Sacred Forests in Tibet

Authors: Miehe, Georg, Miehe, Sabine, Koch, Katja, and Will, Martin

Source: Mountain Research and Development, 23(4) : 324-328

Published By: International Mountain Society

URL: https://doi.org/10.1659/0276-4741(2003)023[0324:SFIT]2.0.CO;2

Georg Miehe
Sabine Miehe
Katja Koch
Martin Will

Sacred Forests in Tibet

Using Geographical Information Systems for Forest Rehabilitation

The treeless desertlike environments of southern Tibet are assumed to be naturally unsuitable for forests. Yet, climatic conditions do allow for the growth of indigenous trees in Lhasa and many parts of southern Tibet, even where there is no high groundwater table or irrigation. This was discovered and proven in a Sino–German research project launched in 1997. The project made an inventory of forest relics, correlated residual tree stands with climatic data, and successfully cultivated nonirrigated indigenous junipers and cypresses. The eroded semidesert landscape of southern Tibet appears to have a huge potential for reforestation. The area with a potential for tree growth was investigated using the Geographical Information System known as GRASS (Geographical Resource Analysis Support System). Reforestation measures could meet the heavy demand for timber and firewood, help combat erosion on overgrazed slopes, and restore the degraded pastures. Grazing must be excluded on reforestation plots. Simultaneously, rangelands may regenerate after overgrazing. The optimum duration of the ungrazed period varies with altitude, humidity, soil conditions, and the degree of degradation. Successional trends observed on exclosure plots suggest that the drier the climate and the lower the initial degree of herbaceous vegetation cover, the longer the ungrazed period will be beneficial for pasture regeneration. Challenges in research and practice resulting from these preliminary results are highlighted.

The environmental challenge

The valleys and lower mountain ranges of south-central Tibet have a semidesert appearance. Overexploitation of vegetation from ancient times until recently has caused severe erosion processes and converted previous forest and scrub communities into open steppe (Figure 1). The main consequences for the local human population have been a marked shortage of firewood and construction wood. The last residues of juniper shrubs are being uprooted in remote areas. Poplar and willow plantations in valleys cover some of the rural demand for construction wood, but they offer firewood of only minor quality and require either irrigation or a high groundwater table.

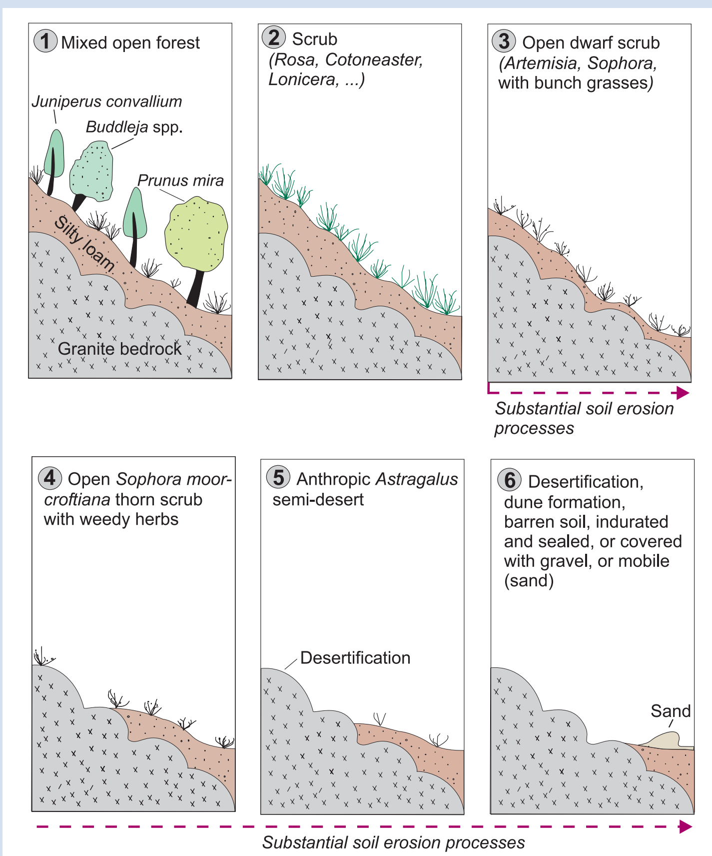


FIGURE 1 Hypothetical desertification process on lower sunny slopes of the Kyi Chu–Yarlung Zhangbo area around Lhasa. The rehabilitation of forests is possible, provided that there is rootable substrate. (Based on sketches by S. Miehe, 2002)

The scientific challenge

The common consensus in the scientific community is that southern Tibet has no potential for tree growth. It hardly seems possible to believe otherwise, in view of the dry and barren Central Asian environment. The only exceptions are sites with surplus water, such as river floodplains, where poplar woodlands and thickets of willow and buckthorn are assumed to grow naturally.

