

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 sqkm¹ in 1990. As of 2016, the most recent year for which data was available, that number had fallen to 39'958'245.9 sqkm², a loss of 1'324'449 sqkm³, or 3.21%⁴.

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 1'279'999.9891 sqkm⁵).

2. REGIONAL OUTLOOK

In 2016, the percent of the total land area of the world designated as forest was 31.38%⁶. 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% forestation⁷.

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% forestation⁸.

Table 2.1: Percent Forest Area by Region, 1990 & 2016:

Region	1990 Forest Percentage	2016 Forest Percentage	Percentage Difference
Sub-Saharan Africa	30.67	28.79	-1.88
South Asia	16.51	17.51	1
North America	35.65	36.04	0.39
Middle East & North	1.78	2.07	0.29

Africa			
Latin America & Caribbean	51.03	46.16	-4.87
Europe & Central Asia	37.28	38.04	0.76
East Asia & Pacific	25.78	26.36	0.58

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%.⁹

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 527'229.062 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 2016.¹⁰

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 5 countries had the largest decrease in forest area over the time period under consideration.¹¹

Table 3.1: Top 5 Amount Decrease in Forest Area by Country, 1990 & 2016:

Country	Region	Absolute Forest Area Change (sqKM) (Decrease)
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Brazil	Latin America & Caribbean	541'510
Indonesia	East Asia & Pacific	282'193.9844
Myanmar	East Asia & Pacific	107'234.0039
Nigeria	Sub-Saharan Africa	106'506.00098
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 (Decrease)
Togo	Sub-Saharan Africa	75.45
Nigeria	Sub-Saharan Africa	61.8
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 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, 2016:¹²

Quartile	Number of Countries
1 (<25%)	85
2 (25%=><50%)	72
3 (50%=><75%)	38
4 (=>75%)	9

The largest number of countries in 2016 were found in the first 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, 2016¹³:

Country	Region	Percent 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

5. RECOMMENDATIONS

5.1. General Situation

Looking at the world bank data, we see that deforestation is getting worse by years. A record-breaking loss of forests can be seen between 1990 and 2016. Almost 1.3 million square kilometers of forest were lost from 1990 to 2016 (about the size of Peru). And why is deforestation so critical? It has different aspects:

1. deforestation causes the destruction of natural habitats and the loss of species. It is known that 70% of the world's plants and animals live in forests. When habitats are lost because of deforestation, it puts pressure on a large number of species and is the direct cause of extinctions.
2. global warming: most countries in the world are experiencing their hottest summer in their history, and deforestation is the major factor in global warming and CO2 emissions.
3. water cycle: trees are essential to the water cycle. In the rainforest ecosystem, over half the water is held within plants as absorbed rainfall, and three quarters of the world's freshwater is supplied by forest catchments. So, when trees are cut down, the water cycle is destroyed as well. More than half the world is currently experiencing severe drought. It affects agriculture directly, which is the main economic source of income for one-third of the world's population.
4. Soil erosion: Without the roots of trees to anchor the soil, it washes away, including the nutrients contained in the soil. If soil erosion is not stopped, it can ultimately turn the land into a desert. Besides that, the Southeast Asian region is experiencing earthquakes due to soil erosion and landslides where thousands of people are dying and their houses are destroyed.

Analysing the world bank data shows that almost 42% (85) of the world's countries have less than 25% forestation. It also shows the worsening situation in the Sub-Saharan Africa region and the Latin America and Caribbean region. However, during the data analysis, East Asia and the Pacific region had an increase of 0.58% in forestation between 1990 and 2016, which may have happened only because of one country—China, which had a tremendous amount of forestation increase. While excluding one country, the others in the region are disappointing. Specifically, looking at Indonesia and Myanmar in the mentioned region (a loss of approximately 390 thousand square kilometers of forestation). In the Latin America and Caribbean region, Brazil's situation is scary (almost half a million square kilometers of lost forests). In the Sub-Saharan Africa region, the top four countries almost lost an average of 61% of their forestation between 1990 and 2016, among which both Nigeria and Tanzania lost almost 208 thousand square kilometers of forest in total.

5.2. What to do?

It is recommended to the World Bank that it should apply restrict measures on awarding of projects, bilateral agreements with the countries, loan approvals, and any other activities and make coping with deforestation a pre-condition in its activities with relevant countries. Besides that, the world bank should put more general preconditions on its loans and grants, such as promotion of sustainable choices, promoting re-use of wooden materials, and award of contracts only to those companies who are actively implementing zero-deforestation policies.

