OVERGRAZING IN CYPRUS

Adaptations and degradation processes

A CASCADE Project case study in the Randi Forest, Pissouri, Cyprus

by

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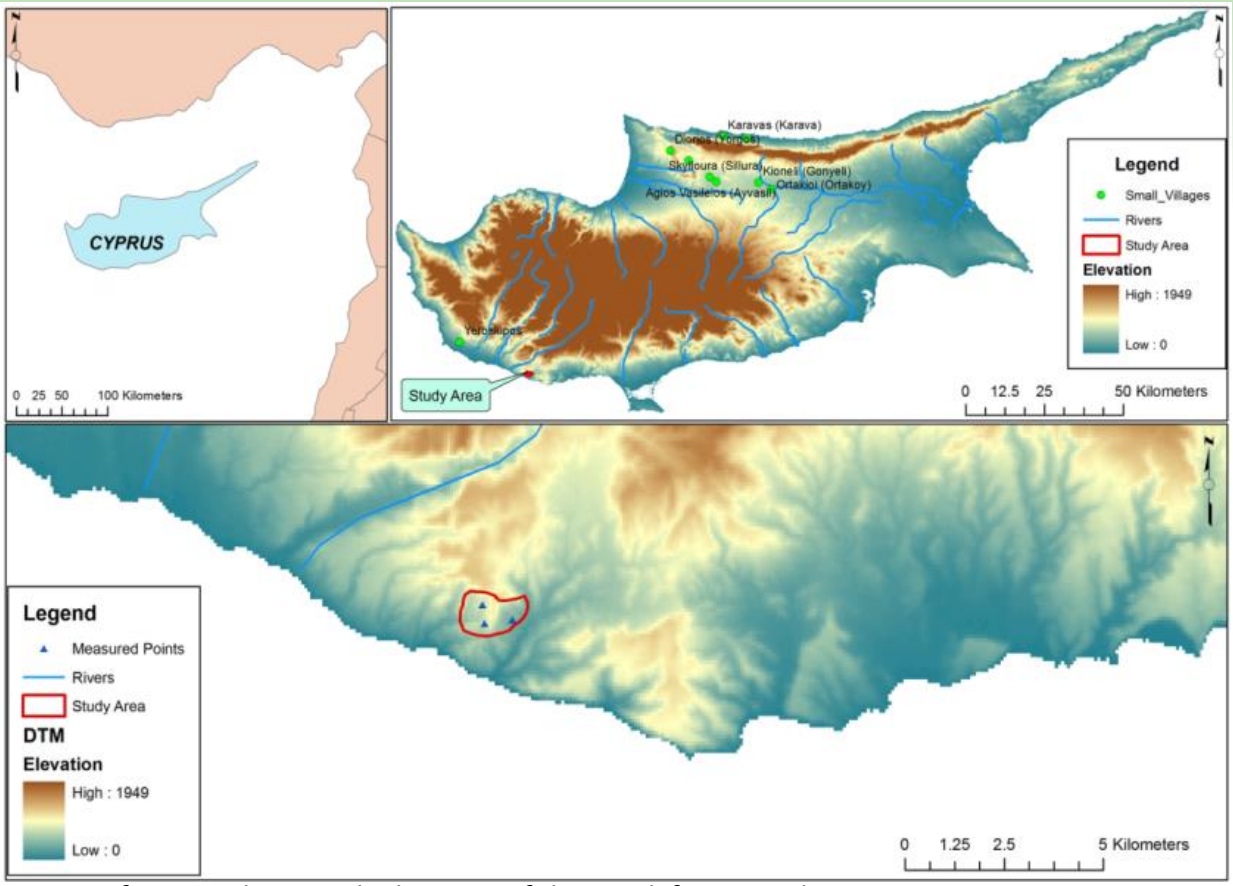
The Pissouri (Randi forest) study site area, where land degradation is associated with overgrazing by goats (photo by V.R. Vallejo)

The Pissouri area is located in southern Cyprus, in the south east part of the Paphos district. Here there was once extensive pine woodland (Randi forest) but during recent history almost all the pines have been removed for shipbuilding, charcoal or local fuel. The shrubby vegetation has been intensively grazed by goats, and where overgrazing has caused the vegetation cover to become patchy, soil erosion has left degraded land with shallow stony soils.



A map of Cyprus showing the location of the Randi forest study area (Technical University of Crete)

The current dryland ecosystem of the Randi forest has developed in response to land use (tree-felling and grazing). Some of the plant species at the site currently show adaptations to grazing pressure by both wild and domestic herbivores.