Several comprehensive ecological inventories were undertaken in southern Tibet between 1995 and 1999 in a cooperative effort involving the Tibet Plateau Institute of Biology in Lhasa and the Faculty of Geography at the University of Marburg, Germany. These investigations

FIGURE 2 *J. tibetica* in the Reting sacred forest at 4400 m. The forest is overmature, and regeneration is inhibited by winter grazing. (Photo by G. Miehe)

revealed numerous isolated tree stands of indigenous juniper species within the desertlike shrublands. Most of the sites have a southern orientation, with a shallow rocky substrate. The trees are of moderate to excellent vitality and produce large quantities of fruit. Young trees occur where trampling or grazing during winter is not too great. Two juniper tree species are widespread in southern Tibet: *Juniperus convallium* Rehder & Wilson in the lower reaches of the Kyi Chu and Yarlung Zhangbo between 3600–3700 m and 4100–4570 m, and *Juniperus tibetica* Komarov from 4100 up to a maximum of 4850 m, the latter reaching far into western Tibet. Most of the trees are under religious protection as junipers are sacred in the Tibetan tradition. The largest stands of juniper trees are even pilgrimage sites, such as Reting Forest, 80 km north of Lhasa (Figure 2).

Sacred forests are still found some 600 km west of the current westernmost forest border as it is shown in the Atlas of Tibet. Rainfall data in the area suggest that the drought limit of juniper trees correlates with annual precipitation of 200–250 mm. The pattern of isolated forests surrounded by vegetation types commonly believed to occur naturally in other climates resembles the isolated tree stands of *Polylepis* within Andean *páramo* grassland, *Erica* in afroalpine heathlands, and *Ulmus* trees in the steppe of Mongolia.

On the basis of field evidence, we hypothesize that the present high mountain deserts of southern Tibet are the result of deforestation due to centuries of woodcutting, use of incense, and grazing. They can be reforested with indigenous tree species without irrigation if grazing is excluded. Figure 3 shows the potential zonation of juniper forests in the Lhasa area, as reconstructed from residual tree stands.

Use of Geographical Resource Analysis Support System to identify areas suitable for reforestation

Intense ecological research on environmental conditions affecting indigenous juniper trees in southern Tibet resulted in a comprehensive data set of point information on distribution. Geographical Information System (GIS) analysis of ecological features makes it possible to detect patterns and relationships that are not clearly evident without visualizing

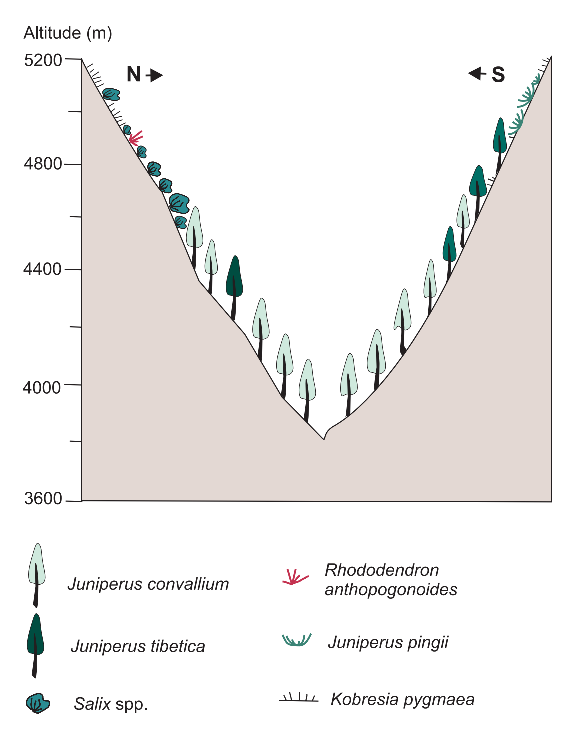
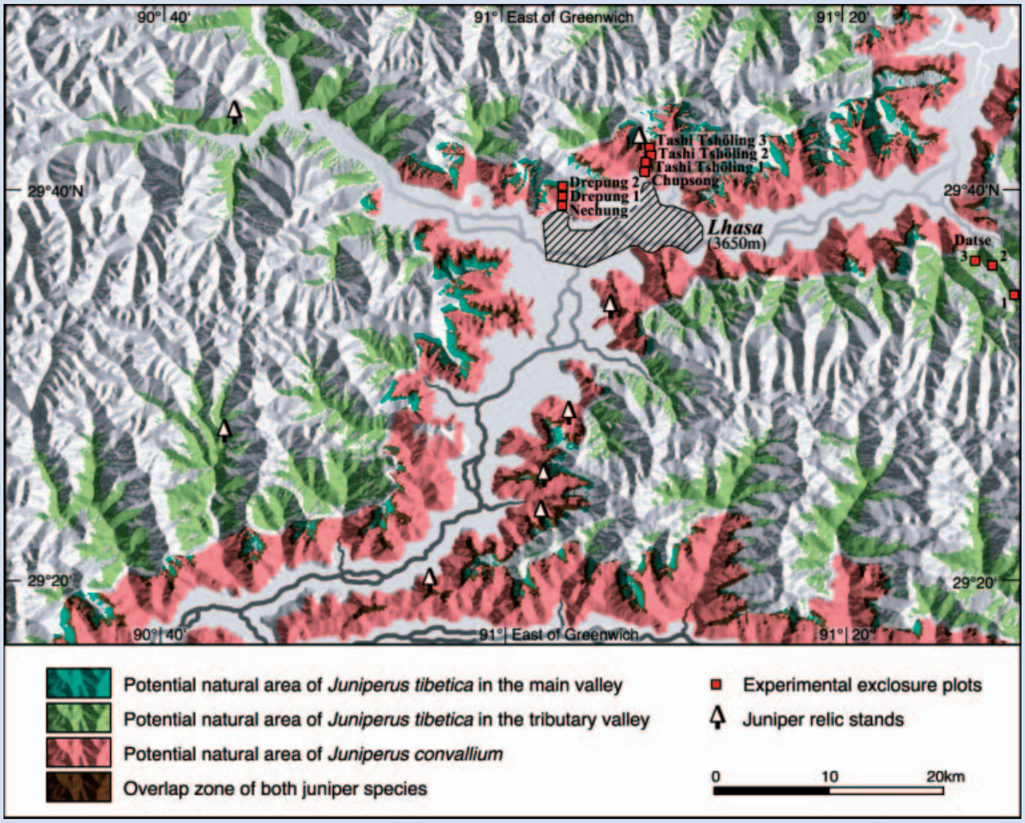


