Report for ForestQuery into Global Deforestation, 1990 to 2016

As part of my work at ForestQuery, an organization dedicated to combating deforestation and raising environmental awareness, I obtained World Bank data on forest and land areas by country and year from 1990 to 2016, as well as a table of countries and their respective regions.

Using SQL, I combined and queried these tables to identify areas of concern and opportunities to learn from successful reforestation initiatives.

1. **GLOBAL SITUATION**

According to the World Bank, the total forest area of the world was **41282694.9 km^2** in 1990. As of 2016, the most recent year for which data was available, that number had fallen to **39958245.9 km^2**, a loss of **1324449 km2,** 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 **1279999.9 km^2**).

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 American and Caribbean**, with **46.16 %**, and the region with the lowest relative forestation was **Middle East & North Africa** with **2.07 %** forestation.

In 1990, the percentage of the total land area of the world designated as forest was **32.42 %**. The region with the highest relative forestation was **Latin American and 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
Middle East & North Africa	**1.78**	**2.07**
South Asia	**16.51**	**17.51**
East Asia & Pacific	**25.78**	**26.36**
Sub-Saharan Africa	**30.67**	**28.79**
World	**32.42**	**31.38**
North America	**35.65**	**36.04**
Europe & Central Asia	**37.28**	**38.04**
Latin America & Caribbean	**51.03**	**46.16**

The only regions of the world that decreased in percent forest area from 1990 to 2016 were **Sub-Saharan Africa** (dropped from **30.67 %** to **28.79 %**) and **Latin America & Caribbean** (**51.03 %** to **46.16 %**). 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 km^2** . 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 km^2**, much lower than the figure for **China**.

The United States 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's** 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 American & Caribbean**	**-541510**
Indonesia	**East Asia & Pacific**	**-282193.9844**
Myanmar	**East Asia & Pacific**	**-107234.0039**
Nigeria	**Sub-Saharan Africa**	**-106506.001**
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**	**-59.27**
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%	73
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
American Samoa	East Asia & Pacific	87.50
Gabon	Sub-Saharan Africa	90.04
Guyana	Latin America & Caribbean	83.90
Lao PDR	East Asia & Pacific	82.11
Micronesia, Fed. Sts.	East Asia & Pacific	91.86
Palau	East Asia & Pacific	87.61
Seychelles	Sub-Saharan Africa	88.41
Solomon Islands	East Asia & Pacific	77.86
Suriname	Latin America & Caribbean	98.26

4. RECOMMENDATIONS

According to the data, the world has lost a total of 3.21% in forest area from 1990 to 2016. The areas of the world with the largest decline in forestation are Latin American & Caribbean and the Sub-Saharan Africa regions. This is most concerning as these regions cover a significant land mass relative to world mass.

In contrast, highly industrialized countries such as China and the United States, have seen an increase in their forest areas from 1990 to 2016. Iceland has also seen a significant increase in forest area totaling a 213.66% increase.

However, despite its luxcious Amazon region, Brazil has shown a tremendous decline in the total forest area. Table 3.1 shows also countries following the sharp decline in forestation among them are with the greatest loss Nigeria, Indonesia, and Myanmar. In addition, it was observed that 85 countries fall in the first quartile of forest area (0-25%) while only 9 countries falling under the last quartile.

My recommendation is to focus on countries with the greatest deline in the forest area (table 3.2) in both Latin America & Caribbean and sub-Saharan Africa by examining factors that may contribute to accelerated deforestation such as pollution, mining, or other environmental factors.

