

ForestQuery: Global Deforestation Report (1990 – 2016)

ForestQuery (**FQ**) is a non-profit organisation which is primarily focused on the issue of deforestation. FQ is committed to combat the effects of deforestation, raise awareness about deforestation and educating the public about deforestation. All this is done on a worldwide scale as deforestation is a global issue affecting everyone in the world, regardless of their geographic location.

FQ's data analytics department recently acquired data from the World Bank (**WB**) which covers forest area and land area, categorised per country, for a 27 year period starting in 1990 and ending in 2016. This data also includes the region that each country is grouped by according to their geographical location and each country's income group status as determined by the WB.

The FQ data analytics department has leveraged SQL¹ to analyse, combine and query the various data tables. As a result, the department has highlighted 3 main areas which, in the department's opinion, should be examined by the FQ executive team.

1. GLOBAL SITUATION

In 1990, according to the WB data, the total forest area globally was around **41 282 695** km². In 2016, the latest year covered by the WB data, the global total forest area was **39 958 246** km². This is a decrease of **1 324 449** km², which represents a **3.31%** decrease over the 27 year period that the WB data covers.

The total amount of forest area lost during this 27 year period is slightly more than the total land area of **Peru**, which is 1 279 951 km² (as of 2016). Essentially, a forest area slightly larger than the entire land area of Peru has been lost since 1990.

¹ Structured Query Language.

2. REGIONAL OUTLOOK

As of 2016, according to the WB data, around **31.38%** of the world's total land area was classified as forest area. The **Latin America & Caribbean (LAC)** region is the region with the highest relative forest area, with around **46.16%** of the region designated as forest area. The region with the lowest relative forest area is the **Middle East & North Africa (MENA)** region, with around **2.07%** of the region being classified as forest area.

Looking back at 1990, the WB data shows that around **32.42%** of the world was categorised as forest area. Just as it was in 2016, the **LAC** region was the region with the highest relative forest area in 1990, with around **51.03%** of the region being designated as forest area. In 1990, the **MENA** region had **1.78%** of its total area classified as forest, with the region having the lowest relative forest area.

Region	1990 Forest Area (%)	2016 Forest Area (%)
East Asia & Pacific	25.78	26.36
Europe & Central Asia	37.29	38.04
Latin America & Caribbean	51.03	46.16
Middle East & North Africa	1.78	2.07
North America	35.65	36.04
South Asia	16.51	17.51
Sub-Saharan Africa	30.68	28.79

Table 1 Forest percent area by Region, 1990 - 2016

The regions that experienced a decrease in forest area between 1990 and 2016 were the **LAC** region, which decreased from 51.03% to 46.16% (a decrease of **4.87%**) and the **Sub-Saharan Africa (SSA)** region, which decreased from 30.68% to 28.79% (a decrease of **1.89%**). In contrast, all the other regions experienced an increase in forest area in the 27 year period covered by the WB data. The sizeable decrease in forest area experienced by the **LAC** and **SSA** regions had the effect that, globally, the world's total forest area decreased from 32.42% to 31.38% (a decrease of **1.04%**) during this period.

3. COUNTRY-LEVEL DETAIL

3.1 Success Stories

A country that is statistically significant in terms of increasing its forest area from 1990 to 2016 is **China**. The WB data showed that **China** increased its forest area by **527 229 km²**, which is over 6 times more than the next ranked country in terms of increased forest area. A further study into the reasons for the Chinese increase in terms of forest area should be looked at in order to understand how such a substantial increase was achieved.

After China, the country that achieved the highest total forest area increase from 1990 to 2016 was the **United States of America (USA)**, which saw an increase of **79 200 km²** in the 27 year period covered by the WB data. This increase is considerably lower when compared to the increase for China.

China and the USA are of course countries with considerable total land areas². Shifting the focus to the highest percentage increase of forest area from 1990 to 2016, the lesser known country of **Iceland (ISL)** holds the number 1 rank based on this metric. In 27 years, **ISL** increased its total forest area by **213.66%**, tripling its forest area percentage (**FAP**) from an initial value of around 16% in 1990 to a final value of around 50% in 2016.

3.2 Largest Concerns

Which countries are deeply or severely affected by deforestation? This question can be viewed from two perspectives. Firstly, the WB data can be examined to find the decrease in forest area by square kilometres over the 27 years that the data covers. Accordingly, the following 5 countries experienced the greatest decrease in forest area from 1990 until 2016:

² China's total land area is 9 387 848 km² and the USA's total land area is 9 147 067 km².

