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Chapter 13: Rejuvenating the elderly and aging the youngsters: ancient management practices in continuously renewed native ash tree forests in the High Atlas of Morocco

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“Ancient forests? How old are they?”: an ongoing debate on where to place the threshold on the notion of ‘ancientness’

Forests can be defined in a number of ways (Gyde, 1999) and the notion of forest ancientness of forests has received much attention from historians and ecologists. The latter consider an ancient forest as a piece of land which has been

covered by trees for a long period, and which has never been used as cropland or experienced soil removal. The temporal threshold is subject to variations, depending on the country. In spite of the different justifications put forward, the main reason is the availability of a reliable document to confirm the presence of the forest as far back in time as possible. Since the duration of a permanent dense cover by trees and the natural evolution of undisturbed forest soils seem to be the main factors for defining biodiversity linked to forest ecosystems, the criteria adopted appear to be appropriate. However, the long-term history of forests can sometimes be full of surprises. For example, the forest of Russy in Sologne, in the center of France, was assumed to have been covered by trees for millennia. Recent research using the LIDAR technology showed that in the Gallo-Roman period, it was used as agricultural land for farming and housing (Crozet *et al.*, 2017). Moreover, in some parts of the world, such as the Mediterranean region, forests have always been widely and intensively exploited by local populations (Stevenson and Harrison, 1992), who always extracted resources critical for their livelihood, and to a large extent shaped forest ecosystems.

It is therefore very difficult to be certain of a continuum of an undisturbed or barely disturbed forest when dealing with the historical ecology of landscapes. This difficulty is exacerbated in regions where historical information on forest landscape cover is rare or non-existent, such as North Africa. For example, the Moroccan High Atlas has long been populated by Berber societies, with no or very fragmented written sources, and presents a long history of conflicts that have made systematic surveys on past land-use patterns difficult (Aderghal and Simenel, 2012). Moreover, the Mediterranean mountain climate, associated with dense and secular occupation by local populations, led to the intensive exploitation of the region's scarce resources. Hence, resources such as deadwood have until present been systematically collected everywhere to provide firewood for local needs and played a role in the particular configuration of Mediterranean forest ecosystems (Barbero *et al.*, 1990; Auclair and Alifriqui, 2012). In this region, the structure and functioning of the forest are systematically impacted by humans to shape anthropogenic forests in the sense of Senanayake (1998) of "Natural tree dominated ecosystems (that) have been impacted by humans with a frequency or intensity to change established serial patterns and natural biodiversity status". Does this mean that the notion of 'ancient forest' cannot be applied to forests found in this part of the world?

Mediterranean forests constitute a keystone element of local livelihoods and

have been maintained for centuries to provide the resources necessary to ensure the resilience of local societies in usually harsh environments over the long term (Auclair *et al.*, 2011; Gauquelin *et al.*, 2018). In contrast to other parts of the world, forests are considered by Berber communities as part of their domestic universe, and deserving of respect and consideration. Moreover, there does not seem to be the same divide as that classically found in western perceptions between 'the wild' and 'the human sphere'. These rural forests present multi-faceted characteristics –ecological, economic and sociocultural (Genin *et al.*, 2013) – which have persisted over the course of centuries and which are an integral part of the conceptual universe of the local societies. Therefore, should these rural forests not be considered as ancient and patrimonial forests because they do not fit all the canonical characteristics established for more temperate forests? As domestic forests in the sense of Michon *et al.* (2007), they are the subject of deep ecological knowledge and know-how concerning their use and management. This knowledge was built up progressively over the centuries, based on observation, mimicry of natural processes, failure and degradation, adaptation, transformations and innovation. To illustrate our meaning, we would like to describe the sophisticated traditional management of the native dimorphic ash tree (*Fraxinus dimorpha* Cosson and Durieu) stands found on the northern slopes of the central High Atlas Mountains to reposition the ancientness of the human-forest relation within the ancient forest debate.

Native dimorphic ash tree stands in the High Atlas mountains

Fraxinus dimorpha occupies a particular ecological niche in the central High Atlas as it is located mainly at the bottom of rocky slopes and ravines with temperature inversions, at an altitude between 1200 and 2000 m asl. The dimorphic ash tree (*imts* in Berber) is characterized by two types of leaves, depending on the development stage of the tree and the level of browsing pressure. It is typically a multi-functional tree for the local community, providing firewood, timber mainly for house roofs and agricultural tools, food (spices) and medicinal products, and its leaves are used for dyeing textiles. But the most critical use is as fodder in the autumn (late August to November), in a period when standing range forage is scarce and dry (Genin *et al.*, 2016).