It is recommended that the World Bank rethink its bilateral activities with the specific countries mentioned below.

5.3. Where to focus?

Focus Areas:

Regions:

- Sub-Saharan Africa region
- Latin America and the Caribbean region
- East Asia and the Pacific region.

Countries:

- Brazil
- Nigeria
- Tanzania
- Indonesia
- Myanmar

List of Queries:

-
- 1
 - 2
 - 3
 - 4
 - 5
 - 6
 - 7
 - 8
 - 9
 - 10
 - 11
 - 12
 - 13

```

CREATE VIEW forestation AS
    SELECT forest_area.country_code AS forest_by_CountryCode,
           forest_area.country_name AS forest_by_Countryname,
           forest_area.year AS forestation_by_year,
           forest_area.forest_area_sqkm AS forestation_by_sq_km,
           land_area.total_area_sq_mi AS land_total_area_sq_mi,
           regions.region AS r_region,
           regions.income_group AS r_income,
           (forest_area.forest_area_sqkm / (land_area.total_area_sq_mi * 2.59) ) *
100 AS percentage_forest_area
    FROM forest_area
        JOIN
        land_area ON forest_area.country_code = land_area.country_code
        JOIN
        regions ON land_area.country_code = regions.country_code
    WHERE forest_area.year = land_area.year
    ORDER BY 1;

```

(1)

```

SELECT *
    FROM forest_area
    WHERE country_name = 'World' AND
           year = '1990';

```

(2)

```

SELECT *
    FROM forest_area
    WHERE country_name = 'World' AND
           year = '2016';

```

(3)

```

WITH Y1990 AS (
    SELECT forest_area_sqkm
        FROM forest_area
        WHERE country_name = 'World' AND
              year = '1990'
),
Y2016 AS (
    SELECT forest_area_sqkm
        FROM forest_area
        WHERE country_name = 'World' AND
              year = '2016'
)
SELECT (Y1990.forest_area_sqkm - Y2016.forest_area_sqkm) change
    FROM Y1990,
        Y2016;

```



```

-----
(4)
SELECT ( ( (
    SELECT sum(forestation_by_sq_km)
    FROM forestation
    WHERE forestation_by_year = 1990 AND
    forest_by_countryname = 'World'
    )
- (
    SELECT sum(forestation_by_sq_km)
    FROM forestation
    WHERE forestation_by_year = 2016 AND
    forest_by_countryname = 'World'
    )
) * 100) / ( (
    SELECT sum(forestation_by_sq_km)
    FROM forestation
    WHERE forestation_by_year = 1990 AND
    forest_by_countryname = 'World'
    )
) AS percentchange;

```

```

-----
(5)
SELECT total_land_area,
    forest_by_countryname
FROM (
    SELECT sum(land_total_area_sq_mi * 2.59) AS total_land_area,
        forest_by_countryname
    FROM forestation
    WHERE forestation_by_year = 2016
    GROUP BY forest_by_countryname
    ORDER BY total_land_area DESC
    )
AS land_area_16
WHERE total_land_area < (
    SELECT ( (
        SELECT sum(forestation_by_sq_km)
        FROM forestation
        WHERE forestation_by_year = 1990 AND
        forest_by_countryname = 'World'
        )
- (
        SELECT sum(forestation_by_sq_km)
        FROM forestation
        WHERE forestation_by_year = 2016 AND
        forest_by_countryname = 'World'
        )
    )
)

