remote sensing

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Review

Remote Sensing of Grassland Production and Management – A Review

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Supplementary Material

Table S1. Copyright information of images of various grasslands downloaded from flickr (www.flickr.com).

Image	Name	Photographer
A)	Sandhills Region, Nebraska	Ken Lund
B)	Oberbayern (Lindegg)	Renate Dodell
C)	Qinghai	sm c
D)	Uruguay	Maureen Barlin Magalie L'Abbe
E)	KwaZulu Natal	Maureen Barlin
F)	Southern New Zealand	hildaandjohn

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Table S2. Full list of reviewed research articles.

Author and Date	Title	Journal
Abuzar et al. 2017	Farm Level Assessment of Irrigation Performance for Dairy Pastures in the Goulburn-Murray District of Australia by Combining Satellite-Based Measures with Weather and Water Delivery Information.	ISPRS International Journal of Geo-Information
Ali et al. 2014	Application of statistical and machine learning models for grassland yield estimation based on a hypertemporal satellite remote sensing time series.	IEEE Geoscience and Remote Sensing Symposium
Ali et al. 2017a	Modeling managed grassland biomass estimation by using multitemporal remote sensing data - A machine learning approach.	IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing
Ali et al. 2017b	Application of repeat-pass TerraSAR-X staring spotlight interferometric coherence to monitor pasture biophysical parameters: limitations and sensitivity analysis.	IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing
An et al. 2013	Estimating above-ground net primary productivity of the tallgrass prairie ecosystem of the Central Great Plains using AVHRR NDVI.	International Journal of Remote Sensing
Anaya et al. 2009	Aboveground biomass assessment in Colombia: A remote sensing approach.	Forest Ecology and Management
Anderson et al. 1993	Evaluating Landsat Thematic Mapper derived vegetation indices for estimating above-ground biomass on semiarid rangelands.	Remote Sensing of Environment
Andrimont et al. 2018	Targeted grassland monitoring at parcel level using Sentinels, street-level images and field observations.	Remote Sensing
Asam et al. 2015	Estimation of grassland use intensities based on high spatial resolution LAI time series.	International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences
Baeza et al. 2010	Spatial variability of above-ground net primary production in Uruguayan grasslands: a remote sensing approach.	Applied Vegetation Science
Baghi et al. 2019	Do soil-adjusted or standard vegetation indices better predict aboveground biomass of semi-arid saline rangelands in North-East Iran?	International Journal of Remote Sensing
Barrachina et al. 2015	Estimating above-ground biomass on mountain meadows and pastures through remote sensing.	International Journal of Applied Earth Observation and Geoinformation
Barrett et al. 2014	Assessment of multi-temporal, multi-sensor radar and ancillary spatial data for grasslands monitoring in Ireland using machine learning approaches.	Remote Sensing of Environment