FIGURE 3 Potential altitudinal forest belts in the Lhasa area in southern Tibet, extrapolated on the basis of forest relics. (Based on sketch by S. Miele, 2002)

FIGURE 4 DTM of the lower Lhasa valley with potential reforestation areas extrapolated from mapped residual trees. 30.4% (1,620 km^2) of the total area is suitable for reforestation with *J. convallium* (red) and *J. tibetica* (green). Intermediate areas are shown in brown. The potential forest area is partly restricted by unsuitable substrates such as solid rock, not included in the DTM. (Model by M. Will)



the data. Information on the occurrence of indigenous juniper trees linked with data on rainfall variability, partly extrapolated, was observed and analyzed using the Geographical Resource Analysis Support System (GRASS) and a digital terrain model (DTM) of 2 selected areas in southern Tibet. Potential forest sites were identified on this basis. Extended areas in the lower Lhasa valley could support tree growth without irrigation (Figure 4). The maps offer a foundation for additional reforestation measures in this area.

Evidence of forest potential

To provide experimental evidence for forest potential in Tibet, saplings of indigenous junipers and cypresses were raised in an experimental tree nursery in the Tibet Plateau Institute of Biology for 1–2 years. In 1999 and 2000, plantation trials were undertaken on fenced experimental plots between 3750 and 4170 m above Lhasa (Figure 5). Despite the short cultivation period (at least 3 years are recommended), the survival rate of saplings averaged 18% in the 1999 plantation and almost 100% in the 2000 campaign. The saplings were only watered in the tree nursery and at the time of plantation. They are presently growing without any supplementary irrigation.

Combining reforestation with rangeland regeneration

Evidence of tree growth in Lhasa reveals that vast areas are secondary shrublands that do replace forest. Thus, the eroded semidesert landscape of southern Tibet has a huge potential for reforestation. Grazing by livestock must be excluded from afforestation plots until the trees are strong enough to resist trampling and browsing. At the same time, rangelands may regenerate from overgrazing. The optimum period for the exclusion of livestock varies with altitude, humidity, soil conditions, and the degree of pasture degradation. However, there is a lack of long-term studies and experiments in this area.

The second purpose of the experimental exclosure plots was to observe and document changes in vegetation that take place after grazing has been excluded at different altitudes. On the lowest of 7 exclosure plots fenced in 1997, situated at 3750 m, the extrapolated annual rainfall was 485 mm. The highest plot is located at 4650 m and receives some 715 mm annual rainfall (rainfall has been measured on all plots since 1997)—more than in the temperate oak–pine forests of southeastern Tibet. On the lowest plot, heavy regeneration of both herb and shrub layers was recorded. Within 4 years, the cover of both strata almost doubled. The cover percentage of the tall dominant grass (*Pennisetum flaccidum*) rose from 10% to 32%. Where it dominates today, it has replaced the less productive small bunch grasses (*Eragrostis* and *Tripogon* spp.), which are probably more resistant to trampling and overgrazing. The latter pioneers have occupied patches of ground that were previously barren. The number of species increased slightly, from 21 to 24. Some grazing weeds have been replaced by plants with a greater demand for nutrients, which are probably provided by accumulated plant litter.