Country	Region	Forest Area Decrease (km ²)
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

Table 2 Top 5 countries forest area decrease amount, 1990 - 2016

Alternatively, an analysis of the WB data according to the percentage decrease in forest area, from 1990 to 2016, identifies the following 5 countries:

Country	Region	Forest Area Decrease (%)
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

Table 3 Top 5 percent decrease in forest area by country, 1990 - 2016

Looking at the table above (Table 3), we can see that of the countries that experienced the highest decrease in forest area between 1990 and 2016, 80% of these countries are from the **SSA** region. These **SSA** countries are **Togo**, **Nigeria**, **Uganda** and **Mauritania**. The fifth ranked country in this category is **Honduras**, which is in the **LAC** region.

Comparing both tables (Table 2 and Table 3 above); worryingly **Nigeria** makes an appearance on each of the tables. This makes Nigeria a clear priority country for FQ to look at as soon as possible.

3.3 Quartiles

Quartiles	Number of Countries
First	85
Second	72
Third	38
Fourth	9

Table 4 Country count by quartile based on FAP, 2016

The first quartile contained the highest amount of countries in 2016, with 85 countries having a **FAP** of 25% or less. 9 countries were categorised into the fourth quartile, which indicates that the following 9 countries had a **FAP** greater than 75% in 2016:

Country	Region	Forest Designation (%)
Suriname	Latin America & Caribbean	98.26
Micronesia	East Asia & Pacific	91.86
Gabon	Sub-Saharan Africa	90.04
Seychelles	Sub-Saharan Africa	88.48
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	77.87

Table 5 Fourth quartile countries by FAP, 2016

In 2016, the USA had a **FAP** of **33.93%**. According to the WB data, there were **94** countries which had a higher **FAP** when compared to the USA.

4. Recommendations

As evidenced the data that was analysed and presented in this report, it is clear that rate of deforestation shows a general increase over the 27 year period covered the WB data. A majority of the countries analysed in this report have 25% or less of **FAP**, with 14 countries in the first quartile having a FAP of 1% or less.

The **LAC** and **SSA** are obvious regions where FQ should focus its efforts, as these are the 2 regions that have seen a decrease in forest area since 1990. Resources should be dedicated to these 2 regions to first combat the effects of deforestation, and then FQ should aim to implement measures within these regions to alleviate the effects of deforestation by engaging with all relevant stakeholders at the regional, national, provincial or state and municipal or local levels to rehabilitate areas in these regions which have negatively affected by deforestation.

On a country level, FQ should dedicate and focus resources in combatting deforestation in **Brazil, Indonesia, Nigeria, Honduras, Togo** and **Uganda**. According to the data analysed for this report, these 6 nations should be regarded as deforestation hotspots for FQ. FQ should also investigate **China** and **Iceland** further in order to delve deeper into the phenomenon of increasing their forest area over the period covered by the WB data. Perhaps the Chinese and Icelandic experience can be shared amongst other similar nations.

5. APPENDIX: SQL QUERIES

Create a **View** called “**forestation**” by joining all three tables - **forest_area**, **land_area** and **regions** in the workspace.

```
CREATE VIEW forestation AS
SELECT la.country_code AS code,
       la.country_name AS country,
       rg.region AS region,
       rg.income_group AS income_group,
       la.year AS year,
       ROUND(fa.forest_area_sqkm) AS forest_area_sq_km,
       ROUND(la.total_area_sq_mi * 2.5899) AS total_area_sq_km,
       ((ROUND(fa.forest_area_sqkm) / ROUND(la.total_area_sq_mi * 2.5899)) * 100)
AS forest_percentage
FROM land_area la
FULL OUTER JOIN forest_area fa
ON la.country_code = fa.country_code AND la.year = fa.year
FULL OUTER JOIN regions rg
ON rg.country_code = la.country_code;
```

5.1 Question 1 – Global Outlook

a. What was the total forest area (in sq km) of the world in 1990?

```
SELECT country,
       year,
       forest_area_sq_km
FROM forestation
WHERE (year = 1990 AND country = 'World');
```

b. What was the total forest area (in sq km) of the world in 2016?

```
SELECT country,
       year,
       forest_area_sq_km
FROM forestation
WHERE (year = 2016 AND country = 'World');
```

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

```
SELECT country,
```

```

    year,
    forest_area_sq_km,
    COALESCE(forest_area_sq_km - LAG(forest_area_sq_km) OVER (ORDER BY
year), 0) AS change
FROM forestation
WHERE (year = 1990 OR year = 2016) AND (country = 'World');

