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 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 km^2, or 3.21 %.

The forest area lost over this time period is slightly more than the entire land area of eru listed for the year 2016 (which has a total area of 1279999.99 km^2 also equivalent to 494208.50 $miles^2$). Next in the list of countries' land area in 2016 in descending order for which this total deforestation is bigger than area Niger, Chad and Angola.

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 and Caribbean, with 46.14 %, and the region with the lowest relative forestation was Middle East and North Africa, with 2.08 % 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 and Caribbean, with 51.08 %, and the region with the lowest relative forestation was Middle East and 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	16.53%	17.50%
East Asia & Pacific	25.57%	26.29%
Sub-Saharan Africa	30.65%	28.72%
North America	35.66%	36.02%
Europe & Central Asia	37.20%	38.07%
Latin America & Caribbean	51.08%	46.14%

The only regions of the world that decreased in percent forest area from 1990 to 2016 were Latin America & Caribbean (dropped from 51.08 % to 46.14 %) and Sub-Saharan Africa (30.65 % to 28.72 %). 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 32.41 % 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 of America, but it only saw an increase of 79200 km^2 much lower than the figure for China.

China and United States of America 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 km^2
Indonesia	East Asia & Pacific	282193.98 km^2
Myanmar	East Asia & Pacific	107234.00 km^2
Nigeria	Sub-Saharan Africa	106506.01 km^2
Tanzania	Sub-Saharan Africa	102320 km^2

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	59.13 %
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
1	85
2	72
3	38
4	9

The largest number of countries in 2016 were found in the 1st quartile range < 25% forestation.

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
Solomon Islands	East Asia & Pacific	77.86 %
Lao PDR	East Asia & Pacific	82.11 %
Guyana	Latin America & Caribbean	83.90 %
American Samoa	East Asia & Pacific	87.50 %
Palau	East Asia & Pacific	87.61 %
Seychelles	Sub-Saharan Africa	88.41 %
Gabon	Sub-Saharan Africa	90.04 %

Micronesia Fed. Sts.	East Asia & Pacific	91.86 %
Suriname	Latin America & Caribbean	98.26 %

4. RECOMMENDATIONS

What we can see from the data is that in the entire world there has been a huge deforestation issue from 1990 to 2016. There seems to be a trend in deforestation that is higher for low income and low-income countries where deforestation rates are much higher. The countries with a highest deforestation rate from 1990 to 2016 are mostly in the Sub-Saharan region in countries who's income level is low and probably it is easier for the country to sell out forest area. The focus should be to first stop this deforestation rate by putting perhaps fines on countries who not only have a CO2 impact and incentivizing to neutralize their carbon emissions, if not to reward countries when the forest area is growing so that low-income countries have incentivization to increase in their forest land.

5. APPENDIX: SQL Queries Used

```
CREATE VIEW forestation AS
SELECT f.country_name, f.year, f.forest_area_sqkm, l.total_area_sq_mi, r.region,
r.income_group
FROM forest_area AS f
INNER JOIN land_area AS l
ON l.year=f.year AND l.country_name=f.country_name
INNER JOIN regions AS r
ON r.country_name = f.country_name
```

Global Situation:

1)

```
SELECT *
FROM forest_area
WHERE forest_area.year IN (1990,2016) AND forest_area.country_name = 'World'
```

2)

```
with lag_table as (
  SELECT *, LAG(forest_area_sqkm) OVER (ORDER BY year) lag_forest
  FROM forest_area
  WHERE forest_area.year IN (1990,2016) AND forest_area.country_name = 'World'
)
```

```
SELECT *, lag_forest - forest_area_sqkm as diff_forest_area, (100*(lag_forest -
forest_area_sqkm))/lag_forest AS percentage_lost
from lag_table
```

3)

```
WITH forest_lost AS(
SELECT a.country_name, a.total_area_sq_mi, a.year, ((a.forest_area_sqkm -
b.forest_area_sqkm)) AS forest_lost_2016_to_1990, a.total_area_sq_mi*2.59 AS
total_area_sqkm
FROM forestation a
JOIN forestation b
ON a.country_name = b.country_name
WHERE a.year IN (1990,2016) and b.year IN (1990,2016)
ORDER BY forest_lost_2016_to_1990 ASC
)

SELECT *
FROM forest_lost AS f_l
WHERE f_l.total_area_sqkm <= 1324449 AND year=2016
ORDER BY f_l.total_area_sqkm DESC
```

Regional Outlook:

1)

```
with aggregated_over_region AS (
  SELECT r.region, SUM(l.total_area_sq_mi*2.59) sum_total_area_sqkm,
SUM(f.forest_area_sqkm) sum_forest_area_sqkm
  FROM land_area AS l
  INNER JOIN forest_area AS f
  ON f.country_name = l.country_name
  INNER JOIN regions AS r
  ON f.country_name = r.country_name
  WHERE f.year=2016
  GROUP BY r.region
)

SELECT aggregated_over_region.region,
100*(aggregated_over_region.sum_forest_area_sqkm/aggregated_over_region.sum_total_area
_sqkm) AS pct_forest_over_total_region
```

```
FROM aggregated_over_region
ORDER BY pct_forest_over_total_region ASC
```

