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 41282694.90 sq km in 1990. As of 2016, the most recent year for which data was available, that number had fallen to 39958245.90 sq km, a loss of 1324449.00 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 1279999.99 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
East Asia & Pacific	25.78	26.36

Europe & Central Asia	37.28	38.04
Latin America & Caribbean	51.03	46.16
Middle East & North Africa	1.78	2.07
North America	35.65	36.04
South Asia	16.51	17.51
Sub-Saharan Africa	30.67	28.79
World	32.42	31.38

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 527229.06 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 79200.00 sq km, much lower than the figure for China.

China and the 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: Brazil, Indonesia and Myanmar.

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
Indonesia	East Asia & Pacific	-282193.98
Myanmar	East Asia & Pacific	-107234.00
Nigeria	Sub-Saharan Africa	-106506.00
Tanzania	Sub-Saharan Africa	-102320.00

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
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 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	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 & 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?*

  From 1990 to 2016 the World has lost 3.31% (or 1324449.00 sq km) of it's forest area, despite the increase of forest area in most of the countries and regions. One of the countries with the biggest increase absolute forest area is China (527229.06 sq km) and the USA (79200.00 sq km). However, the largest percent change in forest area happened in Iceland (by 213.66%). We can learn from the success of these countries and apply their experience to the countries of the biggest concern.

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

  We should focus on the countries with the biggest absolute forest area change first, which are: Brazil, Indonesia, Myanmar, Nigeria and Tanzania. They are the biggest game changers for the World forest area and make the most significant impact. On the second place are the countries with the highest percent decrease in forest area – if the current trend doesn't change, they might lose all their forest area, which will make irreversible damage to the World's biome and damage country's ecosystem.

5. APPENDIX: SQL queries used

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
    f.country_name,
    ROUND(f.forest_area_sqkm::NUMERIC, 2) AS forest_area_sqkm,
    f.year
FROM forest_area AS f
WHERE f.country_name = 'World' AND f.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
    f.country_name,
    ROUND(f.forest_area_sqkm::NUMERIC, 2) AS forest_area_sqkm,
    f.year
FROM forest_area AS f
```

```
WHERE f.country_name = 'World' AND f.year = 2016;
```

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

```
SELECT
    country_name,
    ROUND((LEAD(forest_area_sqkm) OVER (ORDER BY forest_area_sqkm) -
forest_area_sqkm)::NUMERIC, 2) AS forest_area_loss_sqkm
FROM (SELECT
        country_name,
        forest_area_sqkm
    FROM forest_area
    WHERE country_name = 'World' AND year = 2016 OR country_name = 'World' AND
year = 1990
) sub LIMIT 1;
```

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

```
SELECT
    country_name,
    ROUND(((LAG(forest_area_sqkm) OVER (ORDER BY forest_area_sqkm) -
forest_area_sqkm)/forest_area_sqkm*100)::NUMERIC, 2) AS forest_area_loss_percent
FROM (SELECT
        country_name,
        forest_area_sqkm
    FROM forest_area
    WHERE country_name = 'World' AND year = 2016 OR country_name = 'World' AND
year = 1990
) sub
ORDER BY 2 ASC LIMIT 1
```

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
    country_name,
    ROUND((total_area_sq_mi * 2.59)::NUMERIC, 2) as total_area_sq_km
FROM land_area
WHERE total_area_sq_mi * 2.59 <= (
  SELECT LEAD(forest_area_sqkm) OVER (ORDER BY forest_area_sqkm) -
forest_area_sqkm AS forest_area_loss_sqkm
  FROM (SELECT
          country_name, year,
          forest_area_sqkm
```

```
        FROM forest_area
        WHERE country_name = 'World' AND year = 2016 OR country_name = 'World'
AND year = 1990
  ) sub LIMIT 1)
ORDER BY 2 DESC LIMIT 1;
```

2. REGIONAL OUTLOOK

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).

```
CREATE VIEW forestation AS
SELECT
    r.region,
    f.year,
    SUM(f.forest_area_sqkm) AS forest_area_sqkm,
    (SUM(f.forest_area_sqkm)/(SUM(l.total_area_sq_mi)*2.59)*100) AS percent
FROM regions AS r
JOIN forest_area AS f
ON r.country_code = f.country_code
JOIN land_area AS l
ON r.country_code = l.country_code
WHERE f.year = 2016 AND l.year = 2016 OR f.year = 1990 AND l.year = 1990
GROUP BY 1, 2
```

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
    region,
    year,
    ROUND(percent::NUMERIC, 2) AS forest_area_percent
FROM forestation
WHERE year = 2016 OR year =  1990;

SELECT
    region,
    year,
    ROUND(percent::NUMERIC, 2) AS forest_area_percent
FROM forestation
WHERE year = 2016 AND region = 'World';

SELECT
    region,
    year,
```

```
    ROUND((LEAD(percent) OVER (ORDER BY percent) - percent)::NUMERIC, 2) AS
forestation_change
FROM forestation
WHERE region = 'World';

SELECT
    region,
    year,
    ROUND(MAX(percent)::NUMERIC, 2) AS highest_forestation
FROM forestation
WHERE year = 2016
GROUP BY 1, 2
ORDER BY 3 DESC LIMIT 1;

SELECT
    region,
    year,
    ROUND(MIN(percent)::NUMERIC) AS lowest_forestation
FROM forestation
WHERE year = 2016
GROUP BY 1, 2
ORDER BY 3 LIMIT 1;
```

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
    region,
    year,
    ROUND(percent::NUMERIC, 2) AS forestation
FROM forestation
WHERE year = 1990 AND region = 'World';

SELECT
    region,
    year,
    ROUND(MAX(percent)::NUMERIC, 2) AS highest_forestation
FROM forestation
WHERE year = 1990
GROUP BY 1,2
ORDER BY 3 DESC LIMIT 1;

SELECT
    region,
```

```
    year,
    ROUND(MIN(percent)::NUMERIC, 2) AS lowest_forestation
FROM forestation
WHERE 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?