Bastin et al. 2012	Separating grazing and rainfall effects at regional scale using remote sensing imagery: A dynamic reference-cover method.	Remote Sensing of Environment
Bekkema and Elevald 2018	Mapping grassland management intensity using Sentinel-2 satellite data.	GI Forum 2018
Bella et al. 2004	Remote sensing capabilities to estimate pasture production in France.	International Journal of Remote Sensing
Benie et al. 2005	Remote sensing-based spatio-temporal modeling to predict biomass in Sahelian grazing ecosystem.	Ecological Modelling
Bjerke et al. 2015	Impacts of snow season on ground-ice accumulation, soil frost and primary productivity in a grassland of sub-Arctic Norway.	Environmental Research Letters
Blanco et al. 2009	Remote sensing of spatial and temporal vegetation patterns in two grazing systems.	Rangeland Ecology & Management
Boschetti et al. 2007	Assessment of pasture production in the Italian Alps using spectrometric and remote sensing information.	Agriculture, Ecosystems & Environment
Brinkmann et al. 2011	Quantification of aboveground rangeland productivity and anthropogenic degradation on the Arabian Peninsula using Landsat imagery and field inventory data.	Remote Sensing of Environment
Buono et al. 2010	Spatial and temporal variation of primary production of Patagonian wet meadows.	Journal of Arid Environments
Chen et al. 2011	Herbaceous biomass estimation from SPOT 5 imagery in semiarid rangelands of Idaho.	GIScience & Remote Sensing
Chen et al. 2014	The impact of climate change and anthropogenic activities on alpine grassland over the Qinghai-Tibet Plateau.	Agricultural and Forest Meteorology
Chi et al. 2018	Assessing the effects of grazing on variations of vegetation NPP in the Xilingol Grassland, China, using a grazing pressure index.	Ecological Indicators
Chladil and Nunez 1995	Assessing grassland moisture and biomass in Tasmania - the application of remote sensing and empirical models for a cloudy environment.	International Journal of Wildland Fire
Courault et al. 2010	Combined use of FORMOSAT-2 images with a crop model for biomass and water monitoring of permanent grassland in Mediterranean region.	Hydrology and Earth System Sciences
Crabbe et al. 2019	A preliminary investigation of the potential of Sentinel-1 radar to estimate pasture biomass in a grazed pasture landscape.	Remote Sensing
Cui et al. 2012	Classification management for grassland using MODIS data: a case study in the Gannan region, China.	International Journal of Remote Sensing
Diouf et al. 2015	Fodder biomass monitoring in sahelian rangelands using phenological metrics from FAPAR time series.	Remote Sensing

Donald et al. 2010	Using MODIS imagery, climate and soil data to estimate pasture growth rates on farms in the south-west of Western Australia.	Animal Production Science
Donald et al. 2013	Satellite derived evidence of whole farmlet and paddock responses to management and climate.	Animal Production Science
Dube and Pickup 2001	Effects of rainfall variability and communal and semi-commercial grazing on land cover in southern African rangelands.	Climate Research
Dusseux et al. 2011	Identification of grazed and mown grasslands using a time series of high-spatial-resolution remote sensing images.	International Workshop on the Analysis of MultiTemporal Remote Sensing Images
Dusseux et al. 2012	Contribution of radar images for grassland management identification.	SPIERS - Remote Sensing for Agriculture, Ecosystems, and Hydrology XIV
Dusseux et al. 2013	Temporal kernels for the identification of grassland management using time series of high spatial resolution satellite images.	IEEE International Geoscience and Remote Sensing Symposium - IGARSS
Dusseux et al. 2014a	Combined use of multi-temporal optical and radar satellite images for grassland monitoring.	Remote Sensing
Dusseux et al. 2014b	Identification of grassland management practices from leaf area index time series.	Journal of Applied Remote Sensing
Dusseux et al. 2014c	Agricultural practices in grasslands detected by spatial remote sensing.	Environmental Monitoring and Assessment
Dusseux et al. 2015	Evaluation of SPOT imagery for the estimation of grassland biomass.	International Journal of Applied Earth Observation and Geoinformation
Edirisinghe et al. 2011	Quantitative mapping of pasture biomass using satellite imagery.	International Journal of Remote Sensing
Edirisinghe et al. 2012	Spatio-temporal modelling of biomass of intensively grazed perennial dairy pastures using multispectral remote sensing.	International Journal of Applied Earth Observation and Geoinformation
Eisfelder et al. 2017	Above-ground biomass estimation based on NPP time series - A novel approach for biomass estimation in semi-arid Kazachstan.	Ecological Indicators
Estel et al. 2018	Combining satellite data and agricultural statistics to map grassland management intensity in Europe.	Environmental Research Letters
Fan et al. 2010	Assessment of effects of climate change and grazing activity on grassland yield in the Three Rivers Headwaters Region of Qinghai-Tibet Plateau, China.	Environmental Monitoring and Assessment
Feng and Zhao 2011	Grazing intensity monitoring in Northern China steppe: Integrating CENTURY model and MODIS data.	Ecological Indicators

