Journal of Biodiversity and Environmental Sciences (JBES)
ISSN: 2220-6663 (Print) 2222-3045 (Online)
Vol. 7, No. 6, p. 249-259, 2015
http://www.innspub.net

INNSPUB
REVIEW PAPER
OPEN ACCESS

Vegetation Ecology in China- A review

Sehrish Sadia[1], Jin-Tun Zhang[1], Arshad Ali Shedayi[2], Brian Gagosh Nayyar[3], Xiaohang Bai[1], Paras Mazari[1], Sidra Aslam[1], Latif Khan[1]

[1]*College of Life Sciences, Beijing Normal University, Beijing, China*

[2]*Institute of Geographic Science and Natural Resources Research, University of Chinese Academy of Sciences, Beijing, China*

[3]*Depatrment of Botany, Pir Mehr Ali Shah University of Arid Agriculture Rawalpindi, Pakistan*

Article published on December 29, 2015

Key words: Ecology, Vegetation, China, Ecosystem services, Climate.

Abstract

China being third country in extensive biodiversity is the home of almost all types of ecosystems. Grasslands and forests are major source of carbon. Ecosystem services in China contribute 2.71% to that of world. But due to anthropogenic activities and climate changes, vegetation distribution is going to be badly affected. Major factors affecting the Chinese vegetation are temperature and precipitation. A lot of land of Loess plateau is lost due to soil and water lost. Quantitative priorities are needed to be establishing for conservation of endangered plant species and to minimize bad effect of climate variables.

***Corresponding Author:** Sehrish Sadia ✉ sehrish@mail.bnu.edu.cn

Introduction

Largely spontaneously growing plants make a system that is called vegetation. Not all growing plants but the weeds around the plants form this system (Van der Maarel, 2005). There are four major research areas in plant ecology; Invasion biology, Succession biology, Gap/Patch analysis and Effects of global change on plants. Ecology of vegetation change is a reunified term used for Invasion ecology, succession ecology and gap/patch ecology. Underlying processes which studied in plant ecology are; Colonization, Establishment, Turnover, Persistence and Speed. Following factors affect the vegetation ecology; Distribution or changes in interaction with other trophic levels, Dispersal: local or long distance dispersal allows new species to enter existing plant communities, Facilitations and inhibition as well as interaction with other species from other trophic levels and change in community composition effect and are affected by ecosystem processes (Davis *et al.,* 2005).

China is strongly affected by monsoon climate. In eastern part of China, it is cold and dry in winter and warm and humid in summer. With the change from humid to arid climate from east to west, the vegetation type changes from forest, forest steppe, steppe and desert. Primary vegetation has been destroyed in most parts of China. There are eight major vegetation zones in China; cold temperate needle leaf forest region, subtropical evergreen broadleaf forest region, temperate needle leaf and broadleaf mixed forest region, warm temperate deciduous broadleaf forest region, tropical monsoon and rainforest region, temperate steppe region, temperate desert region and Qinghai-Xizang (Tibetan) plateau high cold vegetation region (Fang *et al.,* 2002). Keeping in view the weather, climate and vegetation changes, present review aims to present a brief overview of plant ecological research in China.

Vegetation growth, cover and climate change in China

Climate primarily controls the production of vegetation and its pattern at large spatial scale. It is not only applicable to natural or semi natural ecosystem but also to the agricultural ecosystems (Wang *et al.,* 2013).

Dynamic vegetation cover change during two decades (1982-1999) in China

Normalized difference vegetation index (NDVI) was derived from remote sensing imaging and metrological record. This data was used to know spatial changes and vegetation dynamics in China. During 1982- 1999, climatic change and cover change were closely related to each other and were different in different regions. During these decades, NDVI was remarkably decreased for Tibetan plateau and Northwest China. On the other hand it was increased for Eastern China. Results for NDVI data variously changed each year. Areas (especially northwest arid areas) with decrease in NDVI in 1990s were much larger as compared in 1980s. Zhuijiang river delta and Changjiang delta showed a rapid drop in NDVI during this time span. It may be due to rapid urbanization (Shilong and Jinguan, 2004).

Vegetation cover change in Northwest China (1998-2004)

Maximum value composites (MVC) and linear regression were used for SPOT-VEGETATION data for characterization of trends in change of vegetation cover. Land-use map of Northwest china was used for analysis of NDVI variety of land use types. During 1998-2004 vegetation was highly degraded in a lot of Northwestern Chinese regions. Only in some regions, vegetation cover was increasing. But ratio of increase in those regions was less than ratio of decrease in other regions. Regions with increased vegetation cover were located in Shaanxi and Ningxia province and in the Northwest and Southeast parts of Xingjiang (Yi and Ming-guo, 2007).

