Table S1. Summary of previous estimates of LCC on the QTP

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Study region** | **Period** | **Ground truth data** | **Forage production** | **AGBP** **(g m–2)** | **LCC** **(SSU/ha)** | **References** |
| Status | Period  |
| QTP | 2000-2018 | Non-grazed | July-Aug | AGB | 104.2 | 0.94 | Zhang et al. (2022) |
| 1982-2015 | Grazed | None | NPP-AGB | 95.06 | 1.47 | Yang et al. (2022) |
| 2000-2018 | Grazed | Aug-Sep | NPP-AGB | 47.18 | 1.17 | Mo et al. (2021) |
| Sanjiangyuan region | 2001-2005 | Grazed | July-Sep | AGB | 128 | 0.87 | Yu et al. (2010) |
| 2020-2021 | Unknown | None | NPP-AGB | 144.9 | 1.35 | Cai et al. (2022) |
| 2010 | Grazed | July-Aug | NPP-AGB | 46.57 | 0.51 | Zhang et al. (2014) |
| 2000-2015 | Grazed | None | NPP-AGB | 52.98 | 0.55 | Zhang et al. (2019) |
| Inner Mongolia | 2014-2016 | Grazed | July-Aug | NPP-AGB | 62.5 | 1.25 | Qin et al. (2021) |
| 2000-2015 | Grazed | None | NPP-AGB | 85.5 | 0.93 | Qu et al. (2021) |
| Haibei, Qinghai  | 2013-2014 | Grazed | July-Sep | AGB | 105.0 | 0.93 | Zhang et al. (2017) |
| 2007 | Grazed | July-Sep | AGB | 90.5 | 1.47 | Li et al. (2009) |

Note: AGBP was used as the annual biomass in these studies. The conversion coefficient between grassland AGB (unit: g m–2) and NPP (unit: g C m–2) is 0.45 (Ma et al., 2016; Ni, 2001), NPP-AGB means that NPP was conversed to AGB.

Table 2. List of abbreviations

|  |  |
| --- | --- |
| **Abbreviation** | **Meaning**  |
| AGBA | Annual above ground biomass (grazed grassland) |
| AGBP | Peak above ground biomass (grazed grassland) |
| AGBAN | Annual above ground biomass (non-grazed grassland) |
| AGBPN | Peak above ground biomass (non-grazed grassland) |
| AGBC  | The plant biomass consumed by livestock in growing season (by the time of POS in summer pasture) |
| AGBS | Total produced above ground biomass on summer pasture |
| AGBW | Total demanded above ground biomass for livestock on winter pasture |
| AGBPS | Peak above ground biomass of summer pasture (the AGB remainder) |
| AGBPW | Peak above ground biomass of winter pasture (the AGB remainder) |
| Rs | The ratios including biomass use efficiency, availability, and edibility  |
| L | The daily intake for a standard sheep unit (SU) |
| β | The adjustment ratio to convert AGBP to AGBA for the grazed grassland (regardless rotational regimes) |
| β0 | The adjustment ratio for calculating AGBC based on AGBW (for rotational grazing regimes) |
| k | The standardized fastest AGB growth rate |
| Srate | Slaughter rate (at the end of growing season)  |
| RPT | Remote sensing phenology timings |
| LCC | Livestock carrying capacity |
| ASR | Actual stocking rate |
| ASRS | Actual stocking rate of summer pasture |
| ASRW | Actual stocking rate of winter pasture |
| LCC1 | Livestock carrying capacity for period A |
| LCC2 | Livestock carrying capacity for period B |
| LCCS | Livestock carrying capacity of summer pasture |
| LCCW | Livestock carrying capacity of winter pasture |
| EXD | The day of AGB growth rate F(x)ʹ exceed AGB removal rate R(x)ʹ |
| POS | The peak of the growing season (remote sensing phonology) |
| EOS | The end of the growing season (remote sensing phonology) |
| SOS | The start of the growing season (remote sensing phonology) |
| FOS | The day having the fastest growth rate |
| x0 | The day of EXD in the grazed grassland |
| x1 | The day of POS in the grazed grassland |
| x2 | The day of POS in the non-grazed grassland (POS and EOS are the same day) |
| X | The day having the fastest growth rate (FOS) in the grazed grassland |
| Period A | The period from Early spring to POS (biomass accumulating period) |
| Period B | The period from POS to the next Early spring (the period after POS until growing resumes) |
| F(x) | AGB growth function representing the remaining AGB in the non-grazed grassland |
| F(x)ʹ  | AGB growth rate in the non-grazed grassland |
| R(x) | AGB removal function representing the consumed AGB |
| R(x)ʹ | AGB removal rate |
| f(x) | AGB accumulation representing the remaining AGB in the grazed grassland |

Note: the unit of F(x) and R(x) is g/m2, and their derivative is g/m2/day, the unit of LCC and ASR are SU/ha.

