/
SELECT SUM(forest_area_sq_km*100)/(SUM(land_area_sq_km)) AS percent_of_forest
FROM forestation f
WHERE YEAR = 2016;
```

```
SELECT region,
       AVG(per_forest_area_sqkm) AS forest_area
FROM forestation
WHERE YEAR = 2016
  AND per_forest_area_sqkm IS NOT NULL
GROUP BY 1
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?
 */


SELECT round((SUM(forest_area_sq_km*100)/(SUM(land_area_sq_km)))::numeric, 2) AS
percent_of_forest

--IMP : Round() takes only numeric input expression, double precision NOT allowed, There's no
implicit cast from double precision to numeric, so you'll have to use an explicit cast as above

--SUM(forest_area_sq_km*100)/(SUM(land_area_sq_km)) AS percent_of_forest

--ROUND(SUM(forest_area_sq_km*100)/(SUM(land_area_sq_km))::numeric, 2)AS
percent_of_forest


-- SUM(forest_area_sq_km*100)/(SUM(land_area_sq_km))
```

```
-- AS percent_of_forest
FROM forestation f
WHERE YEAR = 1990;

/*c) Based on the table you created, which regions of the world DECREASED in forest
area from 1990 to 2016?*/
SELECT region,
       (SUM(forest_area_sq_km)*100)/(SUM(land_area_sq_km)) AS percent_of_forest
FROM forestation f
WHERE YEAR = 2016
  AND per_forest_area_sqkm IS NOT NULL
GROUP BY 1
ORDER BY 2 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?*/
WITH forest_1990 AS
  (SELECT country_code,
          YEAR,
          country_name,
```

```
        forest_area_sq_km
   FROM forestation
   WHERE YEAR = 1990),
    forest_2016 AS
  (SELECT country_code,
        YEAR,
        country_name,
        forest_area_sq_km
   FROM forestation
   WHERE YEAR = 2016)
SELECT f16.country_code,
       f16.country_name,
       f90.year AS year_1990,
       f16.year AS year_2016,
       f90.forest_area_sq_km AS forest_1990,
       f16.forest_area_sq_km AS forest_2016,
       (f16.forest_area_sq_km - f90.forest_area_sq_km) AS change_in_forest_area,
        (f16.forest_area_sq_km - f90.forest_area_sq_km)*100/f90.forest_area_sq_km AS
per_change_in_forest_area
FROM forest_1990 f90
JOIN forest_2016 f16 ON f90.country_code = f16.country_code
AND f90.country_name = f16.country_name
WHERE (f90.forest_area_sq_km IS NOT NULL)
  AND (f16.forest_area_sq_km IS NOT NULL)
```

```
  AND (f16.country_name != 'World')
ORDER BY 8 DESC;


/*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 forest_1990 AS
  (SELECT country_code,
          YEAR,
          country_name,
          forest_area_sq_km
   FROM forestation
   WHERE YEAR = 1990),
   forest_2016 AS
  (SELECT country_code,
          YEAR,
          country_name,
          forest_area_sq_km
   FROM forestation
   WHERE YEAR = 2016)
SELECT f16.country_code,
       f16.country_name,
       f90.year AS year_1990,
```

```
	f16.year AS year_2016,
	f90.forest_area_sq_km AS forest_1990,
	f16.forest_area_sq_km AS forest_2016,
	(f16.forest_area_sq_km - f90.forest_area_sq_km) AS change_in_forest_area,
	(f16.forest_area_sq_km - f90.forest_area_sq_km)*100/(f90.forest_area_sq_km) AS
per_change_in_forest_area_sqkm
FROM forest_1990 f90
JOIN forest_2016 f16 ON f90.country_code = f16.country_code
AND f90.country_name = f16.country_name
WHERE (f90.forest_area_sq_km IS NOT NULL)
  AND (f16.forest_area_sq_km IS NOT NULL)
  AND (f16.country_name != 'World')
ORDER BY 8
LIMIT 5;


/*c. If countries were grouped by percent forestation in quartiles, which group had
the most countries in it in 2016?*/
SELECT DISTINCT(quartiles),
	COUNT(country_name) OVER (PARTITION BY quartiles)
FROM
  (SELECT country_name,
	  CASE
		WHEN per_forest_area_sqkm <= 25 THEN 1
		WHEN per_forest_area_sqkm > 25
```

```
            AND per_forest_area_sqkm <= 50 THEN 2
        WHEN per_forest_area_sqkm > 50
            AND per_forest_area_sqkm <= 75 THEN 3
        ELSE 4
      END AS quartiles
  FROM forestation
  WHERE YEAR = 2016
    AND (per_forest_area_sqkm IS NOT NULL)) t1
ORDER BY 2;


/*d) List all of the countries that were in the 4th quartile (percent forest > 75%)
in 2016.*/
SELECT country_name,
       per_forest_area_sqkm,
       region
FROM forestation
WHERE YEAR = 2016
  AND (per_forest_area_sqkm IS NOT NULL)
  AND (per_forest_area_sqkm > 75)
ORDER BY 2 DESC;


SELECT country_name
FROM forest_area
```