Spatiotemporal responses of different vegetation types across China during the period 1982-2011

Normalized difference vegetation index (NDVI) and Standardized precipitation evapotranspiration index

(SPEI) were calculated by using climatic data of temperature and precipitation from 511 different metrological stations in China. NDVI data was taken for 1982-2011 (Tucker *et al.,* 2005). SPEI was calculated at different time scales (1-12 moths). The shrubland, broadleaved forests and needle leaved forests showed response to drought in 9 to 12 months whereas cultivated vegetation, meadows and grassland showed such response in a short time period (1 to 5 months). Both the indices showed positive correlation in the area of short water supply (Northwest china) and negative correlation in the area of excess water supply (Southeastern China). Due to large industrialization in China, severe climatic changes are being occurred which affected the growth of vegetation in various ways. Quantitative studies of spatiotemporal responses could be helpful in accessing and reducing the worst impacts of climate change on vegetation (Li and Zhou, 2015).

Forest vegetation and climate- Scenario of biomass and net production

Ecosystem performance and variation in any country can be indicated by net primary production which is a basic key to indicate relationship of vegetation with climate (Lobell *et al.,* 2002; Liang *et al.,* 2015).

Biomass production

Total biomass in Chinese forests was 9102. 9 × 106 t, of which 8592. 1 × 106 t for stands, 325. 7 × 106 t for economic forest, 185. 0 × 106 t for bamboo forests and 790. 5 × 10' t for scrub forest. The total net production was 1177. 3 × 106 t· a-1 for forest vegetation and 458. 2 × 106 t. a-1 for forests and scrub forests. When analysis of Chinese forests carbon pool contribution to worlds carbon pool was done, it was found that Chinese forests biomass was less than 1% of global forests biomass. It was concluded that average biomass was smaller and mean net production was greater in china as compared to world mean values (Jingyun *et al.,* 1996).

Chinese terrestrial net primary productivity-Estimation by CASA model

The geographic distribution of net primary production was explored in 1997 using GIS and remote sensing imagery (NOAA/AVHRR) together with spatial data on vegetation, climate, soil type and solar radiation. The model estimates China's terrestrial NPP in 1997 as 195 PgC, or about 40% of the world's terrestrial total. NPP decreased from southeast China toward the northwest. Southern Hainan Island, Southwestern Yunnan and Southeastern Tibet showed large NPP values, with the value exceeding 900 gC·m -2·a -1, whereas the Takelamagan desert located in western China had very small values-less than 10 gC·m -2·a -1 (Piao *et al.,* 2001).

Recently Li and Zhou (2015) used CASA model to estimate forest net primary productivity in China. They used metrological and remote sensing data. They also estimated maximum light use efficiency of forests, their relation with the stand stages and use of these functions to calculate the net primary productivity dependent of forest age. It was indicated by results that different forest types showed different maximum light use efficiency. Maximum light use efficiency also depends upon age of forest stand. Maximum light use efficiency for mature, middle and young age stands was 0.60, 0.65 and 0.68 gC MJ-1 in deciduous broadleaf forest, 0.99, 1.01 and 1.05 gC MJ-1 in evergreen broadleaf forest and 0.52, 0.57 and 0.72 gC MJ-1 in evergreen needle leaf forest respectively. Forest on young and middle age were found to be more sensitive to climate changes so they have more fluctuations in net primary productivity.

Phytodiversity Variations of Chinese tropical forests

A study of tree species diversity was conducted in four tropical forests (tropical seasonal rain forest, tropical mountain rain forest, evergreen broad-leaved forest and monsoon forest over limestone) of southwest China. Four species diversity indices (Shannon-Wiener's H′, the complement of Simpson's index, d′, Fisher's α and evenness index E) were calculated for 17 samples taken from these four forests. Results indicated abundance diagrams of these forests except the monsoon forest over limestone. Tropical seasonal rain forest shows the highest tree species diversity of all four vegetation types. Samples of same vegetation taken from different patches had different diversity values. The tree species diversity of single-dominant rain forest is not significantly lower than that of mixed rain forest, because the dominant species of some single-dominant rain forests are principally in the emergent layer. The occurrence of tree species with small population sizes, particularly of species represented by only one individual was highly correlated with the tree species diversity of the local forest vegetation (Cao and Zhang, 1997).