```

```
)  
LIMIT 1;
```

```
-----  
(6)  
WITH land_table AS (  
    SELECT *  
    FROM land_area  
    WHERE year = '2016' AND  
           country_name = 'World'  
) ,  
forest_table AS (  
    SELECT *  
    FROM forest_area  
    WHERE year = '2016' AND  
           country_name = 'World'  
)  
SELECT r.region,  
       SUM(l.total_area_sq_mi * 2.59) total_land_area_sqkm_2016,  
       SUM(f.forest_area_sqkm) total_forest_area_sqkm_2016,  
       ROUND(CAST ( (SUM(f.forest_area_sqkm) / (SUM(l.total_area_sq_mi * 2.59) ) ) *  
100 AS NUMERIC), 2) AS forest_area_by_percent_2016  
FROM land_table l  
     INNER JOIN  
     forest_table f ON f.country_name = l.country_name  
     INNER JOIN  
     regions r ON r.country_code = f.country_code  
GROUP BY 1  
ORDER BY 4 DESC  
LIMIT 10;
```

```
-----  
(7)  
WITH land_table AS (  
    SELECT *  
    FROM land_area  
    WHERE year = '2016'  
) ,  
forest_table AS (  
    SELECT *  
    FROM forest_area  
    WHERE year = '2016'  
)  
SELECT r.region,  
       SUM(l.total_area_sq_mi * 2.59) total_land_area_sqkm_2016,  
       SUM(f.forest_area_sqkm) total_forest_area_sqkm_2016,  
       ROUND(CAST ( (SUM(f.forest_area_sqkm) / (SUM(l.total_area_sq_mi * 2.59) ) ) *  
100 AS NUMERIC), 2) AS forest_area_by_percent_2016  
FROM land_table l  
     INNER JOIN
```

```

        forest_table f ON f.country_name = l.country_name
        INNER JOIN
        regions r ON r.country_code = f.country_code
GROUP BY 1
ORDER BY 4 DESC
LIMIT 10;

```

(8)

```

WITH land_table AS (
    SELECT *
    FROM land_area
    WHERE year = '1990'
),
forest_table AS (
    SELECT *
    FROM forest_area
    WHERE year = '1990'
)
SELECT r.region,
       SUM(l.total_area_sq_mi * 2.59) total_land_area_sqkm_1990,
       SUM(f.forest_area_sqkm) total_forest_area_sqkm_1990,
       ROUND(CAST ( (SUM(f.forest_area_sqkm) / (SUM(l.total_area_sq_mi * 2.59) ) ) *
100 AS NUMERIC), 2) AS forest_area_by_percent_1990
FROM land_table l
    INNER JOIN
    forest_table f ON f.country_name = l.country_name
    INNER JOIN
    regions r ON r.country_code = f.country_code
GROUP BY 1
ORDER BY 4 DESC
LIMIT 10;

```

(9)

```

WITH Y1 AS (
WITH land_table AS (
    SELECT *
    FROM land_area
    WHERE year = '1990'
),
forest_table AS (
    SELECT *
    FROM forest_area
    WHERE year = '1990'
)
SELECT r.region,
       SUM(l.total_area_sq_mi * 2.59) total_land_area_sqkm_1990,
       SUM(f.forest_area_sqkm) total_forest_area_sqkm_1990,
       ROUND(CAST ( (SUM(f.forest_area_sqkm) / (SUM(l.total_area_sq_mi * 2.59) )

```

```

) * 100 AS NUMERIC), 2) AS forest_area_by_percent_1990
    FROM land_table l
        INNER JOIN
            forest_table f ON f.country_name = l.country_name
        INNER JOIN
            regions r ON r.country_code = f.country_code
    GROUP BY 1
    ORDER BY 4 DESC
),
Y2 AS (
WITH land_table AS (
    SELECT *
    FROM land_area
    WHERE year = '2016'
),
forest_table AS (
    SELECT *
    FROM forest_area
    WHERE year = '2016'
)
SELECT r.region,
    SUM(l.total_area_sq_mi * 2.59) total_land_area_sqkm_2016,
    SUM(f.forest_area_sqkm) total_forest_area_sqkm_2016,
    ROUND(CAST ( (SUM(f.forest_area_sqkm) / (SUM(l.total_area_sq_mi * 2.59) )
) * 100 AS NUMERIC), 2) AS forest_area_by_percent_2016
    FROM land_table l
        INNER JOIN
            forest_table f ON f.country_name = l.country_name
        INNER JOIN
            regions r ON r.country_code = f.country_code
    GROUP BY 1
    ORDER BY 4 DESC
)
SELECT Y1.region,
    Y1.forest_area_by_percent_1990 percent_area_1990,
    Y2.forest_area_by_percent_2016 percent_area_2016,
    Y2.forest_area_by_percent_2016 - Y1.forest_area_by_percent_1990
percent_difference_forest_area
    FROM Y1
        JOIN
            Y2 ON Y1.region = Y2.region
    ORDER BY 1 DESC;

