

Multifunctional mountain forests in arid land:

The Tienshan Range in Xinjiang of China

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Abstract

Mountain forests in arid land are rather limited and rare resources. The Tienshan mountains in Xinjiang have forests only on shady slopes in the middle mountains (1600-2700 m) which firstly serve as valuable tourist spots. The forests were appraised the most beautiful forest of China in 2005 by *Chinese National Geography*. Secondly, montane forests help smooth the curve of seasonal runoff by reducing high-water runoff and enhancing dry-season runoff, with flooding disasters much heavier in the southern flank where montane forests appear only in small patches than in the northern. To a large extent, mountain forests act as “umbrella”, i.e., providing ecological security, for the oases downstream where live more than 90% of the local population. Finally, large-area wild fruit forests have been found in the Ili valley in the west section of Chinese Tienshan, including wild apricot, wild apple, wild cherry, wild walnut, etc., which are adversity-resistant and gene resources for world horticulture and biological genetics. The forest management at present, however, is unsustainable, and new forest policies need to be developed.

Rare and fragile montane forests in arid land

In the northwestern arid China, vast deserts (e.g. the Taklimakan Desert, the Gurbantunggut Desert, etc.) and extensive high mountain ranges (e.g. the Kunlun, Tienshan, Altai, etc., usually over 5500-7000 m above sea level) alternate. The typical pattern of natural landscape in Northwest China is the combination of high mountains, oases and deserts. Rivers usually originate in the snow-capped high mountains, flowing through oases and disappearing in the low-lying desert. This constitutes a nearly closed inland system, or a highland/lowland interactive system. Mountain forests are very limited in area, making their appearance only on shady slopes in the middle parts of these mountain ranges, e.g. 2700–3600 m a.s.l. in West Kunlun, 1600–2700 m in the Tienshan, and 1500–2500 m in the Altai. Furthermore, the ecology of these forests is often very fragile due to cold climate above the forest line and dry environment (annual precipitation < 400 mm or even 200 mm) below the forest belt. As a result, it is very difficult or even impossible for these forests to recover if they are seriously destroyed. On the other hand, these forests are rare resources and of special value to the local people and to the sustainable development of the vast arid regions.

The extensive Tienshan range stretches west-east in the middle of the Xinjiang Uygur Autonomous Region in Northwest China. To the south is the Taklimakan Desert, the second-largest shifting sandy desert of the world, and to the north is the Gurbantunggut Desert (Figure 1).

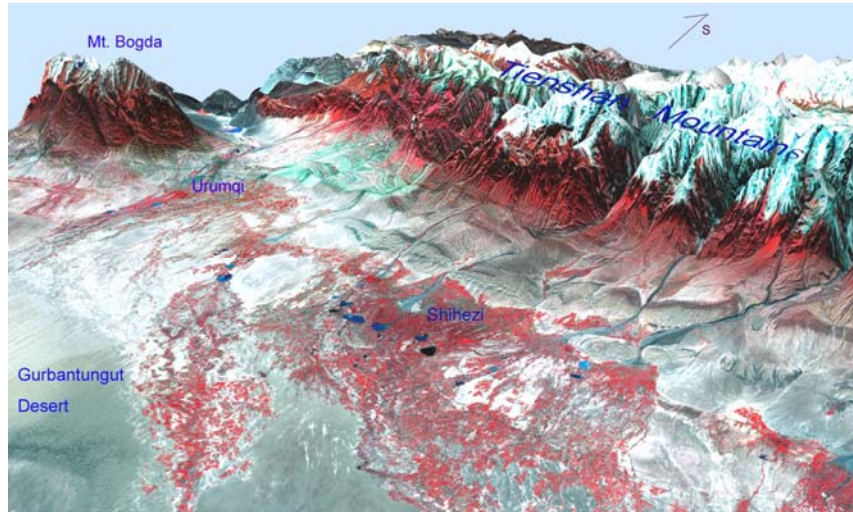


FIGURE 1 The northern flank of Tianshan Mts. and the low-lying oases and desert: a typical pattern of mountain-oasis-desert in northwest arid China. The dark-red parts in the middle mountains are forests (map by Cheng Weiming with TM images and digital elevation model).

