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 **41,282,695 sqkm** in 1990. As of 2016, the most recent year for which data was available, that number had fallen to **39,958,246 sqkm**, a loss of **1,324,449 sqkm**, or **3.315%**.

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 **1,280,000 sqkm**).

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
Latin America & Caribbean	51.03	46.16
Europe & Central Asia	37.28	38.04
North America	35.65	36.04
World	32.42	31.38
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 & 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 **527,229 sqkm**. 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 **79,200 sqkm**, 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	-541,510
Indonesia	East Asia & Pacific	-282,194
Myanmar	East Asia & Pacific	-107,234
Nigeria	Sub-Saharan Africa	-106,506
Tanzania	Sub-Saharan Africa	-102,320

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
Nigeria	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**, **Nigeria**, 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
26-50%	72
51-75%	38
76-100%	9

The largest number of countries in 2016 were found in the **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	87.50
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?*
    - Persistent deforestation in developing economies.
    - Significant reduction in forested areas in Brazil, Indonesia, Pakistan, …
    - Sub-Saharan Africa and Latin America & Caribbean countries continue deforestation at high rates.
    - Developed economies and some emerging markets have reversed the trend, increasing forest areas.
- *Which countries should we focus on over others?*
    - Provide solar and other renewables as an alternative to lumber for energy.
    - Incentivize major food exporters like Brazil to stop converting forests to farmland.
        - Use trade policies and tariffs to disincentivize plantation construction on pristine forests.
    - Introduce sustainable foresting policies, plot allocation and rotation for wood harvesting activities.
    - Increase public awareness.

5. APPENDIX: SQL Queries Used

```
/* Creating forestation view */
CREATE VIEW forestation AS
SELECT f.country_code, f.country_name, f.year, f.forest_area_sqkm,
l.total_area_sq_mi, r.region, r.income_group,
(f.forest_area_sqkm/(l.total_area_sq_mi * 2.59))* 100 forest_over_land
FROM forest_area f
JOIN land_area l
ON f.country_code = l.country_code
AND f.year = l.year
JOIN regions r
ON f.country_code = r.country_code
```

Global Situation

```sql
/* GLOBAL SITUATION */
SELECT country_name, year, forest_area_sqkm
FROM forestation
WHERE year = 1990 AND country_name = 'World';
-- country_name     year    forest_area_sqkm
-- World            1990    41282694.9

SELECT country_name, year, forest_area_sqkm
FROM forestation
WHERE year = 2016 AND country_name = 'World';
-- country_name     year    forest_area_sqkm
-- World            2016    39958245.9

SELECT (t2016.forest_area_sqkm - t1990.forest_area_sqkm) AS
change_forest_sqkm
FROM forestation AS t2016, forestation AS t1990
WHERE t2016.year = '2016' AND t2016.country_name = 'World'
AND   t1990.year = '1990' AND t1990.country_name = 'World';
-- change_forest_sqkm
-- -1324449

SELECT (1-(t1990.forest_area_sqkm / t2016.forest_area_sqkm))*100 AS
percent_change_forest_sqkm
FROM forestation AS t2016, forestation AS t1990
WHERE t2016.year = '2016' AND t2016.country_name = 'World'
AND   t1990.year = '1990' AND t1990.country_name = 'World';
-- percent_change_forest_sqkm
-- -3.314582435161406

WITH area_2016 AS (
   SELECT country_name, (total_area_sq_mi * 2.59) AS total_area_sqkm
   FROM forestation
   WHERE year = '2016'
),
forest_loss_sqkm AS (
```

```
   SELECT (t2016.forest_area_sqkm - t1990.forest_area_sqkm) AS
change_forest_sqkm
   FROM forestation AS t2016, forestation AS t1990
   WHERE t2016.year = '2016' AND t2016.country_name = 'World'
   AND t1990.year = '1990' AND t1990.country_name = 'World'
)
SELECT country_name, total_area_sqkm, change_forest_sqkm
FROM area_2016, forest_loss_sqkm
ORDER BY ABS(-total_area_sqkm - change_forest_sqkm)
LIMIT 1;
-- country_name total_area_sqkm change_forest_sqkm
-- Peru 1279999.9891    -1324449
```

