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 41282694.9km² in 1990. As of 2016, the most recent year for which data was available, that number had fallen to 39958245.9km², a loss of 1324449km², or 3.20%.

The forest area lost over this time period is slightly more than the entire land area of Australia listed for the year 2016 (which is 1250590km²).

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 Latin America & Caribbean, with 46.16%, and the region with the lowest relative forestation was Middle East & North Africa, with 2.06% 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 51.02%, and the region with the lowest relative forestation was Middle East & North Africa, with 1.77% forestation.

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

Region	1990 Forest Percentage	2016 Forest Percentage

Latin America & Caribbean	51.02	46.16
Europe & Central Asia	37.28	38.04
North America	35.65	36.03
World	32.42	31.37
Sub-Saharan Africa	30.67	28.78
East Asia & Pacific	25.77	26.35
South Asia	16.51	17.50
Middle East & North Africa	1.77	2.06

The only regions of the world that decreased in percent forest area from 1990 to 2016 were Latin America & Caribbean (dropped from 51.02 % to 46.16%) and Sub-Saharan Africa (30.67% to 28.78%). 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 31.37%.

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 527229.06km². 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 79200km², 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	-282193.9844
Myanmar	East Asia & Pacific	-107234.0039
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	-61.7999309388418
Nigeria	Sub-Saharan Africa	-59.1286034729531
Uganda	Sub-Saharan Africa	-46.7469879518072
Mauritania	Sub-Saharan Africa	-45.0344149459194
Honduras	Latin America & Caribbean	-43.4507320933914

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 (<=25%)	85
2 (<=50%)	73
3 (<=75%)	38
4 (25% >)	9

The largest number of countries in 2016 were found in the 1'st (<=25%) 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
American Samoa	East Asia & Pacific	87.50
Micronesia, Fed. Sts.	East Asia & Pacific	91.85
Gabon	Sub-Saharan Africa	90.03

5. 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?*

The total forest area of the world reduced by 3.20% from 1990 to 2016. Areas such as Latin America & Caribbean had the highest relative forestation in 2016 with 46.16% Forestation, down from its highest relative forestation in 1990 51.02%. Though this doesn't seem substantial with a 4.86% disparity between the 26-year gap, the impact of the Latin America & Caribbean

regional forestation deficit is substantial enough to be a primary factor in the 2016 forest area of the world's reduction, from 1990. Although the region of Latin America & Caribbean plays an important role in these figures, it is important to focus on countries that had the most notable decrease in forest area between 1990 and 2016, including Togo, Nigeria, Uganda, Mauritania and Honduras. Four of these 5 countries are situated in the Sub-Saharan Africa and one (Honduras) resides within the Latin America & Caribbean region.

In light of this, a primary focus should be placed on the region in which the courtiers noted for forestation decay reside, the Sub-Saharan Africa region. In addition to this, the country of Honduras which is situated in the Latin America & Caribbean region should be of interest, resultant to this country having one of the top 5 notable decreases in forestation between 1990 and 2016 in a region that has maintained its position of having the highest relative forestation. It would be interesting to see how Honduras has contributed towards its Latin America & Caribbean regional deficit of 4.86% between 1990 and 2016.

APPENDIX: SQL Queries Used

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Deforestation Exploration
Joe Karl Magnussen
Udacity SQL Nanodegree Notes:

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PART 1 - GLOBAL SITUATION
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Temporary Table:

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;

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 *
    FROM forestation
    WHERE country_name = 'World'
    AND year = 1990;

    OUTPUT: 41282694.9

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 *
```

```
    FROM forestation
    WHERE country_name = 'World'
    AND year = 2016;

    OUTPUT: 39958245.9
```

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

```
    SELECT (SELECT forest_area_sq_km
    FROM forestation
    WHERE country_name = 'World'
    AND year = 1990) - (SELECT forest_area_sq_km
    FROM forestation
    WHERE country_name = 'World'
    AND year = 2016) AS difference;

    OUTPUT: 1324449
```

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

```
    SELECT (1-((SELECT forest_area_sq_km
    FROM forestation
    WHERE country_name = 'World'
    AND year = 2016) / (SELECT forest_area_sq_km
    FROM forestation
    WHERE country_name = 'World'
    AND year = 1990)))*100 AS percentage;