```

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

```

SELECT country,
    year,
    forest_area_sq_km,
    COALESCE(forest_area_sq_km - LAG(forest_area_sq_km) OVER (ORDER BY
year), 0) AS change,
    ((COALESCE(forest_area_sq_km - LAG(forest_area_sq_km) OVER (ORDER
BY year), 0)) / forest_area_sq_km) * 100 AS change_percentage
FROM forestation
WHERE (year = 1990 OR year = 2016) AND (country = 'World');

```

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,
    year,
    total_area_sq_km
FROM forestation
WHERE total_area_sq_km <= (
    SELECT ABS(change) AS change
    FROM (
        SELECT country,
            year,
            forest_area_sq_km,
            COALESCE(forest_area_sq_km - LAG(forest_area_sq_km) OVER (ORDER
BY year), 0) AS change
        FROM forestation
        WHERE (year = 1990 OR year = 2016) AND (country = 'World')
    ) sub
    WHERE change < 0
)
AND year = 2016
ORDER BY 3 DESC
LIMIT 10;

```

5.2 Question 2 – 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?

a. What was the percent forest of the entire world in 2016 to 2 decimal places?

```
WITH region_sum AS
(
  SELECT region,
         year,
         SUM(forest_area_sq_km) AS forest_area_sum,
         SUM(total_area_sq_km) AS land_area_sum,
         (SUM(forest_area_sq_km)/SUM(total_area_sq_km)) * 100 AS
forest_percentage
  FROM forestation
 GROUP BY 1, 2
)
SELECT region,
       year,
       ROUND(CAST(forest_percentage AS decimal), 2) AS forest_percentage
  FROM region_sum
 WHERE (year = 2016 AND region = 'World');
```

a. Which region had the *HIGHEST* percent forest in 2016, to 2 decimal places?

```
WITH region_sum AS
(
  SELECT region,
         year,
         SUM(forest_area_sq_km) AS forest_area_sum,
         SUM(total_area_sq_km) AS land_area_sum,
         (SUM(forest_area_sq_km)/SUM(total_area_sq_km)) * 100 AS
forest_percentage
  FROM forestation
 WHERE year = 2016
 GROUP BY 1, 2
)
SELECT region,
       year,
       ROUND(CAST(forest_percentage AS decimal), 2) AS forest_percentage
  FROM region_sum
 WHERE region != 'World'
 ORDER BY 3 DESC
 LIMIT 1;
```


a. Which region had the LOWEST percent forest in 2016, to 2 decimal places?

```
WITH region_16 AS
(
  SELECT region,
         year,
         SUM(forest_area_sq_km) AS forest_area_sum,
         SUM(total_area_sq_km) AS land_area_sum,
         (SUM(forest_area_sq_km)/SUM(total_area_sq_km)) * 100 AS
forest_percentage
  FROM forestation
 WHERE year = 2016
 GROUP BY 1, 2
)
SELECT region,
       year,
       ROUND(CAST(forest_percentage AS decimal), 2) AS forest_percentage
  FROM region_16
 WHERE region != 'World'
 ORDER BY 3
 LIMIT 1;
```

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?

b. What was the percent forest of the entire world in 1990 to 2 decimal places?

```
WITH region_sum AS
(
  SELECT region,
         year,
         SUM(forest_area_sq_km) AS forest_area_sum,
         SUM(total_area_sq_km) AS land_area_sum,
         (SUM(forest_area_sq_km)/SUM(total_area_sq_km)) * 100 AS
forest_percentage
  FROM forestation
 GROUP BY 1, 2
)
SELECT region,
       year,
       ROUND(CAST(forest_percentage AS decimal), 2) AS forest_percentage
  FROM region_sum
 WHERE (year = 1990 AND region = 'World');
```

b. Which region had the HIGHEST percent forest in 1990 to 2 decimal places?

```

WITH region_sum AS
(
  SELECT region,
    year,
    SUM(forest_area_sq_km) AS forest_area_sum,
    SUM(total_area_sq_km) AS land_area_sum,
    (SUM(forest_area_sq_km)/SUM(total_area_sq_km)) * 100 AS
forest_percentage
  FROM forestation
  GROUP BY 1, 2
)
SELECT region,
  year,
  ROUND(CAST(forest_percentage AS decimal), 2) AS forest_percentage
FROM region_sum
WHERE year = 1990
ORDER BY 3 DESC;

```

b. Which region had the LOWEST percent forest in 1990 to 2 decimal places?