A few plant species are completely unpalatable to goats because they contain toxic substances in the leaves (e.g. asphodel-type species), so they are ignored by the animals and increase their relative abundance in response to increased grazing pressure.

One of the most common adaptations of shrubs and trees to grazing is bearing thorns that give the plant physical protection. These plants do not completely avoid being browsed, but provide efficient grazing resistance that allows the plant to survive up to a certain pressure. However, these plant species are not resistant to severe degradation processes and tend to disappear in highly degraded conditions.

On the hilly terrain the goats may wander at will and in all directions, choosing new areas to graze. However, they pass through the land close to farm sheds and yards most days and this area suffers the most intensive browsing and degradation.

Goats roam the hillside (photo by N. Geeson)

Researchers examine a prickly bush (photo by N. Geeson)

The ecology of the study site is being studied and recorded in detail. Researchers have discovered that some well-established spiny plants give protection to other more vulnerable species below or within them.

For a short time in the Spring some fragile, less-adapted perennial and annual plants may flower, e.g. Muscari sp. (photo by N. Geeson)

Tragopogon porrifolius (photo by N. Geeson)

Anemone coronaria with grasshopper (photo by N. Geeson)

Overgrazing by herbivores induces hemispherical growth forms as the outer, more tender and palatable sprouts are removed, resulting in small bonsai-type shrubs and trees with unusual shapes and forms. These resistant shrubs protect the soil below them from erosion and also accumulate litter, seeds and soil particles, acting as a sink and generating patches of soil fertility ("fertility islands").

In addition, they protect other more sensitive plant species growing inside the shrub from browsing, which provides a nurse effect. Protected plants can be perennial and annual forbs (herbaceous flowering plants). In the spaces between resistant plant patches, the soil tends to lose permanent plant cover due to grazing and trampling, and is increasingly exposed to rain water runoff, leading to sheet and rill erosion and compaction. These empty spaces are temporarily colonized by annual plants completing their brief life cycles during the relatively wet spring. There is a large diversity of annuals, including small grasses, legumes and forbs.

The spiny shrub Lithodora hispidula, with mauve flowers in spring. Around it, and during the wet season, grow annual grasses and herbs, plus the fleshy leaves of Urginea maritima that are not palatable to goats (photo by N. Geeson)

Sarcopoterium spinosum. Source: © 2014 uludağ sözlük.

Main functional plant types in the Randi forest site are:

Small-medium thorny scrubs. Slow growing, drought-resistant, with small leaves. May provide a nurse effect. They generate fertility islands with improved soil fertility and a seed bank: a microcosm with several small species taking advantage of the protective structure of the thorny scrub. Dominant scrub species in the Randi forest site are (ordered by abundance in the area):

•*Sarcopoterium spinosum* (thorny burnet, Family: *Rosaceae*) Extremely abundant in the Eastern Mediterranean, characteristic of the phrygana, especially in degraded areas (overgrazing, frequent fires), facultative resprouter (see photo above)

•*Lithodora hispidula* ssp. *versicolor* (synonym of *L. versicolor*) (gromwell, Family: *Boraginaceae*). Near-endemic, also found in Turkey and Syria (see photo on previous page)

•*Helichrysum conglobatum* (synonym *H. stoechas* ssp. *barrelieri*) ("everlasting", Family: *Asteraceae*)

Rhamnus oleoides (photo by V.R. Vallejo)

Tall thorny shrubs. Some are leguminous species having the capacity of fixing atmospheric nitrogen, relatively fast-growing.

•*Calicotome villosa* (spiny broom, Fam. *Fabaceae*) Legume. New sprouts are tender, thorns are soft until the arrival of summer, and the twigs are rich in proteins (high fodder value). Flowers are also eaten by goats

•*Genista fasselata* (rasi, Fam. *Fabaceae*). Legume

•*Rhamnus oleoides* (synonym of *R. lycioides* ssp. *oleoides*) (buckthorn, titsirka, Fam. *Rhamnaceae*), common in Eastern Mediterranean (see photo at the right)

•*Olea europaea* (wild olive tree, Fam. *Oleaceae*)

