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 41,282,694.9 sq. km in 1990. As of 2016, the most recent year for which data was available, that number had fallen to 39,958,245.9 sq. km, a loss of 1,324,449 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 1,280,000 sq. km).

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 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 percentage 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
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
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 527,229.1 sq. km. 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 sq. km, 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's forest area increased 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 (sq. km)**
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%
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”

Note: This report template and the instructions for the project as a whole do not seem to understand the meaning of quartiles. Properly grouping the countries by quartiles of forestation percentage should result in four groups of exactly 51 countries each, by the definition of what quartiles are. However, the task required here seems instead to be grouping the countries by forestation percentage with breakpoints at 25%, 50%, and 75%, which is a different concept altogether. Thus, I am putting the term “quartile” in quotation marks throughout this section to indicate that it does not actually refer to a quartile according to the proper definition of that term.

Table 3.3: Count of Countries Grouped by Forestation Percent “Quartiles,” 2016:

“Quartile”	**Number of Countries**
0–25%	85
25–50%	72
50–75%	38
75–100%	9

The largest number of countries in 2016 were found in the bottom (0–25%) “quartile”.

There were nine (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

Clearly the primary focus of forest activists must be on the two world regions that saw forest loss from 1990 to 2016, which are Sub-Saharan Africa and the Latin America & Caribbean regions. In particular, it is important to investigate the root causes of deforestation in these areas and to determine the entities operating in those regions that are the primary drivers of forest loss. Have the decisions leading to deforestation in those regions been made by organizations and governments in those areas themselves, or have they been made by outside influences?

Also, while it does not rank as highly on a percentage basis, Brazil is the nation that has seen by far the most severe deforestation in an absolute sense during this time frame. Indeed, Brazil has seen more forest loss than the next three highest-ranking nations combined. This is especially alarming due to the great ecological diversity of the Amazon rainforest. ForestQuery and its allies in environmental advocacy must ensure that adequate funding and attention is allocated to Brazil, as it is likely to remain at the forefront of the deforestation struggle.

On a more positive note, there have been several countries that have seen significant gains in forestland from 1990 to 2016, such as Iceland, China, and the United States. Further research is needed to ascertain the reasons for forest gain in each of these three places. Moreover, it is striking that these three countries are so profoundly different in terms of culture, government, and geography. This fact is encouraging, as it suggests that forestland reclamation strategies can succeed under a variety of conditions if planned and executed properly.