```
SELECT
    region,
    year,
    percent,
    (SELECT ROUND((LEAD(percent) OVER (ORDER BY percent) -
percent)::NUMERIC, 2) AS forestation_change
  FROM forestation
  WHERE region = f.region
  LIMIT 1
)
FROM forestation AS f
WHERE (
  SELECT
      ROUND((LEAD(percent) OVER (ORDER BY percent) - percent)::NUMERIC, 2) AS
forestation_change
  FROM forestation
  WHERE region = f.region
        LIMIT 1
) > 0 AND year = 2016;

SELECT
    region,
    year,
    percentage,
    (SELECT ROUND((LEAD(percentage) OVER (ORDER BY year) -
percentage)::NUMERIC, 2) AS forestation_change
    FROM forestation
    WHERE region = f.region
    LIMIT 1
)
FROM forestation AS f
ORDER BY 1, 2;
```

3. COUNTRY-LEVEL DETAIL

```
CREATE VIEW country_forestation AS
SELECT
    f.country_name,
    f.country_code,
    r.region, f.year,
    f.forest_area_sqkm,
    ((f.forest_area_sqkm/(l.total_area_sq_mi*2.59))*100) AS forestation_percent
FROM forest_area AS f
JOIN land_area AS l
ON f.country_code = l.country_code
LEFT JOIN regions AS r
ON r.country_code = l.country_code
WHERE f.year = 2016 AND l.year = 2016 OR f.year = 1990 AND l.year = 1990

WITH forestation_2016 AS (
  SELECT
      country_name,
      country_code,
      region,
      year,
      ROUND(forest_area_sqkm::NUMERIC, 2) AS forest_area_sqkm,
      ROUND(forestation_percent::NUMERIC, 2) AS forestation_percent
  FROM country_forestation
  WHERE year = 2016
), forestation_1990 AS (
  SELECT
      country_name,
      country_code,
      region, year,
      ROUND(forest_area_sqkm::NUMERIC, 2) AS forest_area_sqkm,
      ROUND(forestation_percent::NUMERIC, 2) AS forestation_percent
  FROM country_forestation
  WHERE year = 1990
)
```

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?

```
SELECT
    forestation_2016.country_name,
    forestation_2016.region,
    forestation_2016.forest_area_sqkm - forestation_1990.forest_area_sqkm AS
forest_area_change_sqkm
```

```
FROM forestation_2016
JOIN forestation_1990
ON forestation_2016.country_code = forestation_1990.country_code
WHERE forestation_2016.country_code != 'WLD'
ORDER BY 3 ASC 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?

```
SELECT
    forestation_2016.country_name,
    forestation_2016.region,
    ROUND((forestation_2016.forest_area_sqkm -
forestation_1990.forest_area_sqkm)/forestation_1990.forest_area_sqkm*100::NUMERI
C, 2) AS forest_area_change_percent
FROM forestation_2016
JOIN forestation_1990
ON forestation_2016.country_code = forestation_1990.country_code
WHERE forestation_2016.country_name != 'WLD'
ORDER BY 3 ASC LIMIT 5
```

c. Which 5 countries saw the largest amount increase in forest area from 1990 to 2016? What was the difference in forest area for each?

```
SELECT
    forestation_2016.country_name,
    forestation_2016.region,
    forestation_2016.forest_area_sqkm - forestation_1990.forest_area_sqkm AS
forest_area_change_sqkm
FROM forestation_2016
JOIN forestation_1990
ON forestation_2016.country_code = forestation_1990.country_code
WHERE forestation_2016.country_code != 'WLD' AND
forestation_1990.forest_area_sqkm IS NOT NULL
AND forestation_2016.forest_area_sqkm IS NOT NULL
ORDER BY 3 DESC LIMIT 5
```

d. Which 5 countries saw the largest percent increase in forest area from 1990 to 2016? What was the percent change to 2 decimal places for each?

```
SELECT
    forestation_2016.country_name,
    forestation_2016.region,
```

```
    ROUND((forestation_2016.forest_area_sqkm -
forestation_1990.forest_area_sqkm)/forestation_1990.forest_area_sqkm*100::NUMERI
C, 2) AS forest_area_change_percent
FROM forestation_2016
JOIN forestation_1990
ON forestation_2016.country_code = forestation_1990.country_code
WHERE forestation_2016.country_name != 'WLD' AND
forestation_1990.forest_area_sqkm IS NOT NULL
AND forestation_2016.forest_area_sqkm IS NOT NULL
ORDER BY 3 DESC LIMIT 5
```

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

```
SELECT
    COUNT(CASE WHEN forestation_percent < 25 THEN 1 ELSE NULL END)
first_quartile,
    COUNT(CASE WHEN forestation_percent >= 25 AND forestation_percent < 50
THEN 2 ELSE NULL END) second_quartile,
    COUNT(CASE WHEN forestation_percent >= 50 AND forestation_percent < 75
THEN 3 ELSE NULL END) third_quartile,
    COUNT(CASE WHEN forestation_percent >= 75 AND forestation_percent <= 100
THEN 4 ELSE NULL END) fourth_quartile
FROM country_forestation
WHERE year = 2016 AND country_name <> 'World'
```

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

```
SELECT
    country_name,
    region,
    ROUND(forestation_percent::NUMERIC, 2) AS forestation_percent
FROM country_forestation
WHERE year = 2016 AND forestation_percent >= 75
ORDER BY 3 DESC
```