

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 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
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

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** 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 **79200** 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** increased in forest area by **213.66** % from 1990 to 2016.

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 5 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	282194
Myanmar	East Asia & Pacific	107234
Nigeria	Sub-Saharan Africa	106506
Tanzania	Sub-Saharan Africa	102320

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.

QUARTILES

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 **0-25%** quartile.

There were **nine** 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

94 countries had a percent forestation **higher** than the **United States** in 2016.

4. RECOMMENDATIONS

It is observed that the total forest area of the world decreased by **3.21%** from 1990 to 2016, with the forest area lost over this time period being greater than the entire land area of Peru listed for the year 2016.

Analysis of World Bank data points out that the top 5 countries where deforestation happened between 1990 and 2016 are in the regions **Sub-Saharan Africa, Latin America & Caribbean** and **East Asia & Pacific** - both in terms of absolute square kilometer decrease in forest as well as percent decrease.

Absolute square kilometer decrease countries: **Brazil, Indonesia, Myanmar, Nigeria, Tanzania**
Percent decrease countries: **Togo, Nigeria, Uganda, Mauritania, Honduras**

There is a trend of global deforestation and the need for further efforts to combat it.

- Majority of resources should be deployed in the top 5 countries identified in those regions to stop the decline. Remaining resources can be deployed in other countries, where efforts in increasing forest area can provide environmental and economic benefits.
- 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.

5. APPENDIX: SQL Queries Used

Below SQL queries can be used to reproduce or validate results and analysis presented in this report.

Creating a VIEW

```
DROP VIEW IF EXISTS forestation;
```

```
CREATE VIEW forestation
```

```
AS
```

```
(SELECT f.country_code,  
        f.country_name,
```

```

        f.year,
        f.forest_area_sqkm,
        2.59 * l.total_area_sq_mi AS
            land_area_sqkm,
        ( ( forest_area_sqkm / ( 2.59 * l.total_area_sq_mi ) ) * 100 ) AS
            forest_percentage,
        r.region,
        r.income_group
FROM forest_area AS f
LEFT JOIN land_area AS l
    ON f.country_code = l.country_code
    AND f.year = l.year
LEFT JOIN regions AS r
    ON f.country_code = r.country_code);

SELECT *
FROM forestation;

```

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 SUM(forest_area_sqkm)
FROM forestation
WHERE year = 1990
    AND country_name = 'World';

```

Output:

41282694.9

-- b. What was the total forest area (in sq km) of the world in 2016? Please keep in mind that the country record in the table is denoted as "World."

```

SELECT SUM(forest_area_sqkm)
FROM forestation
WHERE year = 2016
    AND country_name = 'World';

```

Output:

39958245.9

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

```
WITH fore_1990
  AS (SELECT SUM(forest_area_sqkm) AS a_1990
      FROM   forestation
      WHERE  year = 1990
            AND country_name = 'World'),
fore_2016
  AS (SELECT SUM(forest_area_sqkm) AS a_2016
      FROM   forestation
      WHERE  year = 2016
            AND country_name = 'World'),
diff
  AS (SELECT a_2016,
            a_1990,
            a_2016 - a_1990 AS diff
      FROM   fore_2016,
            fore_1990)
SELECT diff
FROM   diff;
```

Output:

-1324449

-- d. What was the percent change in forest area of the world between 1990 and 2016?

```
WITH fore_1990
  AS (SELECT ROUND(SUM(forest_area_sqkm::numeric),2) AS a_1990
      FROM   forestation
      WHERE  year = 1990
            AND country_name = 'World'),
fore_2016
  AS (SELECT ROUND(SUM(forest_area_sqkm::numeric),2) AS a_2016
      FROM   forestation
      WHERE  year = 2016
            AND country_name = 'World'),
diff
  AS (SELECT a_2016,
            a_1990,
            ABS(a_2016 - a_1990) AS diff
      FROM   fore_2016,
            fore_1990)
```

