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 1279999.99 sq km).

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 46.14 %, 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 51.08 %, 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	25.57 %	26.29 %
Europe & Central Asia	37.2 %	38.07 %
Latin America & Caribbean	51.08 %	46.14 %
Middle East & North Africa	1.78 %	2.07 %
North America	35.66 %	36.02 %
South Asia	16.53 %	17.5 %
Sub-Saharan Africa	30.65 %	28.72 %

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 (30.66 % 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 32.42 % 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 its forest area from 1990 to 2016 by 527229.06 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 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 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 km^2
Nigeria	Sub-Saharan Africa	106506 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	-75.45 %
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
26-50	73
51-75	36
76-100	11

The largest number of countries in 2016 were found in the 0 - 25 % quartile.

There were 11 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%
Bolivia	Latin America & Caribbean	50.29%
Ecuador	Latin America & Caribbean	50.21%

4. RECOMMENDATIONS

- The world bank data shows us that forest loss on a global scale is not insurmountable. While worldwide efforts ought to continue, I would look at the increasing efforts in the Latin America & Caribbean region. It was one of only two regions where forestation levels decreased over the 1990 to 2016 time point but it was the region by far with the greatest loss with an almost 5 % drop. If this loss could be minimized worldwide forestation levels may actually increase.

- At the country level, I believe the following nations should receive renewed focus on reforestation efforts:
    - China and the United States: Highest and second highest respectively in overall forest area increases through 2016. This likely has to do with their large land masses yet nonetheless they must be employing effective forest conservation strategies and have the potential for continued large forestation increases.
    - Brazil: Greatest loss of forest area of any nation and is from the region with the greatest forestation loss. If Brazilian forestation losses can be minimized, the overall and worldwide losses could be dramatically decreased thereby improving overall worldwide efforts.
    - Nigeria: The only nation in the top five for absolute forest area decrease and percentage area decrease. This was a smaller nation with a huge loss. It may be easier to employ resources in a smaller more condensed area leaving Nigeria as a nation of potential improvement.

5. APPENDIX: SQL Queries Used

INTRO:

```
CREATE VIEW forestation AS
SELECT
   f.country_code,
   f.country_name,
   f.year,
   f.forest_area_sqkm,
   l.total_area_sq_mi,
   (
      l.total_area_sq_mi*2.59
   )
   AS total_area_sqkm,
   (
(f.forest_area_sqkm / (l.total_area_sq_mi*2.59)) * 100
   )
   AS perc_forest_area,
   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 l.country_code = r.country_code;
```

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
   forest_area_sqkm
FROM
   forestation
WHERE
   year = 1990
   AND country_code = 'WLD';
```

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
   forest_area_sqkm
FROM
   forestation
WHERE
   year = 2016
   AND country_code = 'WLD';
```

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

```
WITH t1 AS
(
   SELECT
      country_name,
      forest_area_sqkm AS forest_area_sqkm_90
   FROM
      forestation
   WHERE
      year = 1990
      AND country_code = 'WLD'
)
,
t2 AS
(
   SELECT
      country_name,
      forest_area_sqkm AS forest_area_sqkm_16
   FROM
      forestation
   WHERE
      year = 2016
      AND country_code = 'WLD'
)
SELECT
   t1.country_name,
```

```
   t1.forest_area_sqkm_90,
   t2.forest_area_sqkm_16,
   (
      t1.forest_area_sqkm_90 - t2.forest_area_sqkm_16
   )
   AS forest_area_diff
FROM
   t1
   JOIN
      t2
      ON t1.country_name = t2.country_name;
```

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

```
WITH t1 AS
(
   SELECT
      country_name,
      forest_area_sqkm AS forest_area_sqkm_90
   FROM
      forestation
   WHERE
      year = 1990
      AND country_code = 'WLD'
)
,
t2 AS
(
   SELECT
      country_name,
      forest_area_sqkm AS forest_area_sqkm_16
   FROM
      forestation
   WHERE
      year = 2016
      AND country_code = 'WLD'
)
SELECT
   t1.country_name,
   t1.forest_area_sqkm_90,
   t2.forest_area_sqkm_16,
   (
((t2.forest_area_sqkm_16 - t1.forest_area_sqkm_90) / t1.forest_area_sqkm_90)*100
   )
   AS perc_change_forest
FROM
   t1
     JOIN
      t2
      ON t1.country_name = t2.country_name;
```