Primary forests of this area have been greatly changed because of agricultural exploitation. These have been converted to farmlands and plantation to provide the high yield of rubber and tropical cash crops. As a result secondary vegetation consisting of deciduous monsoon forest, savanna woodland, bamboo*Dendrocalamus membranaceus* forest, grassland and *Chromolaena odoratum* community has developed on the abandoned lands on a large scale. Due to this reason primary forests have been depleted which resulted in a threat to genetic resources. Systematic conservation strategies and alternative plantation methods are immensely required to save the tropical forest resources (Zhang and Cao, 1995).

Grassland Ecology

Carbon density method was used to find out the carbon storages in Chinese grasslands. According to the grassland resource survey, there were 18 types of grasslands in China scattered in warm, temperate and tropical regions. According to median estimation, vegetation, soil and total carbon storage in these grasslands were 3.06, 41.03 and 44.09 pgC respectively. Less carbon was stored in vegetation as compare to soil. Alpine (54.5%) and temperate (31.6%) regions hold more than 85% of total grassland carbon in China. Alpine meadow, alpine steppe and temperate steppe were three grassland types in these two regions and constitute more than half of carbon storage in Chinese grasslands. Generally, steppes (38.6%) and meadows (38.2%) made up more than 2/3 of total grassland carbon. Global carbon cycle may be significantly affected by carbon storage in alpine grasslands (Ni, 2002).

Data was collected in three field surveys along precipitation gradient of temperate grasslands in north-west China and south-east Mongolia Relationship of six plant functional types (C3 plants, C4 plants, grasslands, shrubs, forbs and succulents) with the climate was recorded. Variation in regions and grasslands caused variation in spatial distribution of these plant functional types. Precipitation and aridity were positively related to number of C3 species, C4 species, grasses and forbs and negatively related to shrubs. While there was no relationship between succulents and climate. For aridity, this relationship was more significant as compared precipitation (Ni, 2003).

Secondary succession dynamics proved to be different in high and low saline-alkaline stress grassland communities. Bai *et al.,* (2015) selected one low saline alkaline stress grassland community and one with high stress in Northeast China. A complete randomized design experiment was conducted for four years in triplicate. Five nitrogen levels were also used. High stress community was dominant by *Chloris virgata* and low stress community was dominated by *Kochia sieversiana*. Each year investigation focused on functional group, above ground biomass, community level, species richness, soil pH and soil EC. Results from detrended correspondence analysis showed that secondary succession dynamics were clearly different in both type of communities. There was no promotion of succession by addition of nitrogen even in low stress communities.

Grassland ranking according to first national survey of Chinese grassland resources showed Tibet grassland ecosystem diversity at first as it comprises

17 types of grasslands (Gai *et al.,* 2009). Degradation of Tibetan tropical grasslands is majorly caused by overgrazing. Since 2004, fencing around grasslands in this area started to check this condition. The effect of fencing was recorded recently by investigating three Tibetan grasslands. Results indicated that diversity, dominance and evenness indices did not presented significant change after grazing check. But mean vegetation height, biomass and cover showed significant high values as compared to open grasslands. So type of grassland and fencing both can be helpful to increase vegetation growth and stability. As this study was only based on 5-7 years time period of fencing so more long term continuous studies are needed to access the possible impact of grazing check in these grasslands (Yan and Lu, 2015).

Phytodiversity and environmental factors of Chinese rivers

A transect approach was used to know the changes in plant species diversity and productivity along precipitation gradient and elevation in Inner Mongolia. Species richness, diversity, productivity were negatively correlated with mean annual temperature, ≥10°C cumulative temperature, and aridity. Inverse relationships were also found between species richness, diversity, productivity and precipitation, elevation, soil organic carbon and total nitrogen content. The species richness, Shannon Wiener diversity index, and productivity of the communities declined with a decreasing elevation, precipitation, soil organic carbon and total nitrogen content, and with increasing mean annual temperature and aridity. The effects of the land use type and intensity were also very strong (Bai *et al.,* 2000).

