**MODELAÇÃO DOS RECURSOS FLORESTAIS 2019/20**

***FOREST MODELS 2019/20***

***Continuous evaluation – Topic 3.1***

***Some Topics Related to Tree and Stand Growth***

Consider the data of São Salvador thinning trial presented in Table 1. This trial is located in Viseu (40°46'N, 7°55'W), Portugal, and was established in 1981 in a naturally regenerated maritime pine stand. The trial was 19 years old at the time of establishment.

The trial is composed of 3 blocks of 4 plots each where different thinning severity were tested. The thinning criteria was *Residual Basal Area* and the weighs considered were: heavy (18-20 m2ha-1), intermediate (22-24 m2ha-1) and light (26-28 m2ha-1). Three thinning operations were carried out in 1981, 1986 and 1999. One of the plots represents the control plot where the thinning only removed the few trees that seemed that could die in the near future. The trial was measured in 1981, 1984, 1986, 1987, 1988, 1999, 2000, 2005 and 2012.

Copy table 1 to Excel and answer the following questions:

a) Use the data in table 1 to compute: net growth of the standing volume, net growth and gross growth for the periods 1981-1986 and 1994-1999. What data is missing to allow the computation of gross growth for the same periods?

b) Compute the total volume over time, considering that the stand had never been thinned or cleaned before the age of 19.

c) Compute mean and current annual increment of the total volume and make the following graphs: total and standing volume; mean and current annual increment.

d) Looking at table, which do you think is the control plot and the one representing the heaviest thinning? Do you think the pre-defined thinning severities were followed? Justify both answers.