```
SELECT ROUND(((diff/a_1990)*100),2)
FROM    diff;
```

Output:

3.21%

-- 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 fore_1990
  AS (SELECT SUM(forest_area_sqkm) AS a_1990
      FROM    forestation
      WHERE   year = 1990
            AND country_name = 'World'),
  fore_2016
  AS (SELECT SUM(forest_area_sqkm) AS a_2016
      FROM    forestation
      WHERE   year = 2016
            AND country_name = 'World'),
  diff
  AS (SELECT a_2016,
            a_1990,
            ABS(a_2016 - a_1990) AS diff
      FROM    fore_2016,
            fore_1990)
SELECT country_name,
       year,
       land_area_sqkm
FROM    forestation
WHERE   year = 2016
      AND land_area_sqkm <= (SELECT diff
                           FROM    diff)
ORDER  BY land_area_sqkm DESC
LIMIT  1;
```

Output:

country_name	year	land_area_sqkm
Peru	2016	1279999.9891

REGIONAL OUTLOOK

-- 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?

```
WITH a
  AS (SELECT region,
            ROUND(( SUM(forest_area_sqkm :: NUMERIC) /
                    SUM(land_area_sqkm :: NUMERIC) ) *
                100, 2) AS perc_forest_2016
    FROM   forestation
   WHERE  year = 2016
   GROUP  BY region
   ORDER  BY perc_forest_2016 DESC),
  b
  AS (SELECT region,
            ROUND(( SUM(forest_area_sqkm :: NUMERIC) /
                    SUM(land_area_sqkm :: NUMERIC) ) *
                100, 2) AS perc_forest_1990
    FROM   forestation
   WHERE  year = 1990
   GROUP  BY region
   ORDER  BY perc_forest_1990 DESC)
SELECT *
FROM   a AS a
      FULL join b AS b
      ON a.region = b.region
ORDER  BY perc_forest_2016 DESC;
```

Output:

percent forest of the entire world in 2016: 31.38

Which region had the HIGHEST percent forest in 2016: Latin America & Caribbean : 46.16

which had the LOWEST, to 2 decimal places: 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?

```
WITH a
  AS (SELECT region,
            ROUND(( SUM(forest_area_sqkm :: NUMERIC) /
                    SUM(land_area_sqkm :: NUMERIC) ) *
                100, 2) AS perc_forest_2016
```

```

        FROM   forestation
        WHERE  year = 2016
        GROUP  BY region
        ORDER  BY perc_forest_2016 DESC),
b
AS (SELECT region,
        ROUND(( SUM(forest_area_sqkm :: NUMERIC) /
                SUM(land_area_sqkm :: NUMERIC) ) *
                100, 2) AS perc_forest_1990
    FROM   forestation
    WHERE  year = 1990
    GROUP  BY region
    ORDER  BY perc_forest_1990 DESC)
SELECT *
FROM   a AS a
      FULL join b AS b
      ON a.region = b.region
ORDER  BY perc_forest_1990 DESC;

```

Output:

percent forest of the entire world in 1990: 32.42

Which region had the HIGHEST percent forest in 1990 : Latin America & Caribbean :
51.03

which had the LOWEST, to 2 decimal places? : 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?

```

WITH a
    AS (SELECT region,
        ROUND(( SUM(forest_area_sqkm :: NUMERIC) /
                SUM(land_area_sqkm :: NUMERIC) ) *
                100, 2) AS perc_forest_2016
    FROM   forestation
    WHERE  year = 2016
    GROUP  BY region
    ORDER  BY perc_forest_2016 DESC),
b
    AS (SELECT region,
        ROUND(( SUM(forest_area_sqkm :: NUMERIC) /
                SUM(land_area_sqkm :: NUMERIC) ) *
                100, 2) AS perc_forest_1990

```

```

        FROM   forestation
        WHERE  year = 1990
        GROUP BY region
        ORDER BY perc_forest_1990 DESC)
SELECT *, perc_forest_2016 - perc_forest_1990 AS diff
FROM a AS a
FULL JOIN b AS b
ON a.region=b.region
ORDER BY abs(perc_forest_2016 - perc_forest_1990) DESC;

```

Output:

region	perc_forest_2016	perc_forest_1990	diff
Latin America & Caribbean	46.16	51.03	-4.87
Sub-Saharan Africa	28.79	30.67	-1.88
World	31.38	32.42	-1.04