Data on vegetation of Tarim River was collected and monitored in two years (2000-2002). Results indicated that the main factors affecting the degradation of vegetation in lower reaches of Tarim River were vegetation types and composing, vegetation distribution, vegetation growth in relation to depth of groundwater, continuous decrease in groundwater and loss of soil water. The 4 times of stream water conveyance to the dry up of the lower reaches of the river plays an important role in raising the groundwater level, which is close to the watercourse. The groundwater was raised gradually. The transverse response scope of groundwater level was gradually enlarged to about 1,000 m after the fourth conveyance and the lift range of groundwater level is the highest in the upper section (84%), median in the middle section and the lowest in the lower section (6%) longitudinally. The natural vegetation in the lower reaches is saved and restored along with the rise of groundwater level, the response scope of vegetation is gradually enlarged, i.e., from 200-250 m in width after the first conveyance to 800 m after the fourth conveyance (Chen *et al.,* 2003).
Measurements were taken in 9 transects along lower reaches of Tarim river in which changes of groundwater level and species abundance was recorded. Results indicated that due to water recharges level of groundwater has been increased. The 6–8-m groundwater depths before the water recharges rose to 2–4 m after the recharges. Species were also more abundant in combination of overbank flow and stream recharges. Such a combination may maximize the ecological benefits of water conveyance and accelerate the restoration of the damaged arid ecosystems in this area (Chen *et al.,* 2009).

Field investigation in the mountainous area of Ili river valley and use of TWINSPAN and DCCA showed that up to 235 plant species out of 259 species belong to herb layer and woody plant species were very limited. The species composition varied widely between the northern slope and the southern slope. 35 plots on the northern slope were clustered into 10 groups, and 50 plots on the southern slope were clustered into 11 groups. The DCCA ordination indicated that elevation as a compound factor was the critical driver of species composition on both the slopes. The vegetation patterns were also related to slope gradient, aspect, soil water, soil pH, organic matter and total nitrogen. Available phosphorus and available potassium were important factors on the southern slope only, maybe because of the appearance of shrubs there. The proportion of variation explained was 49.54% on the northern slope and 41.08% on the southern slope. Edaphic variables were more important than topographical variables on the northern slope, while topographical variables seemed to be more influential on the southern slope (Xu *et al.,* 2011).

Vegetation ecology in deserts

In 1956 sand-binding vegetation in the Shapotou region at the southeastern edge of the Tengger Desert was started. In past 46 years, it has not only insured the smooth operation of the Baotou–Lanzhou railway in the sand dune section but has also played an important role in the restoration of the local eco-environment. So it is a very excellent model of desertification control in china. In only 5 years of sand binding plants planting the physical surface structure of the sand dunes stabilized, and inorganic soil crusts formed by atmospheric dust gradually turned into microbiotic crusts. Among the organisms comprising these crusts are cryptogams such as desert algae and mosses. After 46 years of sand binding vegetation establishment, 24 species of algae were found in crust but only few moss species were identified. Other results of the planting were that near-surface wind velocity in the 46-year-old vegetation area was reduced by 54.2% compared with that in the moving sand area and soil organic matter increased from 0.06% in moving sand dunes to 1.34% in the 46-year-old vegetation area. Nutrients of desert ecosystem and soil physiochemical properties were also enhanced. Herbaceous plant colonization was much improved which in turn provided the habitat for a large variety of insects, birds and animals. This restoration effort shows the potential for short-term manipulation of environmental variables (i.e., plant cover via artificial vegetation establishment) to begin the long-term process of ecological restoration, particularly in arid climates, and demonstrates several techniques that can be used to scientifically monitor progress in large-scale restoration projects (Li *et al.,* 2004).

Water required for the development and growth of vegetation in desert oasis is known as its ecological water requirement. It was calculated by the use of GIS, RS and GPS techniques with the combination of field measurement of productivity. Results indicated that 1.53×10^8 m^3 water would be required for maintenance of present state of the desert. And if vegetation will increase to highest productivity level then this requirement would increase thrice (Zhao *et al.,* 2007).

Stability of desert oasis is another important factor for the maintenance and conservation of desert biodiversity. For the stability of oasis, revegetation is an effective phenomenon. Soil and vegetation properties of Hexi desert (Northwest China) oasis ecotone was investigated over a period of 40 years and it was found that level of NP and organic matter was increased. Herbaceous species were also increased in number along with the increase of their cover. This positive relation of soil and vegetation permitted soil binding species to remain stable over a long time (Wang *et al.,* 2015).