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?*/

```
SELECT
   country_name,
   total_area_sqkm AS country_land_area,
   (
      WITH t1 AS
      (
         SELECT
            country_name,
            forest_area_sqkm AS forest_area_sqkm_90
         FROM
            forestation
         WHERE
            year = 1990
            AND country_code = 'WLD'
      )
,
      t2 AS
      (
         SELECT
            country_name,
            forest_area_sqkm AS forest_area_sqkm_16
         FROM
            forestation
         WHERE
            year = 2016
            AND country_code = 'WLD'
      )
      SELECT
(t1.forest_area_sqkm_90 - t2.forest_area_sqkm_16) AS forest_area_diff
      FROM
         t1
         JOIN
            t2
            ON t1.country_name = t2.country_name
   )
   AS world_forest_loss,
   ABS(total_area_sqkm - (WITH t1 AS
   (
      SELECT
         country_name,
         forest_area_sqkm AS forest_area_sqkm_90
      FROM
         forestation
      WHERE
         year = 1990
         AND country_code = 'WLD'
   )
, t2 AS
   (
      SELECT
```

```
      country_name,
      forest_area_sqkm AS forest_area_sqkm_16
   FROM
      forestation
   WHERE
      year = 2016
      AND country_code = 'WLD'
)
SELECT
(t1.forest_area_sqkm_90 - t2.forest_area_sqkm_16) AS forest_area_diff
FROM
   t1
   JOIN
      t2
      ON t1.country_name = t2.country_name)) AS abs_diff
FROM
   forestation
WHERE
   year = 2016
ORDER BY
   abs_diff LIMIT 1;
```

;

;

Regional Outlook:

Create a table that shows the Regions and their percent forest area (sum of forest area divided by the sum of land area) in 1990 and 2016. (Note that 1 sq mi = 2.59 sq km).

```
CREATE VIEW region_area AS
SELECT
   r.region,
   f.year,
   (
      sum(f.forest_area_sqkm) / sum(l.total_area_sq_mi*2.59)
   )
   *100 AS percent_forest_area
FROM
   regions r
   JOIN
      forest_area f
      ON r.country_name = f.country_name
   JOIN
      land_area l
      ON r.country_name = l.country_name
WHERE
   f.year = 1990
   or f.year = 2016
GROUP BY
   r.region,
   f.year
ORDER BY
   r.region;
```

a1)What was the percent forest of the entire world in 2016 to 2 decimal places?

```
SELECT
   region,
   ROUND(CAST(percent_forest_area AS numeric), 2) AS percent_forest_area
FROM
   region_area
WHERE
   year = 2016
   AND region = 'World';
```

a2)Which region had the HIGHEST percent forest in 2016 to 2 decimal places?

```
SELECT
   region,
   ROUND(CAST(percent_forest_area AS numeric), 2) AS percent_forest_area
FROM
   region_area
WHERE
   year = 2016
ORDER BY
   percent_forest_area DESC LIMIT 1;
```

a3)Which had the LOWEST percent forest in 2016 to 2 decimal places?

```
SELECT
   region,
   ROUND(CAST(percent_forest_area AS numeric), 2) AS percent_forest_area
FROM
   region_area
WHERE
   year = 2016
ORDER BY
   Percent_forest_area LIMIT 1;
```

b1)What was the percent forest of the entire world in 1990 to 2 decimal places?

```
SELECT
   region,
   ROUND(CAST(percent_forest_area AS numeric), 2) AS percent_forest_area
FROM
   region_area
WHERE
   year = 1990
   AND region = 'World';
```

b2) Which region had the HIGHEST percent forest in 1990 to 2 decimal places?

```
SELECT
   region,
   ROUND(CAST(percent_forest_area AS numeric), 2) AS percent_forest_area
FROM
   region_area
WHERE
   year = 1990
ORDER BY
   Percent_forest_area DESC LIMIT 1;
```

b3)Which had the LOWEST percent forest in 1990 to 2 decimal places?

```
SELECT
   region,
   ROUND(CAST(percent_forest_area AS numeric), 2) AS percent_forest_area
FROM
   region_area
WHERE
   year = 1990
ORDER BY
   Percent_forest_area LIMIT 1;
```