The most outstanding feature of the Tianshan Range in Xinjiang is the existence of a “green forest belt” on shady (northern) slopes of the middle mountains in the northern flank. Its existence is closely related with a rich rainfall belt (above 500 mm) and a temperature inversion layer in winter in the middle mountains. And the forest is characterized by a single species (Figure 2), mainly Schrenk spruce (*Picea schrenkiana* Fisch. Et Mey), with some deciduous forests in the Ili Valley in the west and some larch forests in the easternmost section (Figure 3).



FIGURE 2 Montane forests in the northern flank of the Tianshan, with the symbolic species, Schrenk spruce (Photo by Zhang Baiping).



FIGURE 3. Wild apple forest in the Ili river valley (phot by Ablimit Abdukadir)

Mountain forests as tourist resources

Generally, people living in arid land prefer to enjoy a cool and comfortable environment. The forested middle mountains, especially coupled with lakes, are the most desired place for such purpose. In the Tianshan mountains, some well-known scenic sites (e.g., the Tianchi scenic spot close to Urumqi city, and the Sarim Lake scenic spot) had been developed earlier by local governments; in recent years, many forest lands, especially those close to cities, have been developed as tourist sites by private enterprises (Figure 4). In 2005, *Chinese National Geography* gave a rank list of the most beautiful places of China according experts' opinions, and the Tianshan mountain forests rank first in the list of the most beautiful forests, thanks to its single species (Schrenk spruce), thick canopy, height (20-30 m, even 60-70 m in Ili River valley in the west section of the Tianshan), straightness, vastness (more than 1700 km only in China), and sharp contrast with the surrounding desert landscape. This undoubtedly enhances the value of Tianshan mountain forests as tourist resources. It is safe to say that montane forest tourism can be highly expected in the future.



FIGURE 4 Privately operated tourist site in mountain forests south of Shihezi (photo by Zhang Baiping).

Montane forests as buffer belt of flooding and low-water runoff

The total area of the northern flank of the Tianshan Range is about 11 700 km², and that of montane forests is only 430 km², with a forest coverage less than 4%. The hydrological effect of montane forest seems to be quite limited. But the effect can still be recognized.

Montane forests help reduce runoff. Studies in the northern flank of the Tianshan show that montane forests have a much greater capability than evaporation in regulating river runoff, with montane forests reducing river runoff by 39.56 mm while evaporation by only 7.62 mm. Watershed runoff is closely related with the area of montane forest than with the storage volume on unit area, namely, 1% increase in forest area could result in 0.33 mm reduction of runoff depth, and 1% increase of forest storage volume of unit watershed area gives rise to 0.27 mm reduction of runoff.

Montane forests enhance dry-season runoff. Analysis of water replenishment of 31 rivers in the northern flank of the Tianshan Range shows that, with the increase of forest coverage and per unit area forest storage volume, dry-season runoff increases by 350 million m³; dry season shortens by 2 months; and the lowest-water month runoff increases by 70 million m³; for every 1% increase of forest coverage, lowest-water month runoff increases by 4 million m³; an increase of 1000 m³ forest storage, lowest-water month runoff increases by 27 million m³.

Studies also show that river runoff increases with forest cover when forest cover is less than 10%, and that river runoff decreases with forest cover when forest cover is more than 10%. This indicates that the function of montane forests as river runoff regulator depends on the spatial scale and the quality of montane forests. Thus, forest coverage can not be used as the only factor when evaluating the relationship between forest cover and runoff.