Vegetation ecological studies in mountains

Herzschuh *et al.,* (2004) applied relationship of pollen spectra to modern vegetation and precipitation pattern to 65 fossil pollen spectra from a 825 cm long sediment record collected in the topographic depression formerly occupied by Eastern Juyan palaeolake (41.89°N; 101.85°E; 892 m a.s.l.). A set of 55 recent pollen spectra from the Alashan Plateau and the Qilian Mountains (Qilianshan), northwestern China was analyzed in this research. Various qualitative and quantitative approaches were tested with surface pollen and then its application was checked on eastern Juyan pollen record. Pollen spectra dated to ca. 10,700–5400 cal. yr B.P. were characterized by highest values of Chenopodiaceae, *E. fragilis*-type and other desert indicating taxa, suggesting rather dry climate. Most favorable conditions were reconstructed between 5400 and 3900 cal. year B.P. on the basis of relative increase in abundance of *Artemisia* pollen. A return to dry conditions occurred at about 3900 cal. yr B.P. The lake finally desiccated after 1700 cal. yr B.P. Reconstructed dry climate oscillations between 5900 and 5400 and 3100 cal. yr B.P. correlated well with similar events found in the published records from northern and western China and central Mongolia. Holocene humidity maximum was not shown in eastern Juyan like monsoon influenced areas of China.

An ecological study was conducted to found the relationship of environmental factors of Alza plateau with vegetation composition. For this purpose seventy species belonging to 46 genera and 16 famalies were surveyed. The largest families were Leguminosae, Polygonaceae, Gramineae and Compositae, representing 20.0%, 15.7%, 14.3% and 14.3% of the total flora, respectively. Phanerophytes and hemicryptophytes were the most abundant life-form. TWINSPAN was used for classification and DCA and CCA were used for knowing the relationship of environments factors with species composition. Six vegetation groups were recognized with specific vegetation and soil type. DCA (detrended correspondence analysis) and CCA (Canonical correspondence analysis) showed that there is very highly relationship between environment factors and vegetation. Results of this study gave a better understanding of management and conservation strategies of vegetation on Alxa plateau (He *et al.,* 2006).

Vegetation map (1:500,000) and the Landsat Thematic Mapper scenes of the Loess Plateau were used to collect vegetation data. The Loess Plateau was divided into small districts of 30′ latitude by 30′ longitude on the vegetation map. In each district areas with different vegetation were measured and used as data. Climate data was taken from metrological record of last 25 years. GIS was used for map analysis. TWINSPAN was used for classification of vegetation and CCA was used for establishing relationship of climate and vegetation. All districts were classified into 7 groups with 7 sub regions of vegetation. First CCA axis represented the variation in climate and vegetation along latitude while second axis showed variation along longitude. Similarly temperature and water variability were also present in both latitude and longitude (Zhang *et al.,* 2006).

A lot of land of Chinese loess plateau has been degraded due severe soil and water loss. . In 1986, fifteen plots of land were planted with five vegetation types: pine woodland, shrub land, sloping cropland, alfalfa and semi-natural grassland. Soil and water variables (Soil water content, runoff, soil erosion) were recorded for each plot. Environmental variables were taken from metrological record. Statistical models were used to find out the relationship between vegetation and soil and water dynamics. Results indicated that growing season is most vulnerable to soil water loss and maximum loss occurred in mid of July. This loss was not fulfilled during rainy season. Pine woodland induced the largest water loss to surface runoff, followed by sloping cropland, alfalfa, semi-natural grassland and shrubland; the poor capability of pine woodland for water conservation may be attributed to soil compaction and poor ground coverage under the tree. Results were exceptional for shrubland and semi natural grassland where soil water loss was moderate high during few periods (Chen *et al.,* 2007).

TWINSPAN study of succession series of plant communities was carried out in abandoned croplands in the eastern Loess Plateau of China and was concluded that plant communities were present in this order; Assoc. *Ixeris chinensis* var.*versicolor+Setaria viridis* → Assoc. *Artemisia* spp. → Assoc. *Artemisia lavandulaefolia+Elymus dahuricus* → Assoc. *Elymus dahuricus+Poa annua+Artemisia* spp. → Assoc. *Hippophae rhamnoides* → Assoc. *Pinus tabulaeformis* → Assoc. *Quercus liaotungensis* → Assoc. *Larix principis-rupprechtii. So a model for the recovery of natural vegetation was established. Life forms in these plant communities and their structure and composition was also changed in succession periods. Analysis of change by various diversity* *indices showed that* as the succession progressed, the richness increased significantly, the evenness decreased slightly and the heterogeneity increased (Zhang, 2005).