Feng et al. 2017	Identifying the relative contributions of climate and grazing to both direction and magnitude of alpine grassland productivity dynamics from 1993 to 2011 on the Northern Tibetan Plateau.	Remote Sensing
Fern et al. 2018	Suitability of NDVI and OSAVI as estimators of green biomass and coverage in a semi-arid rangeland.	Ecological Indicators
Franke et al. 2012	Assessment of grassland use intensity by remote sensing to support conservation schemes.	Journal for Nature Conservation
Franklin et al. 2010	Consequences of buffelgrass pasture development for primary productivity, perennial plant richness, and vegetation structure in the drylands of Sonora, Mexico.	Conservation Biology
Friedl et al. 1994	Estimating grassland biomass and leaf area index using ground and satellite data.	International Journal of Remote Sensing
Frolking et al. 2005	Interannual variability in North American grassland biomass/productivity detected by SeaWinds scatterometer backscatter.	Geophysical Research Letters
Fu et al. 2014	An improved indicator of simulated grassland production based on MODIS NDVI and GPP data: A case study in the Sichuan province, China.	Ecological Indicators
Gaffney et al. 2018	Using APAR to predict aboveground plant productivity in semi-arid rangelands: spatial and temporal relationships differ.	Remote Sensing
Gao et al. 2013a	Using MODIS time series data to estimate aboveground biomass and its spatio-temporal variation in Inner Mongolia's grassland between 2001 and 2011.	International Journal of Remote Sensing
Gao et al. 2013b	Effects of topography and human activity on the net primary productivity (NPP) of alpine grassland in northern Tibet from 1981 to 2004.	International Journal of Remote Sensing
Gao et al. 2016a	Changes in global grassland productivity during 1982 to 2011 attributable to climatic factors.	Remote Sensing
Gao et al. 2016b	Climatic change controls productivity variation in global grasslands.	Scientific Reports
Gao et al. 2017	Aboveground net primary productivity of vegetation along a climate-related gradient in a Eurasian temperate grassland: spatiotemporal patterns and their relationships with climate factors.	Environmental Earth Sciences
Garioud et al. 2019	Challenges in grassland mowing event detection with multimodal sentinel images.	International Workshop on the Analysis of MultiTemporal Remote Sensing Images
Gomez-Gimenez et al. 2017	Determination of grassland use intensity based on multi-temporal remote sensing data and ecological indicators.	Remote Sensing of Environment
Grant et al. 2012	Quantifying biomass production on rangeland in southern Alberta using SPOT imagery.	Canadian Journal of Remote Sensing

Grant et al. 2015a	Satellite-based assessment of grassland yields.	The International Archives of Photogrammetry, Remote Sensing and Spatial Information Sciences
Grant et al. 2015b	The use of radar images for detecting when grass is harvested and thereby improve grassland yield estimates.	Grassland Science in Europe
Griffiths et al. 2020	Towards national-scale characterization of grassland use intensity from integrated Sentinel-2 and Landsat time series.	Remote Sensing of Environment
Gu et al. 2013	Mapping grassland productivity with 250-m eMODIS NDVI and SSURGO database over the Greater Platte River Basin, USA.	Ecological Indicators
Gu and Wylie 2015	Developing a 30-m grassland productivity estimation map for central Nebraska using 250-m MODIS and 30-m Landsat-8 observations.	Remote Sensing of Environment
Guerini et al. 2020	Estimating natural grassland biomass by vegetation indices using Sentinel 2 remote sensing data.	International Journal of Remote Sensing
Guido et al. 2014	Spatial and temporal variability in aboveground net primary production of Uruguayan grasslands	Rangeland Ecology & Management
Guo et al. 2000	Biophysical and spectral characteristics of cool- and warm-season grasslands under three land management practices in Eastern Kansas.	Natural Resources Research
Guo et al. 2003	Grasslands discriminant analysis using Landsat TM single and multitemporal data.	Photogrammetric Engineering & Remote Sensing
Guo et al. 2004	Measuring spatial and vertical heterogeneity of grasslands using remote sensing techniques.	Journal of Environmental Informatics
Guo et al. 2012	Spatial variations in aboveground net primary productivity along a climate gradient in Eurasian temperate grassland: effects of mean annual precipitation and its seasonal distribution.	Global Change Biology
Guo et al. 2019	Remote sensing monitoring of green-up dates in the Xilingol grasslands of northern China and their correlations with meteorological factors.	International Journal of Remote Sensing
Hajj et al. 2014	Irrigated grassland monitoring using a time series of TerraSAR-X and COSMO-SkyMed X-band SAR data.	Remote Sensing
Halabuk et al. 2015	Towards detection of cutting in hay meadows by using of NDVI and EVI Time Series.	Remote Sensing
Hall et al. 2010	Inventorying management status and plant species richness in semi-natural grasslands using high spatial resolution imagery.	Applied Vegetation Science

