Supplementary Material

## Supplementary Tables

**Supplementary Table 1** ANOVA on the effect of vegetation restoration type, seasonal FT process and soil depth on the content of soil carbon pools.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Source of variation | SOC | | MBC | | DOC | | EOC | |
| F | *P* | F | *P* | F | *P* | F | *P* |
| VT | 63.628 | 0.000 | 273.572 | 0.000 | 537.986 | 0.000 | 350.565 | 0.000 |
| SFT | 16.855 | 0.000 | 384.050 | 0.000 | 332.999 | 0.000 | 128.007 | 0.000 |
| D | 501.363 | 0.000 | 552.982 | 0.000 | 2867.619 | 0.000 | 1733.833 | 0.000 |
| VT\*SFT | 15.325 | 0.000 | 104.861 | 0.000 | 16.404 | 0.000 | 39.100 | 0.000 |
| VT\*D | 8.796 | 0.000 | 15.288 | 0.000 | 2.977 | 0.025 | 20.735 | 0.000 |
| SFT\*D | 18.380 | 0.000 | 68.656 | 0.000 | 48.418 | 0.000 | 20.410 | 0.000 |
| VT\*SFT\*D | 1.817 | 0.061 | 11.628 | 0.000 | 9.477 | 0.000 | 6.719 | 0.000 |

Notes: VT, SFT, D denote Type of vegetation restoration, Seasonal FT processes, Depth of soil layer respectively. SOC, Soil organic carbon; MBC, Microbial biomass carbon; DOC, Dissolved organic carbon; EOC, Easily oxidized organic carbon.

**Supplementary Table 2** Results of RDA two-dimensional ranking between soil carbon pools and environmental factors

|  |  |  |  |
| --- | --- | --- | --- |
| **Statistic** | Axis 1 | Axis 2 | Axis 3 |
| Eigenvalues | 0.5398 | 0.0005 | 0.0000 |
| Explained variation (cumulative)(%) | 53.98 | 54.03 | 54.03 |
| Pseudo-canonical correlation | 0.7350 | 0.7535 | 0.6777 |
| Explained fitted variation (cumulative)(%) | 99.91 | 100.00 | 100.00 |

**Supplementary Table 3** Coefficients of variation (CV) of SOC, MBC, DOC, and EOC in each soil layer of 0-40 cm under different vegetation restoration types during seasonal freezing and thawing.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Soil depth (cm) | CV (%) | | | | | | | | | | | | | | | |
| GL | | | |  | | CK | | | |  | XS | | | | |
| BF | EF | SF | TS |  | BF | | EF | SF | TS |  | BF | EF | SF | TS |
| SOC | 0-10 | 2.88 | 5.59 | 3.43 | 6.80 |  | 3.05 | | 10.59 | 6.50 | 18.61 |  | 5.94 | 5.61 | 2.19 | 3.79 |
| 10-20 | 4.83 | 5.84 | 9.81 | 4.30 |  | 11.19 | | 18.96 | 3.98 | 11.36 |  | 3.81 | 2.85 | 5.91 | 3.62 |
| 20-40 | 6.65 | 4.75 | 38.09 | 5.42 |  | 8.49 | | 10.65 | 10.11 | 9.82 |  | 10.42 | 5.67 | 5.57 | 3.83 |
| MBC | 0-10 | 1.71 | 11.86 | 4.50 | 11.48 |  | 7.44 | | 4.05 | 0.17 | 1.04 |  | 0.14 | 7.37 | 4.82 | 8.57 |
| 10-20 | 3.97 | 10.34 | 3.84 | 3.11 |  | 7.16 | | 6.43 | 19.24 | 5.71 |  | 3.32 | 14.18 | 5.20 | 13.17 |
| 20-40 | 1.77 | 13.56 | 16.44 | 1.62 |  | 0.32 | | 9.33 | 7.88 | 19.81 |  | 0.14 | 2.09 | 0.44 | 6.91 |
| DOC | 0-10 | 1.45 | 3.11 | 2.35 | 3.70 |  | 1.85 | | 3.22 | 1.18 | 1.57 |  | 1.94 | 2.49 | 1.54 | 6.04 |
| 10-20 | 4.34 | 5.03 | 1.05 | 3.36 |  | 3.31 | | 3.68 | 1.89 | 3.59 |  | 2.06 | 3.82 | 4.18 | 3.93 |
| 20-40 | 4.25 | 5.20 | 1.53 | 14.34 |  | 3.94 | | 5.08 | 1.31 | 4.68 |  | 3.75 | 3.89 | 1.30 | 2.23 |
| EOC | 0-10 | 2.36 | 1.86 | 1.69 | 5.31 |  | 3.62 | | 1.30 | 2.34 | 4.20 |  | 5.29 | 2.51 | 1.31 | 2.73 |
| 10-20 | 2.80 | 3.54 | 1.36 | 2.51 |  | 3.64 | | 2.49 | 3.69 | 7.00 |  | 2.87 | 0.79 | 2.33 | 5.33 |
| 20-40 | 1.65 | 24.40 | 1.79 | 1.38 |  | 2.99 | | 3.63 | 3.73 | 2.36 |  | 6.70 | 3.35 | 2.56 | 2.00 |

Notes: GL, Grassland; CK, *Caragana korshinskii*; XS, *Xanthoceras sorbifolia*; SI, Sensitivity index. EF, Early stages of freezing; SF, Stable freeze stage; TS, Thawing stage; SOC, Soil organic carbon; MBC, Microbial biomass carbon; DOC, Dissolved organic carbon; EOC, Easily oxidized organic carbon. CV (%) = SD/mean\*100.