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

```
CREATE VIEW difference AS
(
   SELECT
      *
   FROM
      (
         WITH t1 AS
         (
            SELECT
               region,
               percent_forest_area AS pfa_90
            FROM
               region_area
            WHERE
               year = 1990
         )
,
         t2 AS
         (
            SELECT
               region,
               percent_forest_area AS pfa_16
            FROM
               region_area
            WHERE
               year = 2016
         )
         SELECT
            t1.region,
            t1.pfa_90,
            t2.pfa_16
         FROM
            t1
            JOIN
               t2
               ON t1.region = t2.region
      )
      subq
)
```

–Below is a self table join from the above view “difference”.

```
SELECT
   a.region
FROM
   difference a
   JOIN
      difference b
      ON a.region = b.region
      AND b.pfa_90 > a.pfa_16
WHERE
   a.region != 'World';
```

Country-Level Detail:

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 t1 AS
(
   SELECT
      country_name,
      region,
      forest_area_sqkm as forest_area_90
   FROM
      forestation
   WHERE
      year = 1990
      AND forest_area_sqkm IS NOT NULL
)
,
t2 AS
(
   SELECT
      country_name,
      forest_area_sqkm as forest_area_16
   FROM
      forestation
   WHERE
      year = 2016
      AND forest_area_sqkm IS NOT NULL
)
SELECT
   t1.country_name,
   t1.region,
   (
      T2.forest_area_16 - t1.forest_area_90
   )
   AS forest_diff
FROM
   t1
   JOIN
      t2
      ON t1.country_name = t2.country_name
WHERE
   t1.country_name != 'World'
ORDER BY
   3 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 t1 AS
(
   SELECT
      country_name,
      region,
      perc_forest_area
      AS perc_forest_area_90
   FROM
      forestation
   WHERE
      YEAR = 1990
)
,
t2 AS
(
   SELECT
      country_name,
      forest_area_sqkm,
      total_area_sqkm,
      perc_forest_area
      AS perc_forest_area_16
   FROM
      forestation
   WHERE
      YEAR = 2016
)
SELECT
   t1.country_name,
   t1.region,
   round(CAST((((t2.perc_forest_area_16 - t1.perc_forest_area_90)/
  (t1.perc_forest_area_90))*100)AS NUMERIC), 2) AS perc_forest_diff
FROM
   t1
   JOIN
      t2
      ON t1.country_name = t2.country_name
WHERE
   t1.country_name != 'World'
   AND T1.perc_forest_area_90 IS NOT NULL
AND T2.perc_forest_area_16 IS NOT NULL

ORDER BY
   3 LIMIT 5;
```

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

```
SELECT
   T1.perc_forest_area_quartiles,
   COUNT(t1.perc_forest_area_quartiles),
   RANK() OVER (
ORDER BY
   COUNT(t1.perc_forest_area_quartiles)DESC) AS count_rank
FROM
   (
      SELECT
         perc_forest_area,
         CASE
            WHEN
               perc_forest_area <= 25
            THEN
               '0-25'
            WHEN
               perc_forest_area <= 50
               AND perc_forest_area > 25
            THEN
               '26-50'
            WHEN
               perc_forest_area <= 75
               AND perc_forest_area > 51
            THEN
               '51-75'
            ELSE
               '76-100'
         END
         AS perc_forest_area_quartiles
      FROM
         forestation
      WHERE
         YEAR = 2016
         AND perc_forest_area IS NOT NULL
      ORDER BY
         perc_forest_area
   )
   t1
GROUP BY
   perc_forest_area_quartiles
ORDER BY
   2 DESC;
```

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

```
SELECT
   t1.country_name
FROM
   (
      SELECT
         country_name,
         perc_forest_area,
         CASE
            WHEN
               perc_forest_area <= 25
            THEN
               '0-25'
            WHEN
               perc_forest_area <= 50
               AND perc_forest_area > 25
            THEN
               '26-50'
            WHEN
               perc_forest_area <= 75
               AND perc_forest_area > 51
            THEN
               '51-75'
            ELSE
               '76-100'
         END
         AS perc_forest_area_quartiles
      FROM
         forestation
      WHERE
         YEAR = 2016
         AND perc_forest_area IS NOT NULL
   )
   t1
WHERE
   perc_forest_area_quartiles = '76-100'
```

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

```
SELECT
   COUNT(country_name) AS country_count_higher_usa
FROM
   forestation
WHERE
   perc_forest_area >
   (
   SELECT
      perc_forest_area
   FROM
      forestation
   WHERE
      year = 2016
      AND country_name = 'United States'
   )
AND year = 2016;
```