COUNTRY-LEVEL DETAIL

A. SUCCESS STORIES:

```

WITH a
    AS (SELECT country_name,
              region,
              forest_area_sqkm AS forest_2016
    FROM   forestation
    WHERE  year = 2016
          AND forest_area_sqkm IS NOT NULL
          AND country_name <> 'World'
    ORDER BY forest_2016 DESC),
    b
    AS (SELECT country_name,
              region,
              forest_area_sqkm AS forest_1990
    FROM   forestation
    WHERE  year = 1990
          AND forest_area_sqkm IS NOT NULL
          AND country_name <> 'World'
    ORDER BY forest_1990 DESC)
SELECT *, forest_2016 - forest_1990 AS diff

```

```

FROM a AS a
FULL JOIN b AS b
ON a.country_name=b.country_name
ORDER BY diff DESC
LIMIT 5;

```

Output:

Country_name	region	forest_2016	forest_1990	diff
China	East Asia & Pacific	2098635.00	1571405.94	527229.06
United States	North America	3103700.00	3024500.00	79200.00
India	South Asia	708603.98	639390.00	69213.98
Russian Federation	Europe & Central Asia	8148895.00	8089500.00	59395.00
Vietnam	East Asia & Pacific	149020.00	93630.00	55390.00

```

WITH a
    AS (SELECT country_name,
              region,
              forest_area_sqkm AS forest_2016
    FROM   forestation
    WHERE  year = 2016
          AND forest_area_sqkm IS NOT NULL
          AND country_name <> 'World'
    ORDER BY forest_2016 DESC),
    b
    AS (SELECT country_name,
              region,
              forest_area_sqkm AS forest_1990
    FROM   forestation
    WHERE  year = 1990
          AND forest_area_sqkm IS NOT NULL
          AND country_name <> 'World'
    ORDER BY forest_1990 DESC)
SELECT *, ROUND(((forest_2016 - forest_1990)*100/forest_1990)::NUMERIC,2) AS perc_diff
FROM a AS a
FULL JOIN b AS b
ON a.country_name=b.country_name
WHERE ROUND(((forest_2016 - forest_1990)*100/forest_1990)::NUMERIC,2) IS NOT NULL
ORDER BY perc_diff DESC
LIMIT 5;

```

Output:

country_name	region	forest_2016	forest_1990	perc_diff
Iceland	Europe & Central Asia	505	161.0000038	213.66

French Polynesia	East Asia & Pacific	1550	550	181.82
Bahrain	Middle East & North Africa	6.100000143	2.199999988	177.27
Uruguay	Latin America & Caribbean	18677.3999	7977.999878	134.11
Dominican Republic	Latin America & Caribbean	20161.99951	11050	82.46

B. LARGEST CONCERNS

-- 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 a
  AS (SELECT country_name,
            region,
            forest_area_sqkm AS forest_2016
  FROM   forestation
  WHERE  year = 2016
        AND forest_area_sqkm IS NOT NULL
        AND country_name <> 'World'
  ORDER BY forest_2016 DESC),
  b
  AS (SELECT country_name,
            region,
            forest_area_sqkm AS forest_1990
  FROM   forestation
  WHERE  year = 1990
        AND forest_area_sqkm IS NOT NULL
        AND country_name <> 'World'
  ORDER BY forest_1990 DESC)
SELECT *, forest_2016 - forest_1990 AS diff
FROM a AS a
FULL JOIN b AS b
ON a.country_name=b.country_name
ORDER BY diff
LIMIT 5;
```

Output:

country_name	region	forest_2016	forest_1990	diff
Brazil	Latin America & Caribbean	4925540.00	5467050.00	-541510.00
Indonesia	East Asia & Pacific	903256.02	1185450.00	-282193.98
Myanmar	East Asia & Pacific	284946.00	392180.00	-107234.00
Nigeria	Sub-Saharan Africa	65834.00	172340.00	-106506.00

Tanzania	Sub-Saharan Africa	456880.00	559200.00	-102320.00
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-- alternate way using SELF JOIN