5. APPENDIX: SQL Queries Used

```
--
Create
the
VIEW
DROP VIEW IF EXISTS forestation;
CREATE VIEW forestation AS
 SELECT f.country_code country_code,
 f.country_name country_name,
 f.year,
 f.forest_area_sqkm,
 l.total_area_sq_mi*2.59 total_area_sq_km,
 100*f.forest_area_sqkm/(l.total_area_sq_mi*2.59) forestation_percentage,
 r.region,
 r.income_group
 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;
SELECT count(*)
FROM forestation;

-- PART I. GLOBAL SITUATION
-- Difference and percentage drop in forestation area between 1990 and 2016
-- Method 1: Using SELF-JOIN

WITH t1 AS (
 SELECT *
 FROM forestation
 WHERE country_code='WORLD' and year in (1990, 2016)
 ORDER BY year)

SELECT t1_a.forest_area_sqkm forestation_1990,
 t1_b.forest_area_sqkm forestation_2016,
 (t1_b.forest_area_sqkm-t1_a.forest_area_sqkm) AS forest_area_change,
 t1_a.forestation_percentagepct_1990,
 t1_b.forestation_percentagepct_2016,
```

```
ROUND((100*(t1_b.forestation_percentaget1_a.forestation_percentage)/t1_a.forestation_perce
ntage)::NUMERIC, 3) AS
pct_change
FROM t1 t1_a
JOIN t1 t1_b ON t1_a.country_name=t1_b.country_name
WHERE t1_a.year=1990 AND t1_b.year=2016;

-- technique 2: Using window function

WITH t1 AS (
 SELECT *
 FROM forestation
 WHERE country_code='WORLD' and year in (1990, 2016)
 ORDER BY year)

SELECT year,
 forest_area_sqkm,
 LEAD(forest_area_sqkm) OVER (order by year) AS lead,
 LEAD(forest_area_sqkm) OVER (order by year)-forest_area_sqkm AS abs_diff,
 ROUND((100*(LEAD(forest_area_sqkm) OVER (order by year)-
forest_area_sqkm)/forest_area_sqkm)::NUMERIC, 3) AS pct_diff
FROM t1

-- Question: Find the country with its land area in 2016 closest to the
deforestation area between 1990 and 2016

WITH t1 AS (
 SELECT *
 FROM forestation
 WHERE country_code='WORLD' and year in (1990, 2016)
 ORDER BY year),
t2 AS (
 SELECT year,
 forest_area_sqkm,
 LEAD(forest_area_sqkm) OVER (order by year) AS lead,
 LEAD(forest_area_sqkm) OVER (order by year)-forest_area_sqkm AS abs_diff,
 ROUND((100*(LEAD(forest_area_sqkm) OVER (order by year)-
forest_area_sqkm)/forest_area_sqkm)::NUMERIC, 3) AS pct_diff
 FROM t1)

SELECT DISTINCT country_name,
 total_area_sq_km,
```

```
 (SELECT ABS(t2.abs_diff) FROM t2 ORDER BY year LIMIT 1) AS
abs_diff,
 ABS(total_area_sq_km-(SELECT ABS(t2.abs_diff) FROM t2 ORDER BY
year LIMIT 1)) AS diff
FROM forestation
ORDER BY 4

-- Part II. Questions For Regional Outlook
-- Find the world's forestation area percentage in 2016

SELECT country_code,
 country_name,
 year,
 forest_area_sqkm,
 total_area_sq_km,
 ROUND(forestation_percentage::NUMERIC, 2) forestation_percentage
FROM forestation
WHERE year=2016 AND country_code='WORLD';

-- Find the region with the highest forestation percentage in 2016

SELECT year,
 region,
 SUM(forest_area_sqkm) total_forestation,
 SUM(total_area_sq_km) total_land,
 ROUND((100*SUM(forest_area_sqkm)/SUM(total_area_sq_km))::NUMERIC,2)
forestation_pct
FROM forestation
GROUP BY 1,2
HAVING year=2016
ORDER BY forestation_pct DESC
LIMIT 1;

-- Find the region with the lowest forestation percentage in 2016

SELECT year,
 region,
 SUM(forest_area_sqkm) total_forestation,
 SUM(total_area_sq_km) total_land,
 ROUND((100*SUM(forest_area_sqkm)/SUM(total_area_sq_km))::NUMERIC,2)
forestation_pct
FROM forestation
GROUP BY 1,2
```

```
HAVING year=2016
ORDER BY forestation_pct
LIMIT 1;

-- Find the world's forestation area percentage in 1990

SELECT country_code,
 country_name,
 year,
 forest_area_sqkm,
 total_area_sq_km,
 ROUND(forestation_percentage::NUMERIC, 2) forestation_percentage
FROM forestation
WHERE year=1990 AND country_code='WORLD';


-- Find the region with the highest forestation percentage in 1990

SELECT year,
 region,
 SUM(forest_area_sqkm) total_forestation,
 SUM(total_area_sq_km) total_land,
 ROUND((100*SUM(forest_area_sqkm)/SUM(total_area_sq_km))::NUMERIC,2)
forestation_pct
FROM forestation
GROUP BY 1,2
HAVING year=1990
ORDER BY forestation_pct DESC
LIMIT 1;

-- Find the region with the lowest forestation percentage in 1990

SELECT year,
 region,
 SUM(forest_area_sqkm) total_forestation,
 SUM(total_area_sq_km) total_land,
 ROUND((100*SUM(forest_area_sqkm)/SUM(total_area_sq_km))::NUMERIC,2)
forestation_pct
FROM forestation
GROUP BY 1,2
HAVING year=1990
ORDER BY forestation_pct
LIMIT 1;
```