Ash tree stands constitute fragmented wooded areas along the Atlas. We focused our investigations on the rural commune of Ait M'Hamed, located in the central High Atlas, Azilal Province (Figure 12-1). Altitude ranges from 1300 to 1700 m asl. The climate is mountain Mediterranean with annual rainfall between 450 and 600 mm, a mean minimum temperature in winter of 5°C and a mean maximum temperature in summer of 28°C. Local agropastoral systems are low-input systems based on unirrigated cereal cultivation, associated with small flocks of ruminants composed of 20 to 150 sheep and goats in various proportions. The local inhabitants are Berbers, related to the famous Ait Atta nomadic tribe, but sedentarized in the 19th century.

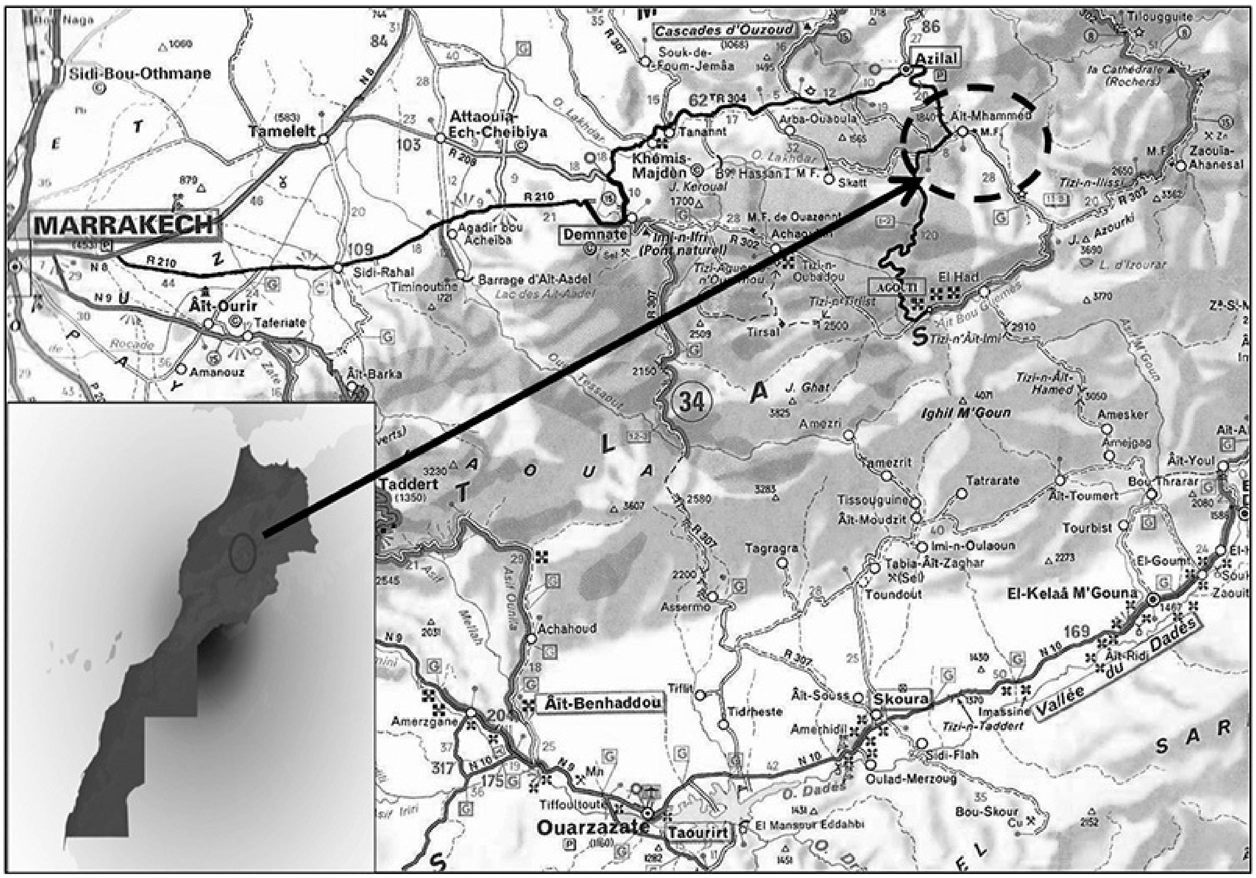

Figure 12-1: Location of dimorphic ash tree stands in the Moroccan central High Atlas mountains.

Forested areas represent about 25% of the total territory and are divided into two categories: those dominated by the holm oak (*Quercus ilex*) and those dominated in the coldest areas by dimorphic ash (*Fraxinus dimorpha*), a tree species native to the mountains of North Africa and Central Asia. These two species also occur together to form mixed forests and parklands. The physionomy of ash tree stands is in the form of scattered trees (15 to 50 trees/ha), parklands or 'tree savannah'-

like, as referred to by Boffa (1999), with a density ranging from 50 to 800 trees/ha, or denser forests (1000 to 2000 trees/ha). *Fraxinus dimorpha* is always spontaneous, and it is never planted by the local inhabitants.