```

```

-----
-----
(10)
WITH Y1990 AS (
    SELECT *
    FROM forest_area
    WHERE country_name != 'World' AND

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        year = '1990' AND
        forest_area_sqkm IS NOT NULL
    ),
    Y2016 AS (
        SELECT *
        FROM forest_area
        WHERE country_name != 'World' AND
        year = '2016' AND
        forest_area_sqkm IS NOT NULL
    )
SELECT Y1990.country_name,
       Y1990.forest_area_sqkm forest_area_sqkm_1990,
       Y2016.forest_area_sqkm forest_area_sqkm_2016,
       (Y1990.forest_area_sqkm - Y2016.forest_area_sqkm) change,
       ROUND(CAST ( ( (Y1990.forest_area_sqkm - Y2016.forest_area_sqkm) /
Y1990.forest_area_sqkm) * 100 AS NUMERIC), 2) AS percent_change
FROM Y1990
JOIN
    Y2016 ON Y1990.country_name = Y2016.country_name
ORDER BY 4
LIMIT 10;

```

```

-----
(11)
WITH Y1990 AS (
    SELECT *
    FROM forest_area
    WHERE country_name != 'World' AND
    year = '1990' AND
    forest_area_sqkm IS NOT NULL
),
Y2016 AS (
    SELECT *
    FROM forest_area
    WHERE country_name != 'World' AND
    year = '2016' AND
    forest_area_sqkm IS NOT NULL
)
SELECT Y1990.country_name,
       regions.region,
       Y1990.forest_area_sqkm forest_area_sqkm_1990,
       Y2016.forest_area_sqkm forest_area_sqkm_2016,
       (Y1990.forest_area_sqkm - Y2016.forest_area_sqkm) change,
       ROUND(CAST ( ( (Y1990.forest_area_sqkm - Y2016.forest_area_sqkm) /
Y1990.forest_area_sqkm) * 100 AS NUMERIC), 2) AS percent_change
FROM Y1990
JOIN
    Y2016 ON Y1990.country_name = Y2016.country_name
JOIN
    regions ON Y1990.country_name = regions.country_name

```

```
ORDER BY 5 DESC
LIMIT 5;
```

(12)

```
WITH g1 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,
           (f.forest_area_sqkm / (l.total_area_sq_mi * 2.59) ) * 100 AS
forest_percent
    FROM forest_area f
         JOIN
         land_area l ON f.country_code = l.country_code AND
                        (f.country_name != 'World' AND
                         f.forest_area_sqkm IS NOT NULL AND
                         l.total_area_sq_mi IS NOT NULL) AND
                        (f.year = 2016 AND
                         l.year = 2016)

    ORDER BY 6 DESC
),
g2 AS (
    SELECT g1.country_code,
           g1.country_name,
           g1.year,
           g1.forest_percent,
           CASE WHEN g1.forest_percent >= 75 THEN 4 WHEN g1.forest_percent < 75 AND
g1.forest_percent >= 50
THEN 3 WHEN g1.forest_percent < 50 AND
g1.forest_percent >= 25 THEN 2 ELSE 1 END AS quartile
    FROM g1
    ORDER BY 5 DESC
)
SELECT g2.quartile,
       COUNT(g2.quartile)
    FROM g2
   GROUP BY 1
   ORDER BY 2 DESC;
```

(13)

```
WITH g1 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,
        (f.forest_area_sqkm / (l.total_area_sq_mi * 2.59) ) * 100 AS
forest_percent
    FROM forest_area f
    JOIN
        land_area l ON f.country_code = l.country_code AND
                    (f.country_name != 'World' AND
                     f.forest_area_sqkm IS NOT NULL AND
                     l.total_area_sq_mi IS NOT NULL) AND
                    (f.year = 2016 AND
                     l.year = 2016)

    ORDER BY 6 DESC
),
g2 AS (
    SELECT g1.country_code,
           g1.country_name,
           g1.year,
           g1.forest_percent,
           CASE WHEN g1.forest_percent >= 75 THEN 4 WHEN g1.forest_percent < 75 AND
                                                         g1.forest_percent >= 50
THEN 3 WHEN g1.forest_percent < 50 AND

           g1.forest_percent >= 25 THEN 2 ELSE 1 END AS quartile
    FROM g1
    ORDER BY 5 DESC
)
SELECT g2.country_name,
       r.region,
       ROUND(CAST (g2.forest_percent AS NUMERIC), 2) AS forest_percent,
       g2.quartile
FROM g2
JOIN
    regions r ON g2.country_code = r.country_code
WHERE g2.quartile = 4
ORDER BY 3 DESC;

```