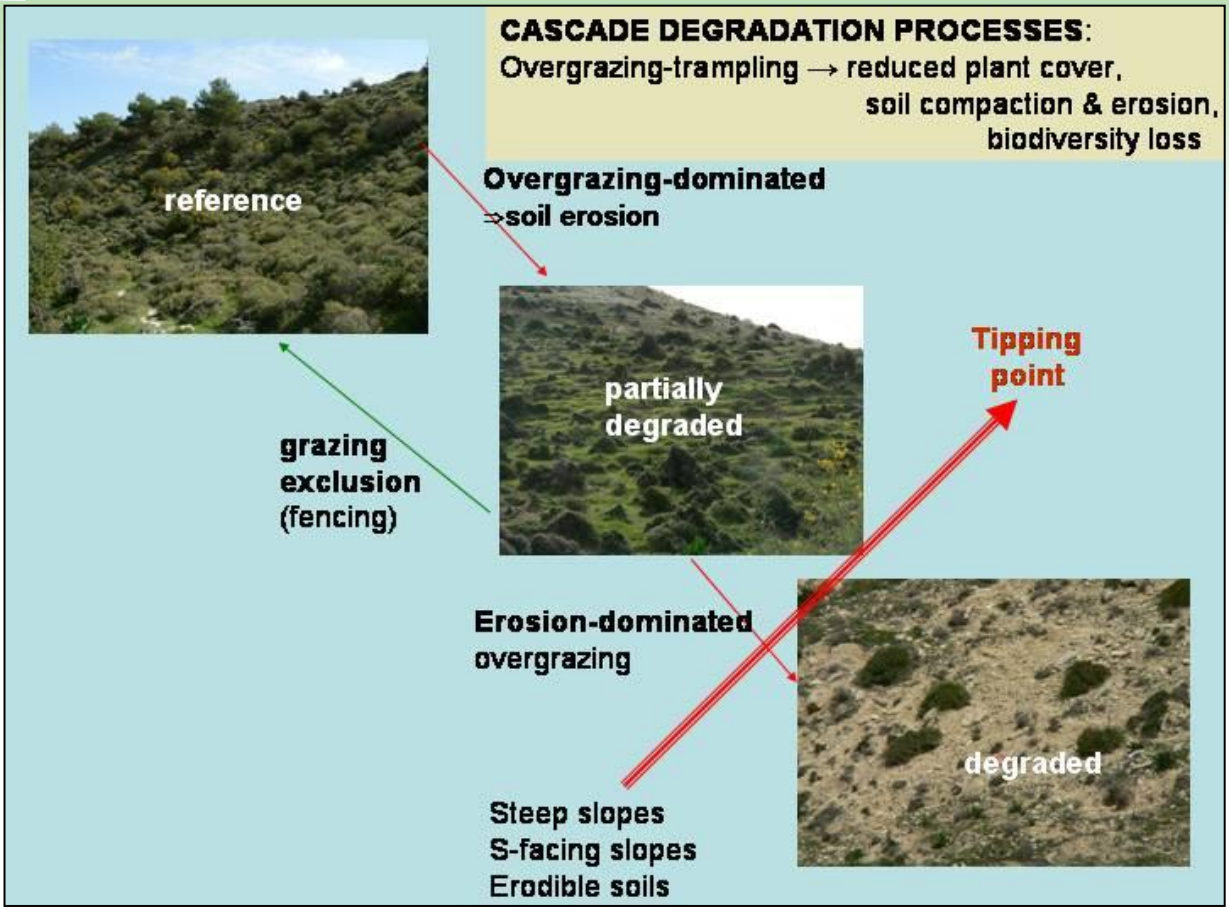
Calicotome villosa or "spiny broom" (main photo by N. Geeson, plus photos from: West-Crete. Com (left); Stridvall L. & A.: Plant Galleries http://www.stridvall.se/la/galleries.php] (right))

Perennial palatable herbs growing protected within thorny shrubs

Unpalatable forbs, geophytes (resprouting from bulbs), above-ground parts dry out in summer, not generating patches, nor fertility islands, nor facilitation to other plants. Little soil protection due to seasonality and low developed root system (bulb + few fine roots):
Urginea maritima (also *Drimia maritima*, sea onion, Family Liliaceae), very common around the Mediterranean, used as medical plant since ancient times. *Asphodelus sp.* (asphodel, Family Liliaceae)

Annuals, or biennials, completing their lifecycle from shoot to seed in a short period of time. Seeds may then remain protected under shrubs until the following year or suitable growing conditions.

Lithodora hispidula ssp. *versicolor, small spiny shrub. (Photo by V.R. Vallejo)*



Preliminary interpretation of degradation processes in the Randi forest site, on the basis of field observations

In spite of plant species adaptations to grazing (and drought), overgrazing may cause severe vegetation and ecosystem degradation. Understanding this degradation requires us to address the following questions:

- What are the features of land degradation processes in the Randi forest site?
- Why and when do the types and vegetation change?
- Can tipping points be identified?