```
SELECT a.country_name, a.region, a.forest_area_sqkm AS forest_2016,
b.forest_area_sqkm AS forest_1990, a.forest_area_sqkm - b.forest_area_sqkm AS diff
FROM forestation a
INNER JOIN forestation b ON a.country_name = b.country_name
WHERE a.year = 2016
AND b.year = 1990
AND a.forest_area_sqkm IS NOT NULL
AND b.forest_area_sqkm IS NOT NULL
AND a.country_name <> 'World'
ORDER BY diff
LIMIT 5;
```

Output:

country_name	region	forest_2016	forest_1990	diff
Brazil	Latin America & Caribbean	4925540.00	5467050.00	-541510.00
Indonesia	East Asia & Pacific	903256.02	1185450.00	-282193.98
Myanmar	East Asia & Pacific	284946.00	392180.00	-107234.00
Nigeria	Sub-Saharan Africa	65834.00	172340.00	-106506.00

-- 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 a
  AS (SELECT country_name,
            region,
            forest_area_sqkm AS forest_2016
      FROM forestation
     WHERE year = 2016
            AND forest_area_sqkm IS NOT NULL
            AND country_name <> 'World'
     ORDER BY forest_2016 DESC),
  b
  AS (SELECT country_name,
            region,
            forest_area_sqkm AS forest_1990
      FROM forestation
     WHERE year = 1990
            AND forest_area_sqkm IS NOT NULL
```

```

        AND country_name <> 'World'
    ORDER BY forest_1990 DESC)
SELECT *, ROUND(((forest_2016 - forest_1990)*100/forest_1990)::NUMERIC,2) AS perc_diff
FROM a AS a
FULL JOIN b AS b
ON a.country_name=b.country_name
ORDER BY perc_diff
LIMIT 5;

```

Output:

country_name	region	forest_2016	forest_1990	perc_diff
Togo	Sub-Saharan Africa	1681.999969	6850	-75.45
Nigeria	Sub-Saharan Africa	65833.99902	172340	-61.80
Uganda	Sub-Saharan Africa	19418.00049	47510	-59.13
Mauritania	Sub-Saharan Africa	2210	4150	-46.75
Honduras	Latin America & Caribbean	44720	81360	-45.03

C. QUARTILES

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

```

WITH a
    AS (SELECT f.country_name,
        CASE
            WHEN f.forest_percentage >= 75 THEN '75%-100%'
            WHEN f.forest_percentage >= 50 THEN '50%-75%'
            WHEN f.forest_percentage >= 25 THEN '25%-50%'
            ELSE '0-25%'
        END AS quartiles
    FROM forestation f
    WHERE year = 2016
        AND f.forest_percentage IS NOT NULL
        AND f.country_name <> 'World')
SELECT quartiles,
    Count(*)
FROM a
GROUP BY quartiles
ORDER BY quartiles;

```

Output:

quartiles	count
-----------	-------

0-25%	85
25%-50%	72
50%-75%	38
75%-100%	9

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

```
WITH a
  AS (SELECT f.country_name,
            f.region,
            f.forest_percentage,
            CASE
              WHEN f.forest_percentage >= 75 THEN '75%-100%'
              WHEN f.forest_percentage >= 50 THEN '50%-75%'
              WHEN f.forest_percentage >= 25 THEN '25%-50%'
              ELSE '0-25%'
            END AS quartiles
  FROM   forestation f
  WHERE  year = 2016
        AND f.forest_percentage IS NOT NULL
        AND f.country_name <> 'World')
SELECT country_name,
       region,
       Round(forest_percentage :: NUMERIC, 2) AS perc_forest
FROM   a
WHERE  quartiles = '75%-100%'
ORDER BY perc_forest DESC;
```

Output:

country_name	region	perc_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


```
-- Alternate way:
SELECT country_name,
       region,
       Round(forest_percentage :: NUMERIC, 2) AS perc_forest
FROM   forestation
WHERE  forest_percentage > 75
       AND year = 2016
ORDER BY perc_forest DESC;

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

```
WITH usa
     AS (SELECT forest_percentage AS usa_percentage
          FROM   forestation f
          WHERE  country_code = 'USA'
                AND year = 2016),
     countries
     AS (SELECT country_name
          FROM   forestation,
                usa
          WHERE  forest_percentage > usa_percentage
                AND year = 2016)
SELECT Count(*)
FROM   countries;
```

Output:

```
count
94
```

```
-- Alternate way using SELF JOIN
WITH usa AS (
    SELECT forest_percentage AS usa_percentage
    FROM   forestation
    WHERE  country_code = 'USA' AND year = 2016
),
countries AS (
    SELECT f.country_name
    FROM   forestation f
    INNER JOIN usa ON f.year = 2016 AND f.forest_percentage > usa.usa_percentage
```

Output:

count

94