Table 1. Measurements of the 4 plots (A, B, C and D) in block 2 of São Salvador Trial.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  |  |  | Stand variables (standing stand) | Thinnings |
| stand | year | t | hdom | dgdom | N | G | V | W | Nthin | Gthin | Vthin |
| m | cm | ha-1 | m2 ha-1 | m3 ha-1 | Mg ha-1 | ha-1 | m2 ha-1 | m3 ha-1 |
| A | 1981 | 19 | 12.12 | 18.93 | 4300 | 36.41 | 184.20 | 114.50 |   |   |   |
| A | 1984 | 22 | 12.80 | 21.87 | 4250 | 44.78 | 245.77 | 154.55 |   |   |   |
| A | 1986 | 24 | 14.75 | 23.05 | 3990 | 46.15 | 283.65 | 172.34 | 20 | 0.01 | 0.04 |
| A | 1986 | 25 | 15.18 | 24.01 | 3860 | 48.42 | 306.73 | 186.33 |   |   |   |
| A | 1987 | 26 | 15.45 | 24.76 | 3880 | 50.20 | 325.84 | 198.53 |   |   |   |
| A | 1988 | 27 | 15.73 | 25.84 | 3300 | 52.28 | 353.60 | 213.70 |   |   |   |
| A | 1989 | 28 | 15.44 | 26.32 | 2760 | 51.02 | 349.95 | 213.28 |   |   |   |
| A | 1990 | 29 | 16.72 | 26.80 | 2740 | 51.19 | 371.10 | 222.30 |   |   |   |
| A | 1991 | 32 | 19.17 | 29.12 | 2430 | 55.34 | 467.99 | 268.12 |   |   |   |
| A | 1994 | 35 | 20.21 | 30.74 | 2430 | 60.00 | 533.78 | 310.30 |   |   |   |
| A | 1999 | 37 | 21.18 | 31.68 | 1970 | 57.48 | 542.41 | 313.24 | 50 | 0.59 | 4.33 |
| A | 1999 | 38 | 21.19 | 32.16 | 1650 | 53.94 | 520.17 | 300.36 |   |   |   |
| A | 2000 | 43 | 24.52 | 34.53 | 1230 | 53.40 | 603.15 | 339.39 |   |   |   |
| A | 2005 | 50 | 25.49 | 38.40 | 960 | 55.60 | 628.96 | 380.04 |   |   |   |
|  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  | Stand variables (standing stand) | Thinnings |
| id\_stand | year | t | hdom | dgdom | N | G | V | W | Nthin | Gthin | Vthin |
| m | cm | ha-1 | m2 ha-1 | m3 ha-1 | Mg ha-1 | ha-1 | m2 ha-1 | m3 ha-1 |
| B | 1981 | 19 | 13.15 | 20.02 | 2460 | 28.57 | 159.05 | 92.77 | 900 | 3.93 | 18.05 |
| B | 1984 | 22 | 12.86 | 22.79 | 2500 | 36.64 | 210.53 | 128.64 |   |   |   |
| B | 1986 | 24 | 13.99 | 24.26 | 1800 | 35.05 | 222.80 | 132.65 | 640 | 5.79 | 35.30 |
| B | 1987 | 25 | 14.61 | 25.05 | 1800 | 38.27 | 252.29 | 149.56 |   |   |   |
| B | 1988 | 26 | 15.24 | 25.55 | 1800 | 38.45 | 261.53 | 154.77 |   |   |   |
| B | 1989 | 27 | 15.87 | 26.76 | 1800 | 42.37 | 301.98 | 176.66 |   |   |   |
| B | 1990 | 28 | 16.50 | 27.43 | 1750 | 43.08 | 319.22 | 185.49 |   |   |   |
| B | 1991 | 29 | 16.44 | 27.26 | 1750 | 42.95 | 317.44 | 187.81 |   |   |   |
| B | 1994 | 32 | 18.85 | 30.49 | 1720 | 51.23 | 442.86 | 250.10 |   |   |   |
| B | 1997 | 35 | 20.21 | 31.22 | 1720 | 53.81 | 488.93 | 280.29 |   |   |   |
| B | 1999 | 37 | 21.09 | 31.59 | 720 | 35.09 | 350.65 | 195.28 | 890 | 19.47 | 168.91 |
| B | 2000 | 38 | 21.64 | 32.70 | 720 | 36.69 | 375.84 | 209.10 |   |   |   |
| B | 2005 | 43 | 23.71 | 31.69 | 700 | 38.99 | 437.37 | 246.12 |   |   |   |
| B | 2012 | 50 | 24.94 | 35.48 | 690 | 44.60 | 513.36 | 306.65 |   |   |   |
|  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  | Stand variables (standing stand) | Thinnings |
| id\_stand | year | t | hdom | dgdom | N | G | V | W | Nthin | Gthin | Vthin |
| m | cm | ha-1 | m2 ha-1 | m3 ha-1 | Mg ha-1 | ha-1 | m2 ha-1 | m3 ha-1 |
| C | 1981 | 19 | 11.95 | 18.35 | 2020 | 23.78 | 125.23 | 75.86 | 1730 | 10.37 | 46.76 |
| C | 1984 | 22 | 13.19 | 20.73 | 2020 | 30.36 | 176.26 | 106.86 |   |   |   |
| C | 1986 | 24 | 13.88 | 22.71 | 1510 | 30.21 | 191.07 | 114.10 | 480 | 4.44 | 26.52 |
| C | 1987 | 25 | 14.56 | 24.08 | 1510 | 33.48 | 220.49 | 130.76 |   |   |   |
| C | 1988 | 26 | 15.23 | 24.24 | 1510 | 33.89 | 230.94 | 136.43 |   |   |   |
| C | 1989 | 27 | 15.90 | 26.04 | 1510 | 37.68 | 269.98 | 157.40 |   |   |   |
| C | 1990 | 28 | 16.69 | 26.69 | 1510 | 38.87 | 290.09 | 167.79 |   |   |   |
| C | 1991 | 29 | 17.31 | 27.13 | 1510 | 39.65 | 305.80 | 176.28 |   |   |   |
| C | 1994 | 32 | 19.04 | 29.70 | 1510 | 46.67 | 408.93 | 229.13 |   |   |   |
| C | 1997 | 35 | 20.69 | 31.47 | 1510 | 50.82 | 474.18 | 267.70 |   |   |   |
| C | 1999 | 37 | 21.20 | 32.69 | 600 | 31.82 | 331.74 | 180.28 | 840 | 20.79 | 184.62 |
| C | 2000 | 38 | 21.72 | 33.31 | 600 | 32.77 | 340.68 | 187.83 |   |   |   |
| C | 2005 | 43 | 25.18 | 35.86 | 590 | 37.99 | 456.26 | 246.99 |   |   |   |
| C | 2012 | 50 | 26.16 | 39.71 | 560 | 45.01 | 526.96 | 311.14 |   |   |   |
|  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  | Stand variables (standing stand) | Thinnings |
| id\_stand | year | t | hdom | dgdom | N | G | V | W | Nthin | Gthin | Vthin |
| m | cm | ha-1 | m2 ha-1 | m3 ha-1 | Mg ha-1 | ha-1 | m2 ha-1 | m3 ha-1 |
| D | 1981 | 19 | 12.58 | 21.19 | 1350 | 19.13 | 107.71 | 62.55 | 1540 | 10.76 | 51.71 |
| D | 1984 | 22 | 12.31 | 25.10 | 1400 | 26.92 | 156.71 | 95.32 |   |   |   |
| D | 1986 | 24 | 13.70 | 26.36 | 940 | 25.19 | 163.35 | 96.36 | 450 | 5.18 | 30.46 |
| D | 1987 | 25 | 14.23 | 26.17 | 940 | 24.78 | 164.17 | 97.20 |   |   |   |
| D | 1988 | 26 | 14.76 | 26.63 | 940 | 27.37 | 188.87 | 110.96 |   |   |   |
| D | 1989 | 27 | 15.30 | 28.92 | 940 | 31.28 | 225.78 | 131.34 |   |   |   |
| D | 1990 | 28 | 15.83 | 29.03 | 940 | 32.28 | 241.14 | 139.60 |   |   |   |
| D | 1991 | 29 | 16.28 | 29.57 | 940 | 33.35 | 255.49 | 148.04 |   |   |   |
| D | 1994 | 32 | 18.07 | 31.86 | 940 | 39.19 | 340.88 | 191.64 |   |   |   |
| D | 1997 | 35 | 19.50 | 32.64 | 940 | 42.24 | 385.54 | 220.05 |   |   |   |
| D | 1999 | 37 | 20.36 | 33.51 | 390 | 25.87 | 263.65 | 144.94 | 550 | 18.70 | 168.22 |
| D | 2000 | 38 | 21.23 | 34.00 | 390 | 26.58 | 276.36 | 152.18 |   |   |   |
| D | 2005 | 43 | 22.58 | 35.23 | 380 | 29.66 | 327.04 | 185.03 |   |   |   |
| D | 2012 | 50 | 23.84 | 39.28 | 380 | 37.05 | 424.57 | 253.08 |   |   |   |