East side of Helan Mountain was also evaluated to know the effect of environmental factors on biodiversity. Analysis was carried out through CCA (Canonical correspondence analysis) and through Shannon- Weiner index flora diversity. The selected environmental factors were in the order of elevation> location> slope> exposure in terms of their impact on biodiversity. Shannon- Weiner index showed a unimodal relationship between the species richness and the environmental condition with regards to altitudinal factors. The altitudinal extent with the highest Shannon–Weiner index was identical to the range, where both the deciduous broad-leaved forest and the temperate evergreen coniferous and deciduous broad-leaved mixed forest distributed. The variation of biodiversity along the altitude was consistent with the vegetation vertical zones. According to the Sorensen index between each pair of altitudinal belts, the transition of vegetation spectrum from one zone to another, as from the base horizontal zone, the desert steppe, to the first vertical zone, the mountain open forest and steppe zone, to the mountain coniferous forest zone, and last to the alpine shrub and meadow zone, could be recognized through floristic evidence (Jiang *et al.,* 2007).

Functional diversity in mountain meadow communities is greatly influenced by disturbance intensity. Impact of disturbance caused by tourism in Dongling mountain meadow communities was accessed by Zhang *at el.,* (2015). Species composition, disturbance intensity, elevation and slope data was recorded in 60 plots. Functional diversity wad calculated by using five different indices. Results showed an inverse relation between functional diversity and disturbance gradient. Functional diversity was also significantly related to slope and elevation. Five diversity indices showed effective results. Functional diversity was suggested as indicator of mountain meadows disturbance and degradation.

Ecosystem services in China

Ecosystem services are very much important to maintain sustainable ecosystem and society. The type and area of terrestrial ecosystems were extracted from Vegetation Map of China (1:4 000 000), and then the distribution map of ecosystem services of China was drawn. According to our calculation, the total value of ecosystem services in China is 77 834.48×10^8 RMB Yuan per annum. The value for terrestrial ecosystem is 56 098.46×10^8yuan per annum, and that for marine ecosystem is 21 736.02×10^8 Yuan per annum. The value of ecosystem services in China is 1.73 times bigger than GDP in 1994. The value for forest ecosystem services is 15 433.98×^{8} Yuan per annum, which is 27.51% of the total annual ecosystem services in China. Although wetland is little in area, its ecosystem service value is huge, which is 26 736.9×^{8}yuan per annum. The value for grassland ecosystem is 8 697.68×^{8} Yuan per annum. Coastal ecosystem service is 12 223.04×^{8} Yuan per annum. Overall, the ecosystem service in China contributes 2.71% to that of our planet (Chen and Zhang, 2000). Databases for vegetation ecosystems, GIS and vegetation eco-accounts have been established by Zhiyuan and Jing (2003). In this study it was concluded that the value of land-vegetation's primary productivity is 199.6 billion Yuan/annum, vegetation's soil and fertilization conservation is 22.64 billion Yuan/annum, vegetation water conservation is 22.66 billion Yuan/annum and the value of fixing CO 2 and releasing O 2 is 352.24 billion Yuan/annum and 374.19 billion Yuan/annum respectively. The total value of ecosystem services is 968.33 billion Yuan/annum. The rate of contribution to the temperate deciduous broad-leaved forest is the highest, accounting for 29.35% of the total value.

Soil desiccation of artificial vegetation in the northern regions of china

Soil deterioration is basically expressed by soil desiccation of artificial vegetation in northern areas.

Because in these areas, annual rainfall is very low which results in lowering of soil water level. This water deficiency leads to the bad effects on plant root system due to extra transpiration of plant. So it can be concluded that precipitation cannot compete with the water needs of soil and plant which eventually leads to increase in surface soil earth crust and soil compactness. So plant growth obviously declines in this situation. Hence soil desiccation is a big hurdle in the growth and plantation of artificial vegetation. Avoidance of improper selection of vegetation type and too high community productivity and density, selection of correct vegetation type according to local conditions and maintenance of balance between water consumption and acquisition are the strategies that should be adopted to attain better growth and high yield of artificial vegetation in northern regions (Weixi, 1996).

Chinese vegetation modeling

Processed based equilibrium terrestrial biosphere model BIOME3 was used for Chinese vegetation modeling. Simulated vegetation distribution was similar to the natural vegetation as the result of numerical comparison between two maps using the ΔV statistic (ΔV = 0.23). Same was the case with measured and predicted net primary productivity. Comparison of simulated vegetation map from two different Co2 scenarios with the basic biome map indicated that climate change alone produced a large reduction in desert, alpine tundra and ice/polar desert, and a general pole-ward shift of the boreal, temperate deciduous, warm–temperate evergreen and tropical forest belts, a decline in boreal deciduous forest and the appearance of tropical deciduous forest. Physiological effects of Co2 also prominently decreased the moist savannas and desert, generally decreased the grasslands and steppe, and disappeared the xeric woodland/scrub. Temperate deciduous broadleaved forest, however, shifted north to occupy nearly half the area of previously temperate mixed forest. Increase in Co2 and change in climate not only affects the biogeography but also potentially net primary productivity (Ni *et al.,* 2000).