2)

```
with aggregated_over_region AS (
  SELECT r.region, SUM(l.total_area_sq_mi*2.59) sum_total_area_sqkm,
SUM(f.forest_area_sqkm) sum_forest_area_sqkm
  FROM land_area AS l
  INNER JOIN forest_area AS f
  ON f.country_name = l.country_name
  INNER JOIN regions AS r
  ON f.country_name = r.country_name
  WHERE f.year=1990
  GROUP BY r.region
)

SELECT aggregated_over_region.region,
100*(aggregated_over_region.sum_forest_area_sqkm/aggregated_over_region.sum_total_area
_sqkm) AS pct_forest_over_total_region
FROM aggregated_over_region
ORDER BY pct_forest_over_total_region ASC
```

Country-Level Outlook:

1)

```
with lag_data_forest as(
  SELECT *, LAG(forest_area_sqkm) OVER (PARTITION BY f.country_name ORDER BY
f.country_name, f.year) AS lag_forest_area_sqkm
  FROM land_area l
  INNER JOIN forest_area f
  ON f.country_name = l.country_name AND f.year = l.year
  WHERE f.year IN (1990,2016)
  ORDER BY f.country_name, f.year
)

SELECT *, forest_area_sqkm - lag_forest_area_sqkm AS diff_forest_area_2016_minus_1990
```

```
FROM lag_data_forest
ORDER BY diff_forest_area_2016_minus_1990 DESC
```

2)

```
with lag_data_forest as(
  SELECT *, LAG(forest_area_sqkm) OVER (PARTITION BY f.country_name ORDER BY
f.country_name, f.year) AS lag_forest_area_sqkm
  FROM land_area l
  INNER JOIN forest_area f
  ON f.country_name = l.country_name AND f.year = l.year
  WHERE f.year IN (1990,2016)
  ORDER BY f.country_name, f.year
),

diff_lag_forest AS(
  SELECT *, forest_area_sqkm - lag_forest_area_sqkm AS diff_forest_area_2016_minus_1990
  FROM lag_data_forest
)

SELECT *
FROM diff_lag_forest
WHERE diff_forest_area_2016_minus_1990 IS NOT NULL
ORDER BY diff_forest_area_2016_minus_1990 DESC
```

3)

```
with lead_data_forest as(
  SELECT *, LEAD(forest_area_sqkm) OVER (PARTITION BY f.country_name ORDER BY
f.country_name, f.year) AS lead_forest_area_sqkm
  FROM land_area l
  INNER JOIN forest_area f
  ON f.country_name = l.country_name AND f.year = l.year
  WHERE f.year IN (1990,2016)
  ORDER BY f.country_name, f.year
),

diff_lead_forest AS(
  SELECT *, lead_forest_area_sqkm - forest_area_sqkm AS
diff_forest_area_2016_minus_1990
  FROM lead_data_forest
)
```

```
SELECT *, 100*(diff_forest_area_2016_minus_1990/forest_area_sqkm) AS
pct_increase_forest_area_1990_to_2016
FROM diff_lead_forest
WHERE diff_forest_area_2016_minus_1990 IS NOT NULL
ORDER BY pct_increase_forest_area_1990_to_2016 DESC
```

4)

```
with lag_data_forest as(
  SELECT f.country_name, f.forest_area_sqkm, LAG(forest_area_sqkm) OVER (PARTITION
BY f.country_name ORDER BY f.country_name, f.year) AS lag_forest_area_sqkm
  FROM land_area l
  INNER JOIN forest_area f
  ON f.country_name = l.country_name AND f.year = l.year
  WHERE f.year IN (1990,2016)
  ORDER BY f.country_name, f.year
),

diff_lag_forest AS(
  SELECT *, forest_area_sqkm - lag_forest_area_sqkm AS diff_forest_area_2016_minus_1990
  FROM lag_data_forest
),

diff_lag_forest_with_region AS(
  SELECT *
  FROM diff_lag_forest
  INNER JOIN regions AS r
  ON r.country_name = diff_lag_forest.country_name
)

SELECT *, 100*(diff_forest_area_2016_minus_1990/forest_area_sqkm) AS
pct_increaase_forest_area_1990_to_2016
FROM diff_lag_forest_with_region
WHERE diff_forest_area_2016_minus_1990 IS NOT NULL
ORDER BY diff_forest_area_2016_minus_1990 ASC
```

