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 listed for the year 2016 (which is 1279999.989).

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 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
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 and the Caribbean (dropped from 51.03 % to 46.16%) and Sub-Saharan Africa (30.67 % to 28.79%).

All other regions 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 its 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	541510.00
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 percentage 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
0-25%	85
25-50%	72
50-75%	38
75-100%	9

The largest number of countries in 2016 were found in the 1st (0-25%) 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
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	87.5
Guyana	Latin America & Caribbean	83.9
Lao PDR	East Asia & Pacific	82.11
Solomon Islands	East Asia & Pacific	77.86

There are 94 countries with a percent forestation higher than the United States in 2016.

4. 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?*

As per the World Bank data analysis, there is a constant reduction in the total forest area, which is evident from the decline in forest cover.

While looking at the overall forest numbers, Latin America & Caribbean countries might hold the highest forest percentage in 2016. Still, this region continues to showcase a decline in its total forested area. The Latin America & Caribbean, and Sub-Saharan African regions continue to register a decline in the total forested area. On the contrary, other countries are trying to increase their forest cover, even though the numbers aren't substantial.

Given the high population numbers, China continues to be a top contender, as it creates a niche for itself in this list. The country registered an increase in the forest area over the years. United States is closely falling suit, as both countries work towards improving their forestation scenarios.

While many countries and regions are improving their forestation volumes, many other individual countries are recording high deforestation volumes. Brazil ranks high in terms of absolute forest change, while Togo and Nigeria registered a high percentage of deforestation.

Countries like Togo, Nigeria, and Uganda need to focus on retaining and replenishing their forest cover to avoid further deforestation.

5. APPENDIX: SQL Queries Used

```
-- forestation view

CREATE VIEW forestation AS (
SELECT a.country_code,
a.country_name,
a.year,
a.forest_area_sqkm,
(b.total_area_sq_mi *2.59) AS total_area_sqkm,
c.region,
c.income_group,
round(((a.forest_area_sqkm/(b.total_area_sq_mi *2.59))*100):: numeric,2) AS forest_pct
FROM forest_area AS a
JOIN land_area AS b
ON a.country_code = b.country_code
AND a.year = b.year
JOIN regions AS c
ON a.country_code = c.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_area_sqkm) FROM forestation WHERE year =1990 AND country_name =
'World';
```

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

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

```
WITH cte1 AS (select sum(forest_area_sqkm) AS forest_area_2016 FROM forestation
WHERE year = 2016 AND country_name = 'World'),

cte2 AS (SELECT sum(forest_area_sqkm) AS forest_area_1990 FROM forestation
WHERE year = 1990 AND country_name = 'World')

SELECT round(abs((forest_area_2016-forest_area_1990))::numeric,2) FROM cte1, cte2;
```

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

```
WITH cte1 AS (select sum(forest_area_sqkm) AS forest_pct_2016 FROM
        forestation
                WHERE year = 2016 AND country_name = 'World'),

cte2 AS (SELECT sum(forest_area_sqkm) AS forest_pct_1990 FROM forestation
WHERE year = 1990 AND country_name = 'World')

SELECT abs(round((((forest_pct_2016-forest_pct_1990)/forest_pct_1990)*100)::numeric,2))
FROM cte1, cte2;
```

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 cte AS
(SELECT a.country_name, a.forest_area_sqkm AS forest_area_2016, b.forest_area_1990,
(a.forest_area_sqkm - b.forest_area_1990) AS forest_decrease
FROM forestation AS a
```

```
LEFT JOIN (SELECT country_name, forest_area_sqkm AS forest_area_1990 FROM
forestation
WHERE year = 1990 AND country_name = 'World') AS b

ON a.country_name=b.country_name
WHERE a.year = 2016
AND a.country_name = 'World'),

cte1 AS (SELECT country_name, total_area_sqkm FROM forestation
WHERE year = 2016 AND total_area_sqkm IS NOT NULL)

SELECT country_name, total_area_sqkm
FROM cte1
WHERE total_area_sqkm <= (SELECT abs(forest_decrease) FROM cte)
ORDER BY 2 desc
LIMIT 1;
```

2. REGIONAL OUTLOOK

a. 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 TABLE regions_1990 AS (
SELECT region,
(sum(forest_area_sqkm)/sum(total_area_sqkm))*100 AS forest_pct_1990
FROM forestation
WHERE year = 1990
GROUP BY 1);

CREATE TABLE regions_2016 AS (
SELECT region,
(sum(forest_area_sqkm)/sum(total_area_sqkm))*100 AS forest_pct_2016
FROM forestation
WHERE year = 2016
GROUP BY 1);

CREATE TABLE regions_new AS (
SELECT a.region,
a.forest_pct_2016,
b.forest_pct_1990
FROM regions_2016 AS a
LEFT JOIN regions_1990 AS b
ON a.region = b.region);
```

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

```
SELECT region, round(forest_pct_2016::numeric, 2) AS forest_pct_2016 FROM regions_new
WHERE region = 'World';

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

--highest

SELECT region, round(max(forest_pct_2016)::numeric, 2) AS max_forest_pct
FROM regions_new
GROUP BY 1
ORDER BY max_forest_pct desc
LIMIT 1;

--lowest

SELECT region, round(min(forest_pct_2016)::numeric, 2) AS min_forest_pct
FROM regions_new
GROUP BY 1
ORDER BY min_forest_pct
LIMIT 1;
```

c. 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?

```
--percent forest of the entire world

SELECT region, round((forest_pct_1990)::numeric, 2) AS world_forest_pct
FROM regions_new
WHERE region = 'World';

--highest

SELECT region, round(max(forest_pct_1990)::numeric, 2) AS max_forest_pct
FROM regions_new
GROUP BY 1
ORDER BY max_forest_pct desc
LIMIT 1;

--lowest

SELECT region, round(min(forest_pct_1990)::numeric, 2) AS min_forest_pct
```

```
FROM regions_new
GROUP BY 1
ORDER BY min_forest_pct
LIMIT 1;
```