Regional Outlook

```
/* REGIONAL OUTLOOK */
WITH percent_forest_region AS (
   SELECT
       SUM(t1990.forest_area_sqkm) AS region_forest_1990,
       SUM(t1990.total_area_sq_mi * 2.59) AS region_area_1990,
       t1990.region,
       SUM(t2016.forest_area_sqkm) AS region_forest_2016,
       SUM(t2016.total_area_sq_mi * 2.59) AS region_area_2016
   FROM forestation t1990
   JOIN forestation t2016 ON t1990.region = t2016.region
   WHERE t1990.year = '1990' AND t2016.year = '2016'
   GROUP BY t1990.region
)
SELECT
   region,
   (region_forest_1990 / region_area_1990) * 100 AS forest_cover_1990,
   (region_forest_2016 / region_area_2016) * 100 AS forest_cover_2016
FROM percent_forest_region
ORDER BY forest_cover_1990 DESC;
-- forest_cover_1990    forest_cover_2016   region
-- 51.03                46.16               Latin America & Caribbean
-- 37.28                38.04               Europe & Central Asia
-- 35.65                36.04               North America
```

```
-- 32.42                31.38               World
-- 30.67                28.79               Sub-Saharan Africa
-- 25.78                26.36               East Asia & Pacific
-- 16.51                17.51               South Asia
-- 1.78                 2.07                Middle East & North Africa
```