It is remarkable that *Artemisia santolinifolia* reinvaded the plots very quickly. This wormwood species is becoming widespread above 3900 m on slopes with a southern orientation above Lhasa. The experiment showed that the growth of this shrub at higher altitudes is not only a function of the greater amount of rainfall measured there; intensive grazing and collecting of fuelwood and incense over centuries reduced *A. santolinifolia* on the lower slopes. A similar connection can be observed with the potential for *Buddleja* spp. trees on the lower valley flanks, which form thickets that suppress most of the grasses during later regeneration stages in the absence of woodcutting.

These preliminary results from an experimentation period of just 5 years provide only rough ideas about crucial questions of combined silvicultural–environmental–pastoral restoration projects:

- How long are fences necessary to protect young trees?
- What is the future development of vegetation in this environment? Will grasses or shrubs dominate after a certain period of time?
- When will the aims of foresters (safe growth of young trees) and of environ-

FIGURE 5 South-facing slope near Lhasa with grazing exclosure plots (dots) between 3800 and 4650 m. White square indicates the location of residual *J. convallium*. (Photo by G. Miehe)

FIGURE 6 Treeless high mountain desert with extended sandy areas along the lower Kyi Chu (Lhasa River) and the Yarlung Zhangbo. This area has a great potential for reforestation. (Photo by G. Miehe)

mental conservationists (dense and diverse plant cover that stabilizes the soils and improves the water catchment) start to diverge from those of pastoralists (dense, palatable, and productive herb layer with a certain resistance to trampling)?

The preliminary observations of regeneration processes made on the different exclosure plots imply that the drier the climate and the lower the initial cover degree of the herbaceous vegetation, the longer it will take to observe significant pasture regeneration.

Conclusions and recommendations

Integrating GIS in environmental research improves decision making in planning for sustainable development and makes it possible to identify areas where reforestation is promising.

Generally, the environmental rehabilitation of both woody and pasture components seems very appropriate in the zone of dry juniper forests of the Kyi Chu and Yarlung Zhangbo catchments (Figure 6). Many questions remain to be answered, however. General recommendations cannot be given as long as so little is known about the vegetation ecology of this area. Thus, environmental rehabilitation projects will necessarily have to include further experiments. The cultivation of junipers and other useful woody species adapted to the local climate can be done by village communities in simple low-input tree nurseries. Fencing is much more problematic. Fences must be livestock-safe but cheap and eventually removable. Mud brick walls are a safe but labor-intensive choice. If mud is taken from sloping sites, erosion problems can be aggravated. Thorn fences and turf walls should be avoided by all means to preserve fragile natural resources. The monitoring of rangeland regeneration should be done in collaboration with local herders, who have the most experience in judging the quality of a pasture.

FURTHER READING

[APMN] ***Asia-Pacific Mountain Network.*** Juniper Forum Web Site. www.mtnforum.org/apmn/juniper_forum.htm.

Farjon A, Miehe G, Miehe S. 2002. The taxonomy, distribution and ecology of *Juniperus* in High Asia. *In:* Forest and Walnut Research Institute and Kyrgyz-Swiss Forestry Support Program, editors. *Problems of Juniper Forests: Looking for Solutions, Methods, Techniques.* Proceedings of the International Symposium, Bishkek, 7–11 Aug 2001. Bishkek, Kyrgyzstan: Forest and Walnut Research Institute, pp 70–79.

Miehe G, Zhang Y, editors. 2000. *Environmental Changes in High Asia*. Proceedings of the International Symposium, Marburg, 29 May 1997; Marburger Geographische Schriften 135. Marburg, Germany: Geographisches Institut der Universität Marburg.

AUTHORS

Georg Miehe, Sabine Miehe, Katja Koch, and Martin Will
Faculty of Geography, University of Marburg, Deutschhausstrasse 10, D-35032 Marburg, Germany.

Georg Miehe and Sabine Miehe are high mountain ecologists interested in the vegetation dynamics of high mountains under the impact of humans and climatic changes.
miehe@staff.uni-marburg.de

Katja Koch is a student researcher working on environmental issues in Tibet, with a special focus on vegetation and grazing ecology.
Katja.Koch@students.uni-marburg.de

Martin Will is a student researcher specializing in GIS.
martin.will.tr@gmx.de