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

```
--tabular data

SELECT region,
round(forest_pct_2016::numeric,2) AS forest_pct_2016,
round(forest_pct_1990::numeric,2) AS forest_pct_1990
FROM regions_new
ORDER BY 1;

-- world changes

SELECT region,
round(forest_pct_2016::numeric,2) AS forest_pct_2016,
round(forest_pct_1990::numeric,2) AS forest_pct_1990
FROM regions_new
WHERE region = 'World';
```

3. COUNTRY-LEVEL DETAIL

A. country - forestation increases

```
-- China
-- US

WITH cte_2016 as (SELECT country_name, region, sum(forest_area_sqkm) AS
forest_area_2016
FROM forestation
WHERE year = 2016
GROUP BY 1,2),

cte_1990 AS (SELECT country_name,region, sum(forest_area_sqkm) as forest_area_1990
FROM forestation
WHERE year = 1990
GROUP BY 1,2)

SELECT * FROM (
SELECT a.country_name, a.region, round((a.forest_area_2016 - b.forest_area_1990)::numeric,
2) AS forest_decrease
```

```
FROM cte_2016 AS a
LEFT JOIN cte_1990 AS b
ON a.country_name = b.country_name) c
WHERE forest_decrease < 0 and country_name <> 'World'
ORDER BY forest_decrease
LIMIT 5;

-- largest percentage change
-- Result: Iceland

WITH cte1 AS
(SELECT country_name, sum(forest_area_sqkm) as forest_area_1990
FROM forestation
WHERE year = 1990
GROUP BY 1),

cte2 AS
(SELECT country_name, sum(forest_area_sqkm) AS forest_area_2016
FROM forestation
WHERE year = 2016
GROUP BY 1)

SELECT * FROM (
SELECT b.country_name, round((((b.forest_area_2016 -
a.forest_area_1990)/a.forest_area_1990)*100)::numeric, 2) AS forest_changes
FROM cte1 AS a
LEFT JOIN cte2 AS b
ON a.country_name = b.country_name) c
WHERE forest_changes > 0
ORDER BY forest_changes desc
LIMIT 1
;
```

3B. Which 5 countries saw the largest amount decrease in forest area from 1990 to 2016? What was the difference in forest area for each?

```
-- first way

-- 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 cte1 AS (
SELECT country_name, region, forest_area_sqkm AS forest_area_1990
FROM forestation
```

```
WHERE year = 1990),

cte2 AS (select country_name, region, forest_area_sqkm AS forest_area_2016
FROM forestation
WHERE year = 2016)

SELECT country_name, region, abs(round(forest_changes::numeric,2)) FROM (
SELECT b.country_name, b.region, b.forest_area_2016-a.forest_area_1990 AS forest_changes
FROM cte1 AS a
LEFT JOIN cte2 AS b
ON a.country_name = b.country_name
WHERE b.country_name <> 'World' ) c
ORDER BY forest_changes
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?

WITH cte1 AS (
SELECT country_name, region, forest_area_sqkm AS forest_area_1990
FROM forestation
WHERE year = 1990),
cte2 AS (SELECT country_name, region, forest_area_sqkm AS forest_area_2016
FROM forestation
WHERE year = 2016)
SELECT country_name, region, round(forest_changes::numeric,2) FROM (
SELECT b.country_name, b.region, (((b.forest_area_2016-
a.forest_area_1990)/a.forest_area_1990)*100) AS forest_changes FROM cte1 AS a
LEFT JOIN cte2 AS b
ON a.country_name = b.country_name
WHERE b.country_name <> 'World' ) c
ORDER BY forest_changes
LIMIT 5;

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

SELECT quartiles, count(country_name) FROM
(SELECT country_name, forest_pct, CASE WHEN forest_pct < 25 THEN 1
 WHEN forest_pct >= 25 and forest_pct < 50 THEN 2
 WHEN forest_pct >= 50 and forest_pct < 75 THEN 3
 ELSE 4
 END AS quartiles
FROM forestation
```

```
WHERE year = 2016
AND region != 'World'
AND forest_pct IS NOT null) a
GROUP BY 1
ORDER BY 2 desc;


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

WITH cte AS (
SELECT country_name, region, forest_pct, CASE WHEN forest_pct < 25 THEN 1
 WHEN forest_pct >= 25 AND forest_pct < 50 THEN 2
 WHEN forest_pct >= 50 AND forest_pct < 75 THEN 3
 ELSE 4
 END AS quartiles
FROM forestation
WHERE year = 2016
AND region != 'World'
AND forest_pct is not null)

SELECT country_name, region, forest_pct
FROM cte
WHERE quartiles = 4
ORDER BY 3 desc;

SELECT country_name, forest_pct FROM forestation
WHERE forest_pct > (
SELECT forest_pct FROM forestation
WHERE country_name = 'United States' AND year = 2016)
AND year = 2016 AND region != 'World' AND forest_pct IS NOT NULL;

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

SELECT count(*) FROM (
SELECT country_name, forest_pct FROM forestation
WHERE forest_pct > (
SELECT forest_pct FROM forestation
WHERE country_name = 'United States' AND year = 2016)
AND year = 2016 AND region != 'World' AND forest_pct IS NOT NULL) AS a;
```