5. APPENDIX: SQL Queries Used

```
/* Preliminary: Create a View called forestation */
CREATE VIEW forestation AS
SELECT
  f.country_code,
  f.country_name,
  f.year,
  f.forest_area_sqkm,
  l.total_area_sq_mi * 2.59 AS total_area_sqkm,
  CASE
    WHEN f.forest_area_sqkm IS NULL
      OR l.total_area_sq_mi IS NULL
      OR l.total_area_sq_mi = 0
      THEN NULL
    ELSE 100 * f.forest_area_sqkm / (
      l.total_area_sq_mi * 2.59
    )
  END AS forest_pct,
  r.region,
  r.income_group
FROM forest_area f
JOIN land_area l
  ON l.country_code = f.country_code
  AND l.year = f.year
JOIN regions r ON r.country_code = f.country_code;


/* Part 1 */

/*
   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 country_name = 'World' AND year = 1990;
/* 41282694.9 */
```

```
/*
   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 country_name = 'World' AND year = 2016;
/* 39958245.9 */

/*
   c. What was the change (in sq km) in the forest
      area of the world from 1990 to 2016?
*/
WITH two_years AS (
  SELECT year, forest_area_sqkm area
  FROM forestation
  WHERE country_name = 'World'
  AND year IN (1990, 2016)
  ORDER BY year
)
SELECT
  year,
  area,
  area - LAG(area) OVER (ORDER BY year) AS change
FROM two_years;
/* -1324449 */

/*
   d. What was the percent change in forest area of
      the world between 1990 and 2016?
*/
WITH two_years AS (
  SELECT year, forest_area_sqkm area
  FROM forestation
  WHERE country_name = 'World'
  AND year IN (1990, 2016)
  ORDER BY year
)
SELECT
  year,
  area,
  100 * (
      area - LAG(area) OVER (ORDER BY year)
  ) / LAG(area) OVER (ORDER BY year) AS pct_change
FROM two_years;
/* -3.2082425898024405 */
```

```
/*
   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?
*/
WITH two_years AS (
  SELECT year, forest_area_sqkm area
  FROM forestation
  WHERE country_name = 'World'
  AND year IN (1990, 2016)
  ORDER BY year
),
loss_table AS (
  SELECT
  ABS(area - LAG(area) OVER (ORDER BY year)) AS loss
  FROM two_years
)
SELECT
  country_name,
  total_area_sqkm,
  ABS(total_area_sqkm - (
      SELECT loss FROM loss_table WHERE loss IS NOT NULL
  )) AS diff
FROM forestation WHERE year = 2016 ORDER BY diff;
/* Peru, 1279999.9891 */
```

```
/* Part 2 */

/* Preliminary: Create regional view */
CREATE VIEW regional_forestation_1990_2016 AS
WITH data_1990 AS (
  SELECT
      country_code code,
      region,
      COALESCE(forest_area_sqkm, 0) AS forest_sqkm,
      COALESCE(total_area_sqkm, 0) AS total_sqkm
  FROM forestation WHERE year = 1990
),
data_2016 AS (
  SELECT
      country_code code,
      COALESCE(forest_area_sqkm, 0) AS forest_sqkm,
      COALESCE(total_area_sqkm, 0) AS total_sqkm
  FROM forestation WHERE year = 2016
),
sums AS(
  SELECT
      d1.region,
      SUM(d1.forest_sqkm) AS forest_sqkm_1990,
      SUM(d1.total_sqkm) AS total_sqkm_1990,
      SUM(d2.forest_sqkm) AS forest_sqkm_2016,
      SUM(d2.total_sqkm) AS total_sqkm_2016
  FROM data_1990 d1
  JOIN data_2016 d2 ON d1.code = d2.code
  GROUP BY region
)
SELECT
  region,
  100 * forest_sqkm_1990 / total_sqkm_1990
      AS forest_pct_1990,
  100 * forest_sqkm_2016 / total_sqkm_2016
      AS forest_pct_2016
FROM sums;

/* Preliminary: Display regional view */
SELECT * FROM regional_forestation_1990_2016
ORDER BY forest_pct_2016 DESC;
```

```
/*
   a. What was the percent forest of the entire world
      in 2016? Which region had the HIGHEST percent
      forest in 2016, and which had the LOWEST, to 2
      decimal places?
*/
SELECT region, forest_pct_2016
FROM regional_forestation_1990_2016
ORDER BY forest_pct_2016 DESC;
/*
    World: 31.38
  Highest: Latin America & Caribbean, 46.16
   Lowest: Middle East & North Africa, 2.07
*/

/*
   b. What was the percent forest of the entire world
      in 1990? Which region had the HIGHEST percent
      forest in 1990, and which had the LOWEST, to 2
      decimal places?
*/
SELECT region, forest_pct_1990
FROM regional_forestation_1990_2016
ORDER BY forest_pct_1990 DESC;
/*
      World: 32.42
  Highest: Latin America & Caribbean, 51.03
   Lowest: Middle East & North Africa, 1.78
*/

/*
   c. Based on the table you created, which regions
      of the world DECREASED in forest area from 1990
      to 2016?
*/
SELECT region, forest_pct_1990, forest_pct_2016
FROM regional_forestation_1990_2016
WHERE forest_pct_1990 > forest_pct_2016
  AND region != 'World';
/*
  Latin America & Caribbean, 51.03 to 46.16
  Sub-Saharan Africa, 30.67 to 28.79
*/
```

```
/* Part 3 */

/* Preliminary: Create national view */
CREATE VIEW national_forestation_1990_2016 AS
WITH data_1990 AS (
  SELECT
      country_code code,
      country_name country,
      region,
      forest_area_sqkm,
      total_area_sqkm,
      forest_pct
  FROM forestation WHERE year = 1990
),
data_2016 AS (
  SELECT
      country_code code,