In short, montane forests help smooth the curve of seasonal runoff by reducing high-water runoff and enhancing dry-season runoff. As a result, flooding disasters are much heavier in the southern flank where montane forests appear only in small patches than in the northern where forest area is relatively large. To a large extent, mountain forests act as “umbrella”, or provides ecological security, for the oases downstream where live more than 90% of the local population.

Mountain forests as hot points of biodiversity

Large-area wild fruit forests have been found in the Tianshan Mountains, especially in the Ili valley in the west part of Chinese Tianshan. These forests total 9300 ha, with wild apricot (*Armeniaca vulgaris* Lam.) of 1300 ha and wild apple (*Malus sieversii*) of 980 ha (Figure 5). A total of 84 species of wild fruit trees have been identified, including 46 species of apricot, 21 species of wild cherry (*Prunus sogdiana* Vass), 14 species of wild walnut (*Juglans Regia* L.), etc. Here, montane forests are simply important gene pool. They are relic species of the Tertiary period, characterized by cold-, disease-, and drought-resistance. So, they are rare adversity-resistant fruit species and gene resources for world horticulture and biological genetics. They are Mediterranean type of deciduous-, broad-leaved forest, and their existence, evolvement and distribution are closely related with advantageous westward-open mountain structure, which helps capture moist-laden air masses from west and promote the occurrence of rainfall (800-1000 mm in the middle mountains), and prevent invasion of cold air masses from the north. It has been also known that there exists a warm layer in middle mountains in winter season, called temperature inversion, in the whole northern flank and in the Ili valley of the Tianshan Mountains. The mean temperature of coldest month (January) on elevations of 2000-2500m is about -10°C, while that below 500m is about -15°C. This winter warm layer helps keep forests live in the coldest season.



FIGURE 5 Montane larch forest in Barkol in the easternmost Tianshan Mountains (photo by Zhang Baiping)

Challenges and suggestions

Unfortunately, these precious forests face many challenges. Firstly, grazing can still not be completely prohibited in the forest land. About one quarter of the forested land is actually sparse forests, where grasses grow well. They have been grazed for many years as traditional pastureland. Since 2000, the Tianshan mountain forests have been listed as logging-banned areas (small volume of timber production is allowed only in the Ili valley) by the national Natural Forest Protection Project (NFPP), but grazing has not been stopped (Figure 6), because the local herdsmen have also lawful land use certificates issued by the local animal husbandry department. Consequently, one piece of land can be lawfully used both by forestry workers and by herdsmen. As a result, forests on these mountain slopes are undergoing degradation, generally from sparse forest land to actual grassland.



FIGURE 6 Grazing sheep in the forest land in Tianshan mountains (Photo by Zhang Baiping).

Secondly, the work of forest management has been weakened. According to the NFPP, the work of forest management is simplified to forest guarding. Other forest management activities that were performed before, e.g., nurturing forest artificially, fencing newly forested land, repairing fences, preventing and curing disease in forest land, have virtually be stopped. In mountains of arid land, forest management and development need artificial nursing. Forest guarding alone could not guarantee the sustainable development. If the necessary forest management activities could not be planned and economically supported, these forests could not regenerate well and even shrink in area.

Thirdly, and, as a result, if the present forestry policy continues, the forest area of the Tianshan Mountains would decrease by 10-20% with 50 years. This certainly contradicts the purpose of the national NFPP, also against the will and concern of the whole society for sustainable environment and ecology.

We have some suggestions as follows:

- (1) Forest management is a systematic project. The national NFPP should extend its working frame, so as to include artificial forest regeneration in the Tianshan Mountains.
- (2) Contending for land between forestry and animal husbandry departments should be well reconciled. As multi-functional resources, mountain forests in arid land especially deserve strict protection and elaborate management.
- (3) Forest management is not only the work of forestry departments, but also the concern of the local people. Forest management could be clear cut with the local people. Participatory management model should be developed to motivate the effort of the local people. Only this way, can forest management be sustainable.

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