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

DROP VIEW IF EXISTS t1;
CREATE VIEW t1 AS (
SELECT year yr,
 region,
 SUM(forest_area_sqkm) total_forestation,
 SUM(total_area_sq_km) total_land,
 ROUND((100*SUM(forest_area_sqkm)/SUM(total_area_sq_km))::NUMERIC,2)
forestation_pct
FROM forestation
GROUP BY 1,2
HAVING year in (1990, 2016)
ORDER BY region, yr);
WITH tab1 AS (
 SELECT region,
 forestation_pct
 FROM t1
 where yr=1990),

 tab2 AS (
 SELECT region,
 forestation_pct
 FROM t1
 where yr=2016)
SELECT tab1.region,
tab1.forestation_pct AS pct_1990,
tab2.forestation_pct AS pct_2019
FROM tab1
JOIN tab2 ON tab1.region=tab2.region

-- Part III. Country-level Detail
-- A. Success Stories
-- Largest change in terms of forest_area

WITH tab_1990 AS (
 SELECT country_code,
 country_name,
 forest_area_sqkm,
 total_area_sq_km,
 forestation_percentage
 FROM forestation
```

```
 WHERE year=1990
 ORDER BY country_name),
 tab_2016 AS (
 SELECT country_code,
 country_name,
 forest_area_sqkm,
 total_area_sq_km,
 forestation_percentage
 FROM forestation
 WHERE year=2016
 ORDER BY country_name),
 tab_join AS (
 SELECT tab_1990.country_name,
 tab_1990.forest_area_sqkm forest_1990,
 tab_2016.forest_area_sqkm forest_2016,
 tab_1990.total_area_sq_km land_1990,
 tab_2016.total_area_sq_km land_2016,
 tab_1990.forestation_percentagepct_1990,
 tab_2016.forestation_percentagepct_2016
 FROM tab_1990
 JOIN tab_2016 ON tab_1990.country_code=tab_2016.country_code)

SELECT country_name,
 forest_1990,
 forest_2016,
 (forest_2016-forest_1990) AS forest_area_change,
 (100*(pct_2016-pct_1990)/pct_1990) AS pct_change,
 land_1990,
 land_2016
FROM tab_join
WHERE forest_1990 IS NOT NULL AND forest_2016 IS NOT NULL AND
country_name!='World'
ORDER BY forest_area_change DESC

-- Largest change in terms of forest_area percentage

WITH tab_1990 AS (
 SELECT country_code,
 country_name,
 forest_area_sqkm,
 total_area_sq_km,
 forestation_percentage
 FROM forestation
```

```
 WHERE year=1990
 ORDER BY country_name),
 tab_2016 AS (
 SELECT country_code,
 country_name,
 forest_area_sqkm,
 total_area_sq_km,
 forestation_percentage
 FROM forestation
 WHERE year=2016
 ORDER BY country_name),
 tab_join AS (
 SELECT tab_1990.country_name,
 tab_1990.forest_area_sqkm forest_1990,
 tab_2016.forest_area_sqkm forest_2016,
 tab_1990.total_area_sq_km land_1990,
 tab_2016.total_area_sq_km land_2016,
 tab_1990.forestation_percentagepct_1990,
 tab_2016.forestation_percentagepct_2016
 FROM tab_1990
 JOIN tab_2016 ON tab_1990.country_code=tab_2016.country_code)

SELECT country_name,
 forest_1990,
 forest_2016,
 (forest_2016-forest_1990) AS forest_area_change,
 (100*(pct_2016-pct_1990)/pct_1990) AS pct_change,
 land_1990,
 land_2016
FROM tab_join
WHERE forest_1990 IS NOT NULL AND forest_2016 IS NOT NULL AND
country_name!='World'
ORDER BY pct_change DESC

-- B. Largest Concerns
-- Calculate Table 3.1 Top 5 Amount Decrease in Forest Area by Country, 1990 &
2016

WITH tab_1990 AS (
 SELECT country_code,
 country_name,
 region,
 forest_area_sqkm,
```

```
 total_area_sq_km,
 forestation_percentage
 FROM forestation
 WHERE year=1990
 ORDER BY country_name),

tab_2016 AS (
 SELECT country_code,
 country_name,
 region,
 forest_area_sqkm,
 total_area_sq_km,
 forestation_percentage
 FROM forestation
 WHERE year=2016
 ORDER BY country_name),

tab_join AS (
 SELECT tab_1990.country_name,
 tab_1990.region,
 tab_1990.forest_area_sqkm forest_1990,
 tab_2016.forest_area_sqkm forest_2016,
 tab_1990.total_area_sq_km land_1990,
 tab_2016.total_area_sq_km land_2016,
 tab_1990.forestation_percentagepct_1990,
 tab_2016.forestation_percentagepct_2016
 FROM tab_1990
 JOIN tab_2016 ON tab_1990.country_code=tab_2016.country_code)