Conclusion

Chinese vegetation contributes largely to world's total biomass and net primary productivity. Forest, grassland, river, desert and mountain ecosystems of China have a rich flora and provide services for mankind. Over exploitation of these natural resources, environmental contamination and urbanization caused the decrease in vegetation cover in last few decades. A lot of plant species are endangered and vulnerable leading to the threat of genetic and benefit loss.

Recommendation

A lot of plant species are just studied by using classical techniques of plant ecology. So there is huge scope to design more genetic and proteomic studies to know the exact behavior of plants with special reference to climate. It will be helpful to conserve the endangered plant species.

References

Bai YF, Li LH, Wang QB, Zhang LX, Zhang Y, Chen Z. 2000. Changes in plant species diversity and productivity along gradients of precipitation and elevation in the Xilin River Basin, Inner Mongolia. Acta Phytoecologica Sinica **6.**

Bai Z, Gao Y, Xing F, Sun S, Jiao D, Wei X, Mu C. 2015. Responses of two contrasting saline-alkaline grassland communities to nitrogen addition during early secondary succession. Journal of Vegetation Science. http://dx.doi.org/10.1111/jvs.12282.

Cao M, Zhang J. 1997. Tree species diversity of forest vegetation in Xishuangbanna, S. W. China. Biodiversity and Conservation **6(7),** 995- 1007.

Chen Z, Zhang X. 2000. Value of ecosystem services in China. Chinese Science Bulletin **45(10),** 870- 876.

Chen Y, Li W, Xu H, Liu J, Zhang H, Chen Y. 2003. The influence of groundwater on vegetation in lower reacher of Tarim River, China. Acta Geographia sinica **4**.

Chen Y, Zhang X, Zhu X, Li W, Zhang Y, Xu H, Zhang H, Chen Y. 2004. Analysis on the ecological benefits of the stream water conveyance to the dried up water of the lower reaches of Tarim River, China. Science in China series, D: Earth Sciences **47(11),** 1053- 1064.

Chen L, Huang Z, Gong J, Fu B, Huang Y. 2007. The effect of land cover vegetation and soil water dynamics in the hilly area of the Loess Plateau, China. Catena **70(2),** 200- 208.

Davis MA, Pergl J, Truscott AM, Kollmann J, Bakker JP, Domenech R, Prach K, Richard AHP, Veeneklaas RM, Pysek P, Morel RD, Hobbs RJ, Collins SL, Pickett STA, Reich PB. 2005. Perspectives in plant ecology. Evolution and Systematic **7,** 69-76.

Fang JY, Son YC, Liu HY, Pio SL. 2002. Vegetation- climate relationship and its application in the division of vegetation zone in China. Acta Botanica Sinica **44(9),** 1105- 1122.

Gai JP, Christie P, Cai XB, Fan JQ, Zhang JL, Feng G, Li XL. 2009. Occurrence and distribution ofarbuscular mycorrhizal fungal species in three types of grassland community of the Tibetan Plateau. Ecological Research **24**, 1345–1350.

Herzschuh U, Tarasov P, Wunnemann B, Hartmann K. 2004. Holocene vegetation and climate of Alshan Plateau, NW China, reconstructed from pollen data. Paleageography, Paleaclimatology and Paleoecology **211(1-2)**, 1-7.

Hu MZ, Zhang JG, Li XR, Qian YL. 2006. Environmental factors affection vegetation composition in Alxa Plateau, China. Journal of Arid Environments **69(3),** 473- 489.

Jiang Y, Kang M, Zhu Y, Xu G. 2007. Plant biodiversity patterns on the Helan Mountain, China. Acta Ecologica **32**, 125- 133.

Jingyun F, Guohua L, Songling X. 1996. Biomass and net production of forest vegetation in China. Acta Ecologica, 5.

Li, XI, Xio HL, Zhang JG, Wang XP. 2004. Long term ecosystem effects of sand binding vegetation in the Tengger Desert, Northern China. Restoration Ecology **12(3),** 376- 390.

Li Z, Zhou T. 2015. Respones of vegetation growth to climate change in China. The international archieves of the photogrammetry, remote sensing and spatial information sciences, Volume XL-7/W3. 36th International Symposium on Remote Sensing of Environment, 11–15 May 2015, Berlin, Germany, 225-229.