He et al. 2014	Large-scale estimation and uncertainty analysis of gross primary production in Tibetan alpine grasslands.	Journal of Geophysical Research - Biogeosciences
Hill et al. 2004	Estimation of pasture growth rate in the south west of Western Australia from AVHRR NDVI and climate data.	Remote Sensing of Environment
Ikeda et al. 1999	Estimation of aboveground grassland phytomass with a growth model using Landsat TM and climate data.	International Journal of Remote Sensing
Irisarri et al. 2012	Patterns and controls of above-ground net primary production in meadows of Patagonia: A remote sensing approach.	Journal of Vegetation Science
Jackson and Prince 2016	Degradation of net primary production in a semiarid rangeland.	Biogeosciences
Jansen et al. 2018	The development of near real-time biomass and cover estimates for adaptive rangeland management using Landsat 7 and Landsat 8 surface reflectance products.	Remote Sensing
Jia et al. 2015	Primary productivity and precipitation-use efficiency in temperate grassland in the Loess Plateau of China.	PLoS ONE
Jia et al. 2016	Estimation and uncertainty analyses of grassland biomass in Northern China: comparison of multiple remote sensing data sources and modeling approaches.	Ecological Indicators
Jia et al. 2018	Uncertainty in simulating regional gross primary productivity from satellite-based models over northern China grassland.	Ecological Indicators
Jiang et al. 2015	The spatial pattern of grassland aboveground biomass on Xizang Plateau and its climatic controls.	Journal of Plant Ecology
Jianlong et al. 1998	Estimating grassland yields using remote sensing and GIS technologies in China.	New Zealand Journal of Agricultural Research
Jin et al. 2014	Remote sensing-based biomass estimation and its spatio-temporal variations in temperate grassland, Northern China.	Remote Sensing
Jin et al. 2019	Grassland production in response to changes in biological metrics over the Tibetan Plateau.	Science of the Total Environment
Jobbagy et al. 2002	Patterns and controls of primary production in the patagonian steppe: a remote sensing approach.	Ecology
John et al. 2018	Grassland canopy cover and aboveground biomass in Mongolia and Inner Mongolia: Spatiotemporal estimates and controlling factors.	Remote Sensing of Environment
Justice and Hiernaux 1986	Monitoring the grasslands of the Sahel using NOAA AVHRR data: Niger 1983.	International Journal of Remote Sensing