SELECT country_name,
 region,
 forest_1990,
 forest_2016,
 (forest_2016-forest_1990) AS forest_area_change,
 (100*(pct_2016-pct_1990)/pct_1990) AS pct_change,
 land_1990,
 land_2016
FROM tab_join
WHERE forest_1990 IS NOT NULL AND forest_2016 IS NOT NULL AND
country_name!='World'
ORDER BY forest_area_change

-- Calculate Table 3.2 Top 5 Percent Decrease in Forest Area by Country, 1990 &
```

2016

```
WITH tab_1990 AS (
 SELECT country_code,
 country_name,
 region,
 forest_area_sqkm,
 total_area_sq_km,
 forestation_percentage
 FROM forestation
 WHERE year=1990
 ORDER BY country_name),
 tab_2016 AS (
 SELECT country_code,
 country_name,
 region,
 forest_area_sqkm,
 total_area_sq_km,
 forestation_percentage
 FROM forestation
 WHERE year=2016
 ORDER BY country_name),
 tab_join AS (
 SELECT tab_1990.country_name,
 tab_1990.region,
 tab_1990.forest_area_sqkm forest_1990,
 tab_2016.forest_area_sqkm forest_2016,
 tab_1990.total_area_sq_km land_1990,
 tab_2016.total_area_sq_km land_2016,
 tab_1990.forestation_percentagepct_1990,
 tab_2016.forestation_percentagepct_2016
 FROM tab_1990
 JOIN tab_2016 ON tab_1990.country_code=tab_2016.country_code)

SELECT country_name,
 region,
 forest_1990,
 forest_2016,
 (forest_2016-forest_1990) AS forest_area_change,
 ROUND((100*(pct_2016-pct_1990)/pct_1990)::NUMERIC, 2) AS pct_change,
 land_1990,
 land_2016
FROM tab_join
```

```
WHERE forest_1990 IS NOT NULL AND forest_2016 IS NOT NULL AND
country_name!='World'
ORDER BY pct_change

-- C. Quartiles
-- Calculate Table 3.3 Count of Countries Grouped by Forestation Percent
Quartiles, 2016

WITH tab_quartile AS (
 SELECT country_name,
 forestation_percentage
 FROM forestation
 WHERE year=2016 AND forestation_percentageIS NOT NULL
 ORDER BY 2),
 tab_quartile1 AS (
 SELECT country_name,
 forestation_percentage,
 CASE
 WHEN forestation_percentage<=25 THEN '0 - 25%'
 WHEN forestation_percentage<=50 THEN '25% - 50%'
 WHEN forestation_percentage<=75 THEN '50% - 75%'
 ELSE '75% - 100%'
 END AS quartiles
 FROM tab_quartile)
SELECT quartiles, count(country_name) number_of_countries
FROM tab_quartile1
GROUP BY 1
ORDER BY 1

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

WITH tab_quartile AS (
 SELECT country_name,
 region,
 forestation_percentage
 FROM forestation
 WHERE year=2016 AND forestation_percentageIS NOT NULL
 ORDER BY 2),
 tab_quartile1 AS (
 SELECT country_name,
 region,
 forestation_percentage,
```

```
 CASE
 WHEN forestation_percentage<=25 THEN '0 - 25%'
 WHEN forestation_percentage<=50 THEN '25% - 50%'
 WHEN forestation_percentage<=75 THEN '50% - 75%'
 ELSE '75% - 100%'
 END AS quartiles
 FROM tab_quartile)
SELECT country_name, region, ROUND(forestation_percentage::NUMERIC, 2)
Pct_Designated_as_Forest
FROM tab_quartile1
WHERE quartiles='75% - 100%'
ORDER BY 1

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

WITH tab_quartile AS (
 SELECT country_name,
 region,
 forestation_percentage
 FROM forestation
 WHERE year=2016 AND forestation_percentageIS NOT NULL
 ORDER BY 2),
 tab_quartile1 AS (
 SELECT country_name,
 region,
 forestation_percentage,
 CASE
 WHEN forestation_percentage<=25 THEN '0 - 25%'
 WHEN forestation_percentage<=50 THEN '25% - 50%'
 WHEN forestation_percentage<=75 THEN '50% - 75%'
 ELSE '75% - 100%'
 END AS quartiles
 FROM tab_quartile)
SELECT COUNT(*)
FROM tab_quartile1
WHERE forestation_percentage>
(SELECT forestation_percentage
FROM tab_quartile1
where country_name='United States')
```