Li Z, Zhou T. 2015. Optimization of forest age-dependent light use efficiency and its implications on climate-vegetation interactions in China. The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences, Volume XL-7/W3, 2015 36th International Symposium on Remote Sensing of Environment, 11–15 May 2015, Berlin, Germany, 449- 454.

Liang W, Yang YT, Fan DM, Guan HD, Zhang T, Long D, Zhou Y, Bai D. 2015. Analysis of spatial and temporal patterns of net primary production and their climate controls in China from 1982 to 2010. Agricultural and Forest Meteorology **204**, 22-36 p.

Lobell DB, Hicke JA, Asner GP, Field CB, Tucker CJ, Los SO. 2002. Satellite estimates of productivity and light-use efficiency in United States agriculture 1982-1998. Global Change Biology **8**, pp. 722-735.

Ni J, Sykes MT, Prentice IC, Cramer W. 2000. Modelling the vegetation of China using the process-based equilibrium terrestrial biosphere model BIOME3. Global Ecology and Biogeography **9**, 463–479.

Ni J. 2002. Carbon storage in grasslands of China. Journal of Arid Environments **50(2),** 205- 218.

Ni J. 2003. Plant functional types and climate along a precipitation gradient in temprate grasslands, Nort-east China and South-east Mongolia. Journal of Arid Environment **53(4)**, 501- 516.

Piao SL, Fang JY, Guo QH. 2001. Application of casa model to the estimation of Chinese terrestrial net primary productivity. Acta Phytoecologica Sinica 5.

Shilong P, Jinguan F. 2004. Dynamic vegetation cover change over the last 18 years in Cina. Quaternary Sciences 1.

Tucker CJ, Pinzon JE, Brown ME, Slayback DA, Pak EW, Mahoney R, Vermote E, Saleous NE. 2005. An extended AVHRR 8-km NDVI dataset compatible with MODIS and SPOT vegetation NDVI data. International Journal of Remote Sensing **26(20)**, 4485-4498.

Van der Maarel E. 2005. Vegetation ecology. Blackswell publishing, Malden. Oxford, 395 p.

Wang H, Prentice IC, Ni J. 2013. Data based modeling and environmental sensitivity of vegetation in China. Biogeosciences **10**, 5817- 5830.

Wang G, Zhao W, Liu H, Zhang G, Li F. 2015. Changes in soil and vegetation with stabilization of dunes in a desert–oasis ecotone. Ecological research.

Weixi Y. 1996. The preliminary discussion on soil desiccation of artificial vegetation in Northern regions of China. Scientia Silvae Sinicae, 1.

Xu YJ, Chen YN, Li WH, Zhou HH, Sun HL, Li Z, Chen YP. 2011. Vegetation patterns and ecological factors in the Ili River, Xingjiang, China. Nordic Journal of Botany **29**, 8796.

Yan Y, Lu X. 2015. Is grazing exclusion effective in restoring vegetation in degraded alpine grasslands in Tibet, China? PeerJ PrePrints/ https://dx.doi.org/10.7287/peerj.preprints.931v1CC-BY 4.0.

Yi S, Ming-guo MA. 2007. Study on vegetation cover change in North-west China based on SPOT vegetation data. Journal of Desert Research 1.

Zhang J, Cao M. 1995. Tropical forest vegetation of Xishuangbanna, SW China and its secondary changes, with special reference to some problems in local nature conservation. Biological Conservation **73(3)**, 229- 238.

Zhang JT. 2005. Succession analysis of plant communities in abandoned croplands in eastern Loess Plateau of China. Journal of arid environments **63(2),** 458- 474.

Zhang JT, Ru W, Li B. 2006. Relationship between vegetation and climate on the Loess Plateau in China. Folia Geobotanica **41(2)**, 151- 163.

Zhang JT, Xiao J, Li L. 2015. Variation of plant functional diversity along a disturbance gradient in mountains of Donglingshan reserve, Beijing, China. Russian journal of ecology **46(2)**, 157- 166.

Zhao WZ, Cheng X, He ZB, Zhang ZH. 2007. Study on vegetation ecological water requirement in Ejina Oasis. Science in China series D: Earth Sciences **50(1),** 121- 129.

Zhiyuan R, Jing L. 2003. The valuation of ecological services from the vegetation ecosystems in Qinling-Daba mountains. Acta Geographica Sinica 4.