Kath et al. 2019	Remotely sensed agricultural grassland productivity responses to land use and hydro-climatic drivers under extreme drought and rainfall.	Agricultural and Forest Meteorology
Kawamura et al. 2005a	Quantifying grazing intensities using geographic information systems and satellite remote sensing in the Xilingol steppe region, Inner Mongolia, China.	Agriculture, Ecosystems & Environment
Kawamura et al. 2005b	Comparing MODIS vegetation indices with AVHRR NDVI for monitoring the forage quantity and quality in Inner Mongolia grassland, China.	Grassland Science
Kogan et al. 2004	Derivation of pasture biomass in Mongolia from AVHRR-based vegetation health indices.	International Journal of Remote Sensing
Kolecka et al. 2018	Regional scale mapping of grassland mowing frequency with Sentinel-2 time series.	Remote Sensing
Kurtz et al. 2010	Ground and satellite based assessment of rangeland management in sub-tropical Argentina.	Applied Geography
Leimgruber et al. 2001	Spatial patterns in relative primary productivity and gazelle migration in the Eastern Steppes of Mongolia.	Biological Conservation
Li et al. 1998	Estimating grassland yields using remote sensing and GIS technologies in China.	New Zealand Journal of Agricultural Research
Li et al. 2005	Establishing grassland yield models using projection pursuit regression method.	New Zealand Journal of Agricultural Research
Li et al. 2013a	Monitoring and modeling spatial and temporal patterns of grassland dynamics using time-series MODIS NDVI with climate and stocking data.	Remote Sensing of Environment
Li et al. 2013b	Estimating grassland aboveground biomass using multitemporal MODIS data in the West Songnen Plain, China.	Journal of Applied Remote Sensing
Li et al. 2013c	A method for estimating the gross primary production of alpine meadows using MODIS and climate data in China.	International Journal of Remote Sensing
Li et al. 2015	Influence of meadow changes on net primary productivity: a case study in a typical steppe area of XilinGol of Inner Mongolia in China.	Geosciences Journal
Li et al. 2016a	Mapping grazing intensity using remote sensing in the Xilingol steppe region, Inner Mongolia, China.	Remote Sensing Letters
Li et al. 2016b	Modeling grassland aboveground biomass using a pure vegetation index.	Ecological Indicators
Li et al. 2018	Renewed estimates of grassland aboveground biomass showing drought impacts.	Journal of Geophysical Research - Biogeosciences
Li et al. 2019a	Spatial and temporal variations in grassland production from 2006 to 2015 in Mongolia along the China-Mongolia railway.	Sustainability

Li et al. 2019b	Spatial variation of human influences on grassland biomass on the Qinghai-Tibetan plateau.	Science of The Total Environment
Li et al. 2019c	Temporal variability of precipitation and biomass of alpine grasslands on the Northern Tibetan Plateau.	Remote Sensing
Liang et al. 2009	Remotely sensed dynamics monitoring of grassland aboveground biomass and carrying capacity during 2001-2008 in Gannan pastoral area.	Acta Prataculturae Sinica
Liang et al. 2016	Multi-factor modeling of above-ground biomass in alpine grassland: a case study in the Three-River Headwaters Region, China.	Remote Sensing of Environment
Liu et al. 2004	Assessment of grassland degradation near Lake Qinghai, West China, using Landsat TM and in situ reflectance spectra data.	International Journal of Remote Sensing
Liu et al. 2015	Modeling aboveground biomass of an alpine desert grassland with SPOT-VGT NDVI.	GIScience & Remote Sensing
Liu et al. 2017	Spatiotemporal dynamics of grassland aboveground biomass on the Qinghai-Tibet Plateau based on validated MODIS NDVI.	Scientific Reports
Liu et al. 2019	Estimating rangeland forage production using remote sensing data from a small Unmanned Aerial System (sUAS) and PlanetScope satellite.	Remote Sensing
Lopes et al. 2017	Object-based classification of grasslands from high resolution satellite image time series using gaussian mean map kernels.	Remote Sensing
Luo et al. 2014	Responses of grass production to precipitation in a mid-latitude typical steppe watershed.	Transactions of the ASABE
Ma et al. 2019	Quantifying grazing intensity using remote sensing in alpine meadows on Qinghai-Tibetan Plateau.	Sustainability
Magiera et al. 2017	Modelling biomass of mountainous grasslands by including a species composition map.	Ecological Indicators
Malss et al. 2018	The use of radar satellite images for the detection of cutting frequency of grassland.	Grassland Science in Europe
Mao et al. 2014	Spatiotemporal dynamics of grassland aboveground net primary productivity and its association with climatic pattern and changes in Northern China.	Ecological Indicators
Marsett et al. 2006	Remote Sensing for grassland management in the arid southwest.	Rangeland Ecology & Management
Maselli et al. 2013	Simulation of grassland productivity by the combination of ground and satellite data.	Agriculture, Ecosystems & Environment
Medina et al. 2009	Use of satellite images to assess forage production in the rangelands of Zacatecas.	Tecnica Pecuria en Mexico
Meng et al. 2017	Evaluation of remote sensing inversion error for the above-ground biomass of alpine meadow grassland based on multi-source satellite data.	Remote Sensing

