Report for ForestQuery into GlobalDeforestation (1990 - 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 km^2** in 1990. As of 2016, the most recent year for which data was available, that number had fallen to **39958245.90 km^2**, a loss of **1324449 km^2** 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 km^2**).

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 **527229.062 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**.

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	-106506.001
Tanzania	Sub-Saharan Africa	-102320

*(**NOTICE**: Sign **'-'** (**minus**) in the last column means **decrease**)*

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

*(**NOTICE**: Sign **'-'** (**minus**) in the last column means **decrease**)*

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

Quartiles	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 (or '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

There are **94 countries** with their percent forestation higher than that of the United States.

4. RECOMMENDATIONS

Write out a set of recommendations as an analyst on the ForestQuery team.

1. What have you learned from the World Bank data?

- The result of deforestation is astonishing. In just 26 years from 1990 to 2016, the world's total forest area has dropped by ***3.208%*** or **1324449 km^2**, which is about the land size of **Peru**.
- Although there are only 2 out of 7 regions seeing dropping in forest coverage, the general trend for world's forestation area is decreasing. Especially **Latin America & Caribbean,** being the region with the largest forest coverage ever, has dropped nearly **5%** from **1990 (51.03%)** to **2016 (46.16%)**.
- **China** is on the top the increasing list in terms of forestation area from 1990 to 2016, over 6 times as large as that of the **United States**, which holds the 2nd place. There must be something interesting to explore and study.
- **4** out of the t**op 5** countries whose forest area decreased the most from 1990 to 2016 are in the **Sub-Saharan Africa** region. Specifically, the country of **Nigeria** is both referred to in either absolute forest area decrease or percentage decrease.
- In the **218** countries being investigated, there are **85** countries whose forest coverage rate is less than **25%**, the largest number of countries when grouped in forestation percent quartile. Only **47** countries have their forest coverage percentage above **75%**.

2. Which countries should we focus on over others?

Togo, Nigeria, Uganda and Mauritania in the **Sub-Saharan Africa** and **Honduras** need more attention as they are the countries that decreased in percentage of forest area the most. We need further exploration and study on what caused these decreasing and what actions could be taken, such as in law, education, economic aid, resource allocation, population control etc.

In general speaking, deforestation is becoming more and more serious in our modern world. We should make deliberate plans and take instant action against it. If not, a sequence of chain events could happen such as climate change, air pollution, wildlife extinction and so on.

5. APPENDIX: SQL Queries Used

```sql
-- 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)
pct_forestation,
         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 betweeb 1990
and 2016
WITH t1 AS (
  SELECT *
  FROM forestation
  WHERE country_code='WLD' and year in (1990, 2016)
  ORDER BY year)

SELECT year,
  forest_area_sqkm,
  LEAD(forest_area_sqkm) OVER (order by year) AS lead,
```

```sql
  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

-- 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='WLD' 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. 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(pct_forestation::NUMERIC, 2) pct_forestation
FROM forestation
WHERE year=2016 AND country_code='WLD';

-- Find the region with the highest forestation percentage in 2016
SELECT year,
       region,
       SUM(forest_area_sqkm) total_forestation,
```

```sql
       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(pct_forestation::NUMERIC, 2) pct_forestation
FROM forestation
WHERE year=1990 AND country_code='WLD';

-- 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;
```

```sql

-- 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
```

```sql

-- 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,
         pct_forestation
  FROM forestation
  WHERE year=1990
  ORDER BY country_name),

  tab_2016 AS (
    SELECT country_code,
           country_name,
           forest_area_sqkm,
           total_area_sq_km,
           pct_forestation
    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.pct_forestation pct_1990,
           tab_2016.pct_forestation pct_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

```

```sql
-- Largest change in terms of forest_area percentage
WITH tab_1990 AS (
  SELECT country_code,
         country_name,
         forest_area_sqkm,
         total_area_sq_km,
         pct_forestation
  FROM forestation
  WHERE year=1990
  ORDER BY country_name),

  tab_2016 AS (
    SELECT country_code,
           country_name,
           forest_area_sqkm,
           total_area_sq_km,
           pct_forestation
    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.pct_forestation pct_1990,
           tab_2016.pct_forestation pct_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
```

```sql
WITH tab_1990 AS (
  SELECT country_code,
         country_name,
         region,
         forest_area_sqkm,
         total_area_sq_km,
         pct_forestation
  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,
           pct_forestation
    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.pct_forestation pct_1990,
           tab_2016.pct_forestation pct_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

```

```sql
-- 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,
         pct_forestation
  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,
           pct_forestation
    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.pct_forestation pct_1990,
           tab_2016.pct_forestation pct_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
```

```sql
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,
         pct_forestation
  FROM forestation
  WHERE year=2016 AND pct_forestation IS NOT NULL
  ORDER BY 2),

  tab_quartile1 AS (
    SELECT country_name,
           pct_forestation,
           CASE
             WHEN pct_forestation<=25 THEN '0 - 25%'
             WHEN pct_forestation<=50 THEN '25% - 50%'
             WHEN pct_forestation<=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,
         pct_forestation
  FROM forestation
  WHERE year=2016 AND pct_forestation IS NOT NULL
  ORDER BY 2),

  tab_quartile1 AS (
    SELECT country_name,
           region,
           pct_forestation,
           CASE
             WHEN pct_forestation<=25 THEN '0 - 25%'
             WHEN pct_forestation<=50 THEN '25% - 50%'
```

```
            WHEN pct_forestation<=75 THEN '50% - 75%'
            ELSE '75% - 100%'
          END AS quartiles
    FROM tab_quartile)

SELECT country_name, region, ROUND(pct_forestation::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,
         pct_forestation
  FROM forestation
  WHERE year=2016 AND pct_forestation IS NOT NULL
  ORDER BY 2),

  tab_quartile1 AS (
    SELECT country_name,
           region,
           pct_forestation,
           CASE
             WHEN pct_forestation<=25 THEN '0 - 25%'
             WHEN pct_forestation<=50 THEN '25% - 50%'
             WHEN pct_forestation<=75 THEN '50% - 75%'
             ELSE '75% - 100%'
           END AS quartiles
    FROM tab_quartile)

SELECT COUNT(*)
FROM tab_quartile1
WHERE pct_forestation>
(SELECT pct_forestation
FROM tab_quartile1
where country_name='United States');
```