**References**

Cai, Z. et al., 2022. Grazing pressure index considering both wildlife and livestock in Three-River Headwaters, Qinghai-Tibetan Plateau. Ecological Indicators, 143.<https://doi.org/10.1016/j.ecolind.2022.109338>

Li, W., Ma, X., Chen, Q., 2009. Research on grassland resources yield and balance between forage resources and livestock numbers in Haidong and Haibei prefecture of Qinghai. Acta Prataculturae Sinica, 18, 270-275.

Ma, A., He, N., Yu, G., Wen, D., Peng, S., 2016. Carbon storage in Chinese grassland ecosystems: Influence of different integrative methods. Scientific Reports, 6, 21378.<https://doi.org/10.1038/srep21378>

Mo, X.G. et al., 2021. Variations of forage yield and forage-livestock balance in grasslands over the Tibetan Plateau, China. Chinese Journal of Applied Ecology, 32, 2415-2425.<https://doi.org/10.13287/j.1001-9332.202107.002>

Ni, J., 2001. Carbon storage in terrestrial ecosystems of China: estimates at different spatial resolutions and their responses to climate change. Climatic Change, 49, 339-358.

Qin, P. et al., 2021. Estimation of grassland carrying capacity by applying high spatiotemporal remote sensing techniques in Zhenglan Banner, Inner Mongolia, China. Sustainability (Switzerland), 13.<https://doi.org/10.3390/su13063123>

Qu, Y., Zhao, Y., Ding, G., Chi, W., Gao, G., 2021. Spatiotemporal patterns of the forage-livestock balance in the Xilin Gol steppe, China: implications for sustainably utilizing grassland-ecosystem services. Journal of Arid Land, 13, 135-151.<https://doi.org/10.1007/s40333-021-0053-x>

Yang, Y., Zhao, D., Chen, H., 2022. Full Title: Quantifying the ecological carrying capacity of alpine grasslands on the Qinghai-Tibet Plateau. Ecological Indicators, 136, 108634.<https://doi.org/10.1016/j.ecolind.2022.108634>

Yu, L., Zhou, L., Liu, W., Zhou, H.K., 2010. Using Remote Sensing and GIS Technologies to Estimate Grass Yield and Livestock Carrying Capacity of Alpine Grasslands in Golog Prefecture, China. Pedosphere, 20, 342-351.[https://doi.org/10.1016/S1002-0160(10)60023-9](https://doi.org/10.1016/S1002-0160%2810%2960023-9)

Zhang, F., Wang, H., Zhu, Y., Zhang, Z., Li, X., 2017. Study on the Aboveground Biomass of Natural Grassland and Balance between Forage and Livestock in Qilian County. JOURNAL OF NATURAL RESOURCES, 32, 1183-1192.<https://doi.org/10.11849/zrzyxb.20160770>

Zhang, J., Zhang, L., Liu, W., Qi, Y., Wo, X., 2014. Livestock-carrying capacity and overgrazing status of alpine grassland in the Three-River Headwaters region, China. Journal of Geographical Sciences, 24, 303-312.<https://doi.org/10.1007/s11442-014-1089-z>

Zhang, J., Zhang, L., Liu, X., Qiao, Q., 2019. Research on sustainable development in an alpine pastoral area based on equilibrium analysis between the grassland yield, livestock carrying capacity, and animal husbandry population. Sustainability (Switzerland), 11.<https://doi.org/10.3390/su11174659>

Zhang, X., Li, M., Wu, J., He, Y., Niu, B., 2022. Alpine Grassland Aboveground Biomass and Theoretical Livestock Carrying Capacity on the Tibetan Plateau. Journal of Resources and Ecology, 13, 129-141.<https://doi.org/10.5814/j.issn.1674-764x.2022.01.015>