```

WITH region_sum AS
(
  SELECT region,
    year,
    SUM(forest_area_sq_km) AS forest_area_sum,
    SUM(total_area_sq_km) AS land_area_sum,
    (SUM(forest_area_sq_km)/SUM(total_area_sq_km)) * 100 AS
forest_percentage
  FROM forestation
  GROUP BY 1, 2
)
SELECT region,
  year,
  ROUND(CAST(forest_percentage AS decimal), 2) AS forest_percentage
FROM region_sum
WHERE year = 1990
ORDER BY 3;

```

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

```

WITH region_percent AS
(
  SELECT sub.region AS region,
    sub.year AS year,
    ROUND(CAST(sub.forest_percentage AS decimal), 2) AS forest_percentage

```

```

FROM (
  SELECT region,
    year,
    SUM(forest_area_sq_km) AS forest_area_sum,
    SUM(total_area_sq_km) AS land_area_sum,
    (SUM(forest_area_sq_km)/SUM(total_area_sq_km)) * 100 AS
forest_percentage
  FROM forestation
  GROUP BY 1, 2
) sub
WHERE (sub.year = 1990 OR sub.year = 2016)
)
SELECT region,
  year,
  forest_percentage,
  forest_percentage - LAG(forest_percentage) OVER
(PARTITION BY region ORDER BY forest_percentage) AS change
FROM region_percent
ORDER BY 1, 2;

```

5.3 Question 3 – Country-Level Detail

Success Stories query for top 2 countries with highest forest area increase in terms of square kilometers

```

WITH fadc AS
(
  SELECT country,
    forest_area_2016 -forest_area_1990 AS change
  FROM (
    SELECT f90.country,
      f90.forest_area_sq_km AS forest_area_1990,
      f16.forest_area_sq_km AS forest_area_2016
    FROM forestation f90
    LEFT JOIN forestation f16
    ON f90.country = f16.country
    WHERE (f90.year = 1990) AND (f16.year = 2016)
  ) sub
)
SELECT country,
  change,
  ROW_NUMBER() OVER (ORDER BY change DESC) AS ranking
FROM fadc
WHERE (change IS NOT NULL) AND (country != 'World');

```

This query is used to identify the country with the highest forest area percentage increase from 1990 to 2016

```
WITH fapc AS (
  SELECT sub.country AS country,
         CAST((sub.forest_area_2016 - sub.forest_area_1990) / sub.forest_area_1990
AS decimal) AS quotient
  FROM (
    SELECT f90.country AS country,
           f90.forest_area_sq_km AS forest_area_1990,
           f90.total_area_sq_km AS land_area_1990,
           (f90.forest_area_sq_km/f90.total_area_sq_km) * 100 AS
forest_percentage_1990,
           f16.forest_area_sq_km AS forest_area_2016,
           (f16.forest_area_sq_km/f16.total_area_sq_km) * 100 AS
forest_percentage_2016,
           f16.total_area_sq_km AS land_area_2016
    FROM forestation f90
    LEFT JOIN forestation f16
    ON f90.country = f16.country
    WHERE (f90.year = 1990) AND (f16.year = 2016)
  ) sub
)
SELECT country,
       ROUND(quotient * 100, 2) AS percent_change
FROM fapc
WHERE (ROUND(quotient * 100, 2) IS NOT NULL) AND (country != 'World')
ORDER BY 2 DESC;
```

This query is used to provide the numerical information for the total land area for China and the USA for footnote 2 within the report.

```
SELECT country,
       year,
       total_area_sq_km
FROM forestation
WHERE (country = 'China' OR country = 'United States') AND (year =2016)
ORDER BY 1, 2;
```

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 fadc AS
(
  SELECT country,
```

```

        forest_area_2016 - forest_area_1990 AS change
FROM (
    SELECT f90.country,
           f90.forest_area_sq_km AS forest_area_1990,
           f16.forest_area_sq_km AS forest_area_2016
    FROM forestation f90
    LEFT JOIN forestation f16
    ON f90.country = f16.country
    WHERE (f90.year = 1990) AND (f16.year = 2016)
) sub
),
    rgn AS
(
    SELECT DISTINCT country,
           region
    FROM forestation
)
SELECT fadc.country,
       rgn.region,
       fadc.change,
       RANK() OVER (ORDER BY fadc.change ) AS ranking
FROM fadc
JOIN rgn
ON fadc.country = rgn.country
WHERE (fadc.change IS NOT NULL) AND (fadc.country != 'World');