5)

```
with lead_data_forest as(
  SELECT *, LEAD(forest_area_sqkm) OVER (PARTITION BY f.country_name ORDER BY
f.country_name, f.year) AS lead_forest_area_sqkm
  FROM land_area l
  INNER JOIN forest_area f
  ON f.country_name = l.country_name AND f.year = l.year
```

```
  WHERE f.year IN (1990,2016)
  ORDER BY f.country_name, f.year
),

diff_lead_forest AS(
  SELECT *, lead_forest_area_sqkm - forest_area_sqkm AS
diff_forest_area_2016_minus_1990
  FROM lead_data_forest
)

SELECT *, 100*(diff_forest_area_2016_minus_1990/forest_area_sqkm) AS
pct_increase_forest_area_1990_to_2016
FROM diff_lead_forest
WHERE diff_forest_area_2016_minus_1990 IS NOT NULL
ORDER BY pct_increase_forest_area_1990_to_2016 ASC

6)

with forestation_percent AS(
  SELECT f.country_name, f.year, (100*(forest_area_sqkm/(total_area_sq_mi*2.59))) AS
pct_forestation
  FROM forest_area as f
  INNER JOIN land_area as l
  ON f.country_name = l.country_name AND f.year = l.year
),

forestation_pct_only_countries_2016 AS(
  SELECT *
  FROM forestation_percent AS f_p
  WHERE f_p.year = 2016
  EXCEPT

  SELECT *
  FROM forestation_percent AS f_p
  WHERE f_p.year = 2016 AND f_p.country_name = 'World'                ),

forestation_pct_only_countries_2016_quartile AS(
  SELECT *,
  CASE
          WHEN f_p_2016.pct_forestation <= 25 THEN 1
    WHEN f_p_2016.pct_forestation <= 50 THEN 2                        WHEN
f_p_2016.pct_forestation <= 75 THEN 3
    WHEN f_p_2016.pct_forestation <= 100 THEN 4
  END AS quartile
```

```
  FROM forestation_pct_only_countries_2016 AS f_p_2016
  WHERE f_p_2016.pct_forestation IS NOT NULL
)

SELECT f_p_2016_quartile.quartile, COUNT(*)
FROM forestation_pct_only_countries_2016_quartile as f_p_2016_quartile
GROUP BY f_p_2016_quartile.quartile
ORDER BY f_p_2016_quartile.quartile


with forestation_percent AS(
  SELECT f.country_name, f.year, (100*(forest_area_sqkm/(total_area_sq_mi*2.59))) AS
pct_forestation
  FROM forest_area as f
  INNER JOIN land_area as l
  ON f.country_name = l.country_name AND f.year = l.year
),

forestation_pct_only_countries_2016 AS(
  SELECT *
  FROM forestation_percent AS f_p
  WHERE f_p.year = 2016
  EXCEPT

  SELECT *
  FROM forestation_percent AS f_p
  WHERE f_p.year = 2016 AND f_p.country_name = 'World'                ),

forestation_pct_only_countries_2016_quartile AS(
  SELECT *,
  CASE
          WHEN f_p_2016.pct_forestation <= 25 THEN 1
    WHEN f_p_2016.pct_forestation <= 50 THEN 2                          WHEN
f_p_2016.pct_forestation <= 75 THEN 3
    WHEN f_p_2016.pct_forestation <= 100 THEN 4
  END AS quartile
  FROM forestation_pct_only_countries_2016 AS f_p_2016
  WHERE f_p_2016.pct_forestation IS NOT NULL
)

SELECT f_p_2016_quartile.quartile, COUNT(*)
FROM forestation_pct_only_countries_2016_quartile as f_p_2016_quartile
GROUP BY f_p_2016_quartile.quartile
ORDER BY f_p_2016_quartile.quartile
```

7)

```
with forestation_percent AS(
  SELECT f.country_name, f.year, (100*(forest_area_sqkm/(total_area_sq_mi*2.59))) AS
pct_forestation
  FROM forest_area as f
  INNER JOIN land_area as l
  ON f.country_name = l.country_name AND f.year = l.year
),

forestation_pct_only_countries_2016 AS(
  SELECT *
  FROM forestation_percent AS f_p
  WHERE f_p.year = 2016
  EXCEPT

  SELECT *
  FROM forestation_percent AS f_p
  WHERE f_p.year = 2016 AND f_p.country_name = 'World'                ),

forestation_pct_only_countries_2016_quartile AS(
  SELECT *,
  CASE
          WHEN f_p_2016.pct_forestation <= 25 THEN 1
    WHEN f_p_2016.pct_forestation <= 50 THEN 2                          WHEN
f_p_2016.pct_forestation <= 75 THEN 3
    WHEN f_p_2016.pct_forestation <= 100 THEN 4
  END AS quartile
  FROM forestation_pct_only_countries_2016 AS f_p_2016
  WHERE f_p_2016.pct_forestation IS NOT NULL
)

SELECT *
FROM forestation_pct_only_countries_2016_quartile as f_p_2016_quartile
INNER JOIN regions AS r
ON r.country_name = f_p_2016_quartile.country_name
WHERE f_p_2016_quartile.quartile = 4
ORDER BY f_p_2016_quartile.pct_forestation
```