The cascade of degradation processes beyond tipping points can be described as follows:

Overgrazing: Reduction and modification of growth pattern of thorny shrubs

trampling → soil compaction, reduced soil infiltration, increase bare soil and ecosystem patchiness → **increased runoff and soil erosion**

We can identify two stages along a degradation gradient:

1. **Partly degraded shrublands** (as a result of overgrazing) which have lost some of their plant cover, and any plant growth is limited. The consequence is a reduction in ecosystem services. However, partly-degraded shrublands can be restored by excluding grazing, e.g. with fences.

2. **Irreversibly degraded shrublands**, which have been grazed and eroded, removing vegetation and soil to an extent beyond a tipping point. Steep slopes and erodible soils, (such as soils on marl bedrock), make the likelihood of degradation worse. Also, the process may be aggravated by further stresses, such as a drought event that removes more vegetation, or heavy rain storms that wash away more of the uncovered soil.

Irreversible over-grazing, soil compaction and erosion → Drastic reduction in plant cover and biodiversity ,including loss of keystone species (e.g. Calicotome), unpalatable forbs and annuals; further grazing not possible; Severe soil loss by water and wind → **Bare bedrock, where new soil formation will be very slow; most ecosystem services lost**

Partly degraded areas: overgrazed shrubs and scrubs, annuals (light green color) growing between them (interpatch more or less continuous matrix). (Photos by V.R. Vallejo)

Palatable perennial forbs (herbaceous plant species, Prasium majus) grow protected within thorny scrubs (marked with arrow) (Photo by V.R. Vallejo)

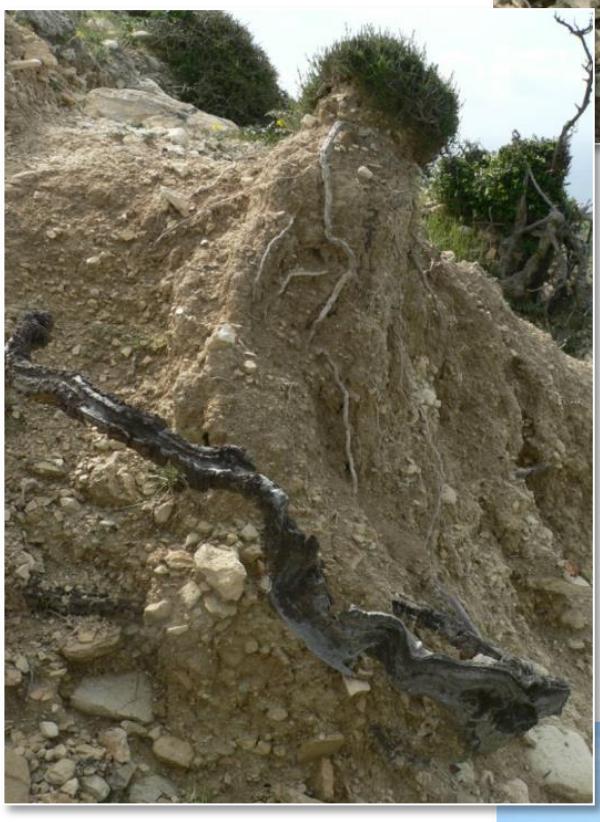
The growth rate of small shrubs is slow, due to the dry climate and persistent grazing – see the thick, old stem (Photo by V.R. Vallejo)

Over-grazing by herbivores results in shrubs becoming deformed into strange shapes (photo by V.R. Vallejo)

Evidence of sheet erosion of soil, leaving bare soil patch between vegetated patches (photo by V.R. Vallejo)

Unpalatable forbs. Herbaceous flowering plants on partly degraded plot. (Photo by V.R. Vallejo)

Extremely degraded area (photo by V.R. Vallejo)



Extremely degraded areas with severe soil erosion. (Photos by V.R. Vallejo)

Healthy shrubland, with scattered pines (reference plot). Could it be recovered from overgrazed areas? (Photo by V.R. Vallejo)

Conclusions

- The Randi forest study area provides a very clear example of how human mismanagement, through excessive grazing pressure, produces land degradation to a point where the land is not productive any longer

- The degradation trajectory may cross a threshold (tipping point) leading to irreversible degradation; irreversible at both the human and ecological time scales

- Intermediate degradation stages were identified for which restoration is still possible, on the basis of the adaptations of remaining native plants and after controlling overgrazing

- The CASCADE research results provide clues to manage grazing in a sustainable way, making agricultural land use compatible with the conservation of natural resources

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