      forest_area_sqkm,
      total_area_sqkm,
      forest_pct
  FROM forestation WHERE year = 2016
)
SELECT
  d1.country,
  d1.region,
  d1.forest_area_sqkm forest_sqkm_1990,
  d1.total_area_sqkm total_sqkm_1990,
  d1.forest_pct forest_pct_1990,
  d2.forest_area_sqkm forest_sqkm_2016,
  d2.total_area_sqkm total_sqkm_2016,
  d2.forest_pct forest_pct_2016
FROM data_1990 d1
JOIN data_2016 d2 ON d1.code = d2.code;

/* Preliminary: Display national view */
SELECT * FROM national_forestation_1990_2016
ORDER BY forest_pct_2016 DESC;
```

```
/*
   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?
*/
SELECT
  country,
  region,
  forest_sqkm_2016 - forest_sqkm_1990
      AS forest_sqkm_change
FROM national_forestation_1990_2016
WHERE country != 'World'
ORDER BY forest_sqkm_change;
/*
  Brazil, -541510
  Indonesia, -282193.98439999996
  Myanmar, -107234.00390000001
  Nigeria, -106506.00098
  Tanzania, -102320
*/
```

```
/*
   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?
*/
SELECT
  country,
  region,
  CASE
      WHEN forest_sqkm_1990 IS NULL
      OR forest_sqkm_1990 = 0
      OR forest_sqkm_2016 IS NULL
      THEN NULL
      ELSE 100 * (
      forest_sqkm_2016 - forest_sqkm_1990
      ) / forest_sqkm_1990
  END AS forest_pct_change
FROM national_forestation_1990_2016
WHERE country != 'World'
ORDER BY forest_pct_change;
/*
  Togo -75.45
  Nigeria -61.80
  Uganda -59.13
  Mauritania -46.75
  Honduras -45.03

  first four: Sub-Saharan Africa
  Honduras: Latin America & Caribbean
*/
```

```
/*
   c. If countries were grouped by percent
      forestation in quartiles, which group had the
      most countries in it in 2016?

  Remark:

  The question as written does not make sense.
  Quartiles, by definition, will always either contain
  the same number of items or differ by at most 1
  if the number of items in the data set is not
  divisible by 4.

  Instead, I am speculating that the question wants me
  to create four groups of countries by percent
  forestation with break points at 25%, 50%, and 75%.
  These are NOT quartiles, but at least such a
  classification is a sensible thing to do.
*/
WITH levels AS (
  SELECT
      country,
      CASE
      WHEN forest_pct_2016 > 75 THEN 4
      WHEN forest_pct_2016 > 50 THEN 3
      WHEN forest_pct_2016 > 25 THEN 2
      ELSE 1
      END AS forestation_level_2016
  FROM national_forestation_1990_2016
  WHERE forest_pct_2016 IS NOT NULL
  ORDER BY forest_pct_2016 DESC
)
SELECT
  forestation_level_2016,
  COUNT(*)
FROM levels
GROUP BY forestation_level_2016
ORDER BY forestation_level_2016 DESC;
/*
  group 4:  9
  group 3: 38
  group 2: 72
  group 1: 85

  bottom group, below 25% forestation, has the most
*/
```

```
/*
   d. List all of the countries that were in the 4th
      quartile (percent forest > 75%) in 2016.
*/
SELECT
  country,
  region,
  forest_pct_2016
FROM national_forestation_1990_2016
WHERE forest_pct_2016 > 75
ORDER BY forest_pct_2016 DESC;
/*
  Suriname, 98.26
  Micronesia, Fed. Sts., 91.86
  Gabon, 90.04
  Seychelles, 88.41
  Palau, 87.61
  American Samoa, 87.50
  Guyana, 83.90
  Lao PDR, 82.11
  Solomon Islands, 77.86
*/

/*
   e. How many countries had a percent forestation
      higher than the United States in 2016?
*/
SELECT COUNT(*)
FROM national_forestation_1990_2016
WHERE forest_pct_2016 > (
  SELECT forest_pct_2016
  FROM national_forestation_1990_2016
  WHERE country = 'United States'
);
/* 94 */



/*
  This is the end of the questions provided with the
  project instructions. However, some additional
  information is needed to fill in the remaining
  blanks in the report template. I have added some
  more questions and their corresponding SQL queries
  below.
*/
```

```
/*
   f. Which 2 countries saw the largest amount
      increase in forest area from 1990 to 2016? What
      was the difference in forest area for each?
*/
SELECT
  country,
  forest_sqkm_2016 - forest_sqkm_1990
      AS forest_sqkm_change
FROM national_forestation_1990_2016
WHERE country != 'World'
AND forest_sqkm_1990 IS NOT NULL
AND forest_sqkm_2016 IS NOT NULL
ORDER BY forest_sqkm_change DESC;
/*
  China, 527229.0619999999
  United States, 79200
*/

/*
   g. Which country saw the largest percent increase
      in forest area from 1990 to 2016? What was the
      percent change to 2 decimal places for each?
*/
SELECT
  country,
  region,
  CASE
      WHEN forest_sqkm_1990 IS NULL
      OR forest_sqkm_1990 = 0
      OR forest_sqkm_2016 IS NULL
      THEN NULL
      ELSE 100 * (
      forest_sqkm_2016 - forest_sqkm_1990
      ) / forest_sqkm_1990
  END AS forest_pct_change
FROM national_forestation_1990_2016
WHERE country != 'World'
AND forest_sqkm_1990 IS NOT NULL
AND forest_sqkm_1990 != 0
AND forest_sqkm_2016 IS NOT NULL
ORDER BY forest_pct_change DESC;
/* Iceland, 213.66% */
```