Moreau et al. 2003	Assessing the biomass dynamics of Andean bofedal and totora high-protein wetland grasses from NOAA/AVHRR.	Remote Sensing of Environment
Munyati and Makgale 2009	Multitemporal Landsat TM imagery analysis for mapping and quantifying degraded rangeland in the Bahurutshe communal grazing lands, South Africa.	International Journal of Remote Sensing
Na et al. 2018	Effects of different grazing systems on aboveground biomass and plant species dominance in typical Chinese and Mongolian steppes.	Sustainability
Numata et al. 2007	Characterization of pasture biophysical properties and the impact of grazing intensity using remotely sensed data.	Remote Sensing of Environment
Otgonbayar et al. 2019	Mapping pasture biomass in Mongolia using Partial Least Squares, Random Forest regression and Landsat 8 imagery.	International Journal of Remote Sensing
Palmer et al. 2010	Biomass production and water use efficiency of grassland in KwaZulu-Natal, South Africa.	African Journal of Range and Forage Science
Paruelo et al. 1997	ANPP estimates from NDVI for the central grassland region of the United States.	Ecology
Paruelo et al. 2000	Estimation of primary production of subhumid rangelands from remote sensing data.	Applied Vegetation Science
Paudel and Anderson 2010	Assessing rangeland degradation using multi temporal satellite images and grazing pressure surface model in Upper Mustang, Trans Himalaya, Nepal.	Remote Sensing of Environment
Piao et al. 2007	Changes in biomass carbon stocks in China's grasslands between 1982 and 1999.	Global Biogeochemical Cycles
Pineiro et al. 2006	Seasonal variation in aboveground production and radiation-use efficiency of temperate rangelands estimated through remote sensing.	Ecosystems
Porter et al. 2014	Estimating biomass on CRP pastureland: A comparison of remote sensing techniques.	Biomass & Bioenergy
Potter 2014	Monitoring the production of Central California coastal rangelands using satellite remote sensing.	Journal of Coastal Conservation
Price et al. 2002a	Optimal Landsat TM band combinations and vegetation indices for discrimination of six grassland types in eastern Kansas.	International Journal of Remote Sensing
Price et al. 2002b	Comparison of Landsat TM and ERS-2 SAR data for discriminating among grassland types and treatments in eastern Kansas.	Computers and Electronics in Agriculture
Prince 1991	Satellite remote sensing of primary production: comparison of results for Sahelian grasslands 1981-1988.	International Journal of Remote Sensing
Propastin et al. 2011	Modified light use efficiency model for assessment of carbon sequestration in grasslands of Kazakhstan: combining ground biomass data and remote-sensing.	International Journal of Remote Sensing

Punalekar et al. 2018	Application of Sentinel-2A data for pasture biomass monitoring using a physically based radiative transfer model.	Remote Sensing of Environment
Qamer et al. 2016	An assessment of productivity patterns of grass-dominated rangelands in the Hindu Kush Karakoram region, Pakistan.	Sustainability
Quan et al. 2017	A radiative transfer model-based method for the estimation of grassland aboveground biomass.	International Journal of Applied Earth Observation and Geoinformation
Raab et al. 2020	Target-oriented habitat and wildlife management: estimating forage quantity and quality of semi-natural grasslands with Sentinel-1 and Sentinel-2 data.	Remote Sensing in Ecology and Coservation
Ramoelo et al. 2015	Monitoring grass nutrients and biomass as indicators of rangeland quality and quantity using random forest modelling and WorldView-2 data.	International Journal of Applied Earth Observation and Geoinformation
Reeves et al. 2001	Mapping weekly rangeland vegetation productivity using MODIS algorithms.	Journal of Range Management
Reeves et al. 2006	Applying improved estimates of MODIS productivity to characterize grassland vegetation dynamics.	Rangeland Ecology & Management
Reeves and Baggett 2014	A remote sensing protocol for identifying rangelands with degraded productive capacity.	Ecological Indicators
Reinfelds et al. 2011	Monitoring and Assessment of Surface Water Abstractions for Pasture Irrigation from Landsat Imagery: Bega-Bemboka River, NSW, Australia.	Water Resources Management
Ren and Feng 2015	Are soil-adjusted vegetation indices better than soil-unadjusted vegetation indices for above-ground green biomass estimation in arid and semi-arid grasslands?	Grass and Forage Science
Ricotta et al. 2003	The role of C3 and C4 grasses to interannual variability in remotely sensed ecosystem performance over the US Great Plains.	International Journal of Remote Sensing
Robinson et al. 2014	Mapping the global distribution of livestock.	PLoS ONE
Robinson et al. 2019	Rangeland productivity partitioned to sub-pixel plant functional types.	Remote Sensing
Roeder et al. 2008	Trend analysis of Landsat-TM and -ETM+ imagery to monitor grazing impact in a rangeland ecosystem in Northern Greece.	Remote Sensing of Environment
Rossi et al. 2018	Optical responses on multiple spatial scales for assessing vegetation dynamics- a case study for alpine grasslands.	IEEE International Geoscience and Remote Sensing Symposium
Rossi et al. 2019	A comparison of the signal from diverse optical sensors for monitoring alpine grassland dynamics.	Remote Sensing
Rossini et al. 2012	Remote sensing-based estimation of gross primary production in a subalpine grassland.	Biogeosciences