Relationships between the forest and the local population are illustrated by two highly visible features. These features reflect the silvopastoral nature of activities and deep ecological knowledge of ‘surgical’ practices on trees in a context of resource scarcity: the generalized pollarding of trees and a high heterogeneity of tree ports, particularly with the presence of trees with large, thickset and compartmentalized trunks with a basal diameter of sometimes more than 1 m (Figure 12-2).

Figure 12-2: Overall physiognomy of ash tree forests (left), and heterogeneity of ash tree port (right), particularly with large, thickset compartmentalized trunks (in the background left of the picture).

The ‘circular’ time of patiently developed tree exploitation cycles

Ash trees are mainly pollarded for use as fodder, which is browsed directly in the forest by small flocks of goats and sheep. People (generally men) climb up a previously selected tree and use an axe to cut nearly all the branches that had resprouted from a previous cutting operation. Cutting follows a highly rigorous four-year cycle. Branches which had developed during this lapse of time present a stem diameter of about 3-4 cm and a length of 3.5-4m (Figure 12-3). The cutting period runs from the end of August until the leaves turn yellow and fall

(late October to mid-November). During this period, ash tree foliar forage represents almost half of the daily diet consumed by sheep and goats, and constitutes good quality forage in a period when forage resources are very scarce (Genin *et al.*, 2016). Measurements taken directly in the fields showed a mean daily consumption of ash leaves of about 220 gDM/head (SE=61) in flocks depending exclusively on rangelands. Since ash tree stands are mainly privately owned, pastoralists know exactly the number of ash trees they will be able to pollard, and can therefore more or less accurately estimate the available quantity of forage from trees.

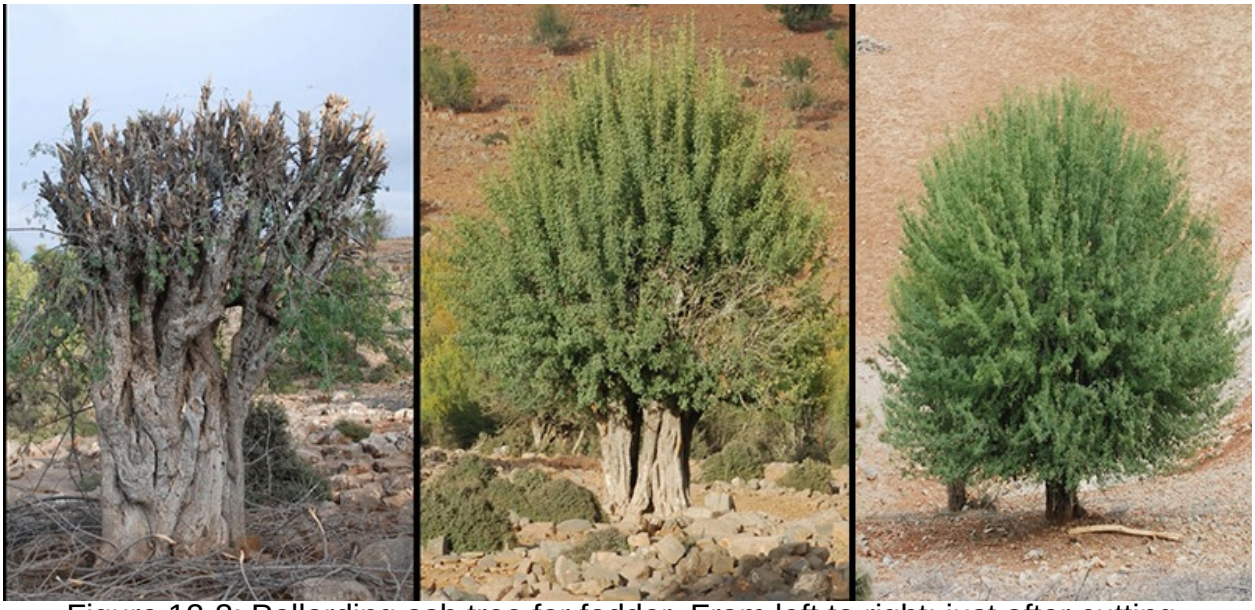

Figure 12-3: Pollarding ash tree for fodder. From left to right: just after cutting, two years after cutting and four years after cutting.

Sometimes, certain straight branches are preserved, the leaves are picked off along lengths of 3.5 meters and left to complete another four-year cycle. After eight years, they produce standardized 7-cm diameter and 3.5-4-m long poles used to cover the roofs of houses. Some particularly robust poles are sometimes left to grow and are shaped directly on the living tree to produce beams with a wider diameter after about 30 years to sustain house roofs. Hence, on the same living tree, three types of resource are produced and shaped according to refined nested exploitation cycles (Figure 12-4). This form of exploitation makes it possible to 1) provide annually diversified resources from living trees, 2) obtain ‘calibrated’ products as a result of shaping resprouts directly on the tree, and 3) estimate more