```

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 pad AS
(
    SELECT sub.country AS country,
           ROUND(CAST(sub.forest_percentage_1990 AS decimal), 2) AS
forest_percent_1990,
           ROUND(CAST(sub.forest_percentage_2016 AS decimal), 2) AS
forest_percent_2016,
           CAST(sub.forest_percentage_2016 / sub.forest_percentage_1990 AS decimal)
AS quotient
    FROM (
        SELECT f90.country AS country,
               f90.forest_area_sq_km AS forest_area_1990,
               f90.total_area_sq_km AS land_area_1990,
               (f90.forest_area_sq_km/f90.total_area_sq_km) * 100 AS
forest_percentage_1990,
               f16.forest_area_sq_km AS forest_area_2016,
               (f16.forest_area_sq_km/f16.total_area_sq_km) * 100 AS
forest_percentage_2016,
               f16.total_area_sq_km AS land_area_2016

```

```

FROM forestation f90
LEFT JOIN forestation f16
ON f90.country = f16.country
WHERE (f90.year = 1990) AND (f16.year = 2016)
) sub
),
rgn AS
(
SELECT DISTINCT country,
region
FROM forestation
)
SELECT pad.country,
rgn.region,
ROUND((1 - pad.quotient) * 100, 2) AS forest_area_percent_change
FROM pad
JOIN rgn
ON pad.country = rgn.country
WHERE (pad.country != 'World') AND (ROUND((1 - pad.quotient) * 100, 2) IS NOT
NULL)
ORDER BY 3 DESC
LIMIT 5;

```

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

```

WITH qtl AS (
SELECT sub.country AS country,
sub.forest_percentage AS forest_percentage,
CASE WHEN sub.forest_percentage <= 25 THEN '1st_quartile'
WHEN sub.forest_percentage > 25 AND sub.forest_percentage <= 50
THEN '2nd_quartile'
WHEN sub.forest_percentage > 50 AND sub.forest_percentage < 75 THEN
'3rd_quartile'
ELSE '4th_quartile' END AS quartile
FROM (
SELECT country,
year,
CAST(forest_percentage AS decimal) AS forest_percentage
FROM forestation
WHERE (year = 2016) AND (forest_percentage IS NOT NULL) AND (country !=
'World')
) sub
ORDER BY 3
)
SELECT quartile,
COUNT(quartile) AS quartile_count
FROM qtl

```

```
GROUP BY 1
ORDER BY 1;
```

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

```
WITH qtl AS
(
  SELECT sub.country AS country,
         sub.forest_percentage AS forest_percentage,
         CASE WHEN sub.forest_percentage <= 25 THEN '1st_quartile'
              WHEN sub.forest_percentage > 25 AND sub.forest_percentage <= 50
              THEN '2nd_quartile'
              WHEN sub.forest_percentage > 50 AND sub.forest_percentage < 75 THEN
              '3rd_quartile'
              ELSE '4th_quartile' END AS quartile
  FROM (
    SELECT country,
           year,
           CAST(forest_percentage AS decimal) AS forest_percentage
    FROM forestation
    WHERE (year = 2016) AND (forest_percentage IS NOT NULL) AND (country !=
    'World')
  ) sub
),
rgn AS
(
  SELECT DISTINCT country,
                 region
  FROM forestation
)
SELECT qtl.country,
       rgn.region,
       ROUND(qtl.forest_percentage, 2) AS forest_percentage,
       qtl.quartile
FROM qtl
JOIN rgn
ON qtl.country = rgn.country
WHERE qtl.quartile = '4th_quartile'
ORDER BY 3 DESC;
```

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

```
WITH gtusa AS
(
  SELECT country,
```

```

        year,
        forest_percentage
    FROM forestation
    WHERE (year = 2016) AND (forest_percentage IS NOT NULL) AND (country !=
'World')
        AND forest_percentage > (
            SELECT ABS(sub1.forest_percentage) AS usa_fap
            FROM (
                SELECT country,
                    year,
                    forest_percentage
                FROM forestation
                WHERE (country = 'United States' AND year = 2016)
            ) sub1
        )
    )
    SELECT COUNT(*) AS country_count
    FROM gtusa;

```

Below are a few queries which have been created to return the count of the number of countries within the database that have a forest percentage value of 0 (or near 0).

```

WITH nfa AS
(
    SELECT country,
        forest_percentage
    FROM (
        SELECT country,
            year,
            forest_percentage
        FROM forestation
        WHERE (year = 2016) AND (forest_percentage IS NOT NULL) AND (country !=
'World')
    ) sub
    WHERE forest_percentage >= 0 AND forest_percentage < 1
)
SELECT COUNT(*) AS no_forest_count
FROM nfa

```