Roumiguie et al. 2017	Insuring forage through satellites: testing alternative indices against grassland production estimates for France.	International Journal of Remote Sensing
Rufin et al. 2015	Land use intensity trajectories on Amazonian pastures derived from Landsat time series.	International Journal of Applied Earth Observation and Geoinformation
Sankey et al. 2009	Geospatial assessment of grazing regime shifts and sociopolitical changes in a Mongolian rangeland.	Rangeland Ecology & Management
Schucknecht et al. 2017	Phenology-based biomass estimation to support rangeland management in semi-arid environments.	Remote Sensing
Schuster et al. 2011	Towards detecting swath events in TerraSAR-X time series to establish NATURA 2000 grassland habitat swath management as monitoring parameter.	Remote Sensing
Schuster et al. 2015	Grassland habitat mapping by intra-annual time series analysis - comparison of RapidEye and TerraSAR-X satellite data.	International Journal of Applied Earth Observation and Geoinformation
Seaquist et al. 2003	A remote sensing-based primary production model for grassland biomes.	Ecological Modelling
Si et al. 2012	Mapping spatio-temporal variation of grassland quantity and quality using MERIS data and the PROSAIL model.	Remote Sensing of Environment
Sibanda et al. 2016	Comparing the spectral settings of the new generation broad and narrow band sensors in estimating biomass of native grasses grown under different management practices.	GIScience & Remote Sensing
Sibanda et al. 2017	Testing the capabilities of the new WorldView-3 space-borne sensor's red-edge spectral band in discriminating and mapping complex grassland management treatments.	International Journal of Remote Sensing
Siegmund et al. 2016	Satellite-based monitoring of grassland: assessment of harvest dates and frequency using SAR.	Remote Sensing for Agriculture, Ecosystems, and Hydrology XVIII
Siegmund et al. 2019	Grassland monitoring based on Sentinel-1.	Remote Sensing for Agriculture, Ecosystems, and Hydrology XVIII
Silverman et al. 2019	Low-tech riparian and wet meadow restoration increases vegetation productivity and resilience across semiarid rangelands.	Restoration Ecology
Skinner et al. 2011	Impact of sward properties on the predictability of forage quality and yield in grassland using remote sensing.	Agronomy Journal
Smit et al. 2008	Spatial distribution of grassland productivity and land use in Europe.	Agricultural Systems
Smith et al. 2011	Near real-time Feed On Offer (FOO) from MODIS for early seasongrazing management of Mediterranean annual pastures.	International Journal of Remote Sensing