    OUTPUT: 3.20824258980245
```

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 * FROM forest_area WHERE forest_area_sqkm <= 1324449 AND year = 2016 ORDER BY
forest_area_sqkm DESC LIMIT 1;

    OUTPUT: 1250590 - Australia

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PART 2 - REGIONAL OUTLOOK
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Answering these questions will help you add information into the template.
Use these questions as guides to write SQL queries.
Use the output from the query to answer these questions.

Create a table that shows the Regions and their percent forest area (sum of forest area divided by sum of
land area) in 1990 and 2016. (Note that 1 sq mi = 2.59 sq km).
Based on the table you created, ...

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

    SELECT (SUM(forest_area_sq_km)/SUM(land_area_sq_km)*100) AS perecent_forest FROM
forestation WHERE year = 2016 ORDER BY perecent_forest DESC LIMIT 1;

    Output:

    perecent_forest
    31.3441787357731

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

Which region had the HIGHEST percent forest in 2016?
```

```
SELECT region, (SUM(forest_area_sq_km)/SUM(land_area_sq_km)*100) AS perecent_forest FROM forestation WHERE year = 2016 GROUP BY region ORDER BY perecent_forest DESC LIMIT 1;

Output:

region                  perecent_forest
Latin America & Caribbean   46.1620721996047
```

and which had the LOWEST?

```
Output:

SELECT region, (SUM(forest_area_sq_km)/SUM(land_area_sq_km)*100) AS perecent_forest FROM forestation WHERE year = 2016 GROUP BY region ORDER BY perecent_forest ASC LIMIT 1;

region                  perecent_forest
Middle East & North Africa  2.06826486871501
```

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?

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

```
SELECT (SUM(forest_area_sq_km)/SUM(land_area_sq_km)*100) AS perecent_forest FROM forestation WHERE year = 1990 ORDER BY perecent_forest DESC LIMIT 1;

Output:

perecent_forest
32.2111306265193
```

Which region had the HIGHEST percent forest in 1990?

SELECT region, (SUM(forest_area_sq_km)/SUM(land_area_sq_km)*100) AS perecent_forest FROM forestation WHERE year = 1990 GROUP BY region ORDER BY perecent_forest DESC LIMIT 1;

Output:

region perecent_forest
Latin America & Caribbean 51.0299798667514

and which had the LOWEST?

SELECT region, (SUM(forest_area_sq_km)/SUM(land_area_sq_km)*100) AS perecent_forest FROM forestation WHERE year = 1990 GROUP BY region ORDER BY perecent_forest ASC LIMIT 1;

region perecent_forest
Middle East & North Africa 1.77524062469353

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)/SUM(land_area_sq_km)*100) AS perecent_forest FROM forestation WHERE year = 2016 GROUP BY region ORDER BY perecent_forest DESC;

AND

SELECT region, (SUM(forest_area_sq_km)/SUM(land_area_sq_km)*100) AS perecent_forest FROM forestation WHERE year = 1990 GROUP BY region ORDER BY perecent_forest DESC;

Output/ Findings:

Latin America and Caribbean (dropped from 51.02% to 46.16%) and Sub-Saharan Africa (30.67% to 28.78%)

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PART 3 - COUNTRY-LEVEL DETAIL
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top % change from 1990 - 2016?


      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
forest_area_disparity, (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 per_change_in_forest_area DESC LIMIT 1;


      Output:
```

```
country_code  country_name  forest_area_disparity       per_change_in_forest_area
ISL           Iceland       343.9999962                 213.664588870028
```

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 forest_area_disparity

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 forest_area_disparity DESC LIMIT 6

Order BY land_area_sq_km and then forest_area_disparity 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 forest_area_disparity, (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 per_change_in_forest_area ASC LIMIT 6;
```

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

```
SELECT DISTINCT(forestation_quartiles),
COUNT(country_name)
OVER (PARTITION BY forestation_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 forestation_quartiles
FROM forestation
WHERE year = 2016
AND (per_forest_area_sqkm IS NOT NULL)) fq
```

Output:

forestation_quartiles	count
1	85
2	73
3	38
4	9

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

```
SELECT region, per_forest_area_sqkm, country_name
FROM forestation WHERE year = 2016
AND (per_forest_area_sqkm > 75);
```

(could add ORDER BY 2 DESC;)