Country Level

```
/* COUNTRY-LEVEL */
SELECT t2016.country_name, t2016.region,
(t2016.forest_area_sqkm - t1990.forest_area_sqkm) AS change_forest_sqkm
FROM forestation AS t2016
JOIN forestation AS t1990 ON t2016.country_code = t1990.country_code
WHERE t2016.year = '2016' AND t1990.year = '1990'
AND t2016.country_name != 'World' --- Ignore World as a country
AND t2016.forest_area_sqkm != 0 AND t1990.forest_area_sqkm != 0
ORDER BY change_forestArea_sqkm DESC
LIMIT 5;
-- country_name region                          change_forestarea_sqkm
-- China        East Asia & Pacific             527229.0619999999
-- United       States  North America           79200
-- India        South Asia                      69213.98439999996
-- Russian      Federation  Europe & Central Asia   59395
-- Vietnam      East Asia & Pacific             55390

SELECT t2016.country_name, t2016.region,
(t2016.forest_area_sqkm - t1990.forest_area_sqkm) AS change_forest_sqkm
FROM forestation AS t2016
JOIN forestation AS t1990 ON t2016.country_code = t1990.country_code
WHERE t2016.year = '2016' AND t1990.year = '1990'
AND t2016.country_name != 'World' --- Ignore World as a country
ORDER BY change_forestArea_sqkm ASC
LIMIT 5;
-- country_name region                    change_forestarea_sqkm
-- Brazil       Latin America & Caribbean   -541510
-- Indonesia    East Asia & Pacific         -282193.98439999996
-- Myanmar      East Asia & Pacific         -107234.00390000001
-- Nigeria      Sub-Saharan Africa          -106506.00098
```

```
-- Tanzania     Sub-Saharan Africa          -102320


SELECT t2016.country_name, t2016.region,
(t2016.forest_area_sqkm / (t1990.forest_area_sqkm) - 1) * 100 AS
percent_change_forest
FROM forestation AS t2016
JOIN forestation AS t1990 ON t2016.country_code = t1990.country_code
WHERE t2016.year = '2016' AND t1990.year = '1990'
AND t1990.forest_area_sqkm != 0 AND t2016.forest_area_sqkm != 0
ORDER BY percent_change_forestArea DESC
LIMIT 5;
-- country_name region
percent_change_forestarea
-- Iceland      Europe & Central Asia                  213.66458887002833
-- French       Polynesia   East Asia & Pacific        181.81818181818184
-- Bahrain      Middle East & North Africa             177.27273528512399
-- Uruguay      Latin America & Caribbean              134.11130841834793
-- Dominican    Republic    Latin America & Caribbean  82.46153402714933

SELECT t2016.country_name, t2016.region,
(t2016.forest_area_sqkm / (t1990.forest_area_sqkm) - 1) * 100 AS
percent_change_forest
FROM forestation AS t2016
JOIN forestation AS t1990 ON t2016.country_code = t1990.country_code
WHERE t2016.year = '2016' AND t1990.year = '1990'
AND t1990.forest_area_sqkm != 0 AND t2016.forest_area_sqkm != 0
ORDER BY percent_change_forestArea ASC
LIMIT 5;
-- country_name region                     percent_change_forestarea
-- Togo         Sub-Saharan Africa         -75.44525592700731
-- Nigeria      Sub-Saharan Africa         -61.79993093884182
-- Uganda       Sub-Saharan Africa         -59.12860347295307
-- Mauritania   Sub-Saharan Africa         -46.74698795180723
-- Honduras     Latin America & Caribbean  -45.034414945919366
```

```sql
WITH percent_forest AS (
   SELECT country_name, region,
   (forest_area_sqkm / (total_area_sq_mi * 2.59)) * 100 AS
percent_forestation
   FROM forestation
   WHERE year = '2016'
   AND country_name != 'World'
   AND forest_area_sqkm != 0 AND total_area_sq_mi != 0
)
SELECT
   CASE
       WHEN percent_forestation <= 25 THEN '0-25%'
       WHEN percent_forestation > 25 AND percent_forestation <= 50 THEN
'26-50%'
       WHEN percent_forestation > 50 AND percent_forestation <= 75 THEN
'51-75%'
       ELSE '76-100%'
   END AS quartile,
   COUNT(*) AS num_countries
FROM percent_forest
GROUP BY quartile
ORDER BY quartile ASC;
-- quartile num_countries
-- 0-25%    85
-- 26-50%   72
-- 51-75%   38
-- 76-100%  9


WITH percent_forest AS (
   SELECT country_name, region,
   (forest_area_sqkm / (total_area_sq_mi * 2.59)) * 100 AS
percent_forestation
   FROM forestation
   WHERE year = '2016'
   AND country_name != 'World'
   AND forest_area_sqkm != 0 AND total_area_sq_mi != 0
```

```
),
quartiles AS (
   SELECT
       CASE
           WHEN percent_forestation <= 25 THEN '0-25%'
           WHEN percent_forestation > 25 AND percent_forestation <= 50
THEN '26-50%'
           WHEN percent_forestation > 50 AND percent_forestation <= 75
THEN '51-75%'
           ELSE '76-100%'
       END AS quartile,
       country_name,
       region,
       percent_forestation
   FROM percent_forest
)
SELECT country_name, region, percent_forestation
FROM quartiles
WHERE quartile = '76-100%'
ORDER BY percent_forestation DESC;
-- country_name             region
percent_forestation
-- Suriname                 Latin America & Caribbean   98.2576939676578
-- Micronesia, Fed. Sts.    East Asia & Pacific         91.85723907152479
-- Gabon                    Sub-Saharan Africa          90.0376418700565
-- Seychelles               Sub-Saharan Africa          88.41113673857889
-- Palau                    East Asia & Pacific         87.60680854912036
-- American Samoa           East Asia & Pacific         87.5000875000875
-- Guyana                   Latin America & Caribbean   83.90144891106817
-- Lao PDR                  East Asia & Pacific         82.10823176408609
-- Solomon Islands          East Asia & Pacific         77.86351779450665
```