Stendardi et al. 2019	Exploiting time series of Sentinel-1 and Sentinel-2 imagery to detect meadow phenology in mountain regions.	Remote Sensing
Stumpf et al. 2020	Spatial monitoring of grassland management using multi-temporal satellite imagery.	Ecological Indicators
Sun et al. 2013	Evaluation of net primary productivity and its spatial and temporal patterns in southern China's grasslands.	Rangeland Journal
Sun et al. 2017	Grassland degradation and restoration monitoring and driving forces analysis based on long time-series remote sensing data in Xilin Gol League.	Acta Ecologica Sinica
Tamm et al. 2016	Relating Sentinel-1 interferometric coherence to mowing events on grasslands	Remote Sensing
Tan et al. 2010	Application of the ORCHIDEE global vegetation model to evaluate biomass and soil carbon stocks of Qinghai-Tibetan grasslands.	Global Biogeochemical Cycles
Tang et al. 2014	Simulating spatiotemporal dynamics of Sichuan grassland net primary productivity using the CASA model and in situ observations.	Scientific World Journal
Taravat et al. 2019	Automatic grassland cutting status detection in the context of spatiotemporal Sentinel-1 imagery analysis and artificial neural networks.	Remote Sensing
Tieszen et al. 1997	NDVI, C-3 and C-4 production, and distributions in great plains grassland land cover classes.	Ecological Applications
Tiscornia et al. 2019	Can we monitor height of native grasslands in Uruguay with earth observation?	Remote Sensing
Todd et al. 1998	Biomass estimation on grazed and ungrazed rangelands using spectral indices.	International Journal of Remote Sensing
Tsalyuk et al. 2015	Monitoring the impact of grazing on rangeland conservation easements using MODIS vegetation indices.	Rangeland Ecology & Management
Tucker et al. 1986	Monitoring the grasslands of the Sahel 1984-1985.	International Journal of Remote Sensing
Ulises et al. 2017	Satellite and field radiometry for the estimation of biomass production in a grassland site in state of Durango, Mexico.	Range Management and Agroforestry
Ullah et al. 2012	Estimation of grassland biomass and nitrogen using MERIS data.	International Journal of Applied Earth Observation and Geoinformation
Vescovo and Gianelle 2008	Using the MIR bands in vegetation indices for the estimation of grassland biophysical parameters from satellite remote sensing in the Alps region of Trentino (Italy).	Advances in Space Research
Voormansik et al. 2013	Towards a detection of grassland cutting practices with dual polarimetric TerraSAR-X data.	International Journal of Remote Sensing

Voormansik et al. 2015	Observations of cutting practices in agricultural grasslands using polarimetric SAR.	IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing
Wang et al. 2008	Relations between NDVI, grassland production, and crop yield in the Central Great Plains.	Geocarto International
Wang et al. 2010	Modeling gross primary production of maize cropland and degraded grassland in northeastern China.	Agricultural and Forest Meteorology
Wang et al. 2016	Simulation of the grazing effects on grassland aboveground net primary production using DNDC model combined with time-series remote sensing data - a case study in Zoige Plateau, China.	Remote Sensing
Wang et al. 2017	Prediction of aboveground grassland biomass on the Loess Plateau, China, using a random forest algorithm.	Scientific Reports
Wang et al. 2019a	Assessing the impacts of drought on grassland net primary production at the global scale.	Scientific Reports
Wang et al. 2019b	Multi-satellite analyses of spatiotemporal variability in photosynthetic activity over the Tibetan Plateau.	Journal of Geophysical Research - Biogeosciences
Wang et al. 2019c	Modelling above-ground biomass based on vegetation indexes: a modified approach for biomass estimation in semi-arid grasslands.	International Journal of Remote Sensing
Wang et al. 2019d	Estimating leaf area index and aboveground biomass of grazing pastures using Sentinel-1, Sentinel-2 and Landsat images.	ISPRS Journal of Photogrammetry and Remote Sensing
Wang et al. 2020	Detecting intra- and inter-annual variability in gross primary productivity of a North American grassland using MODIS MAIAC data.	Agricultural and Forest Meteorology
Wehlage et al. 2016	Interannual variability in dry mixed-grass prairie yield: a comparison of MODIS, SPOT, and field measurements.	Remote Sensing
Wei et al. 2019	Driving mechanism of gross primary production changes and implications for grassland management on the Tibetan Plateau.	Journal of Resources and Ecology
Wu et al. 2008	Modeling gross primary production of a temperate grassland ecosystem in Inner Mongolia, China, using MODIS imagery and climate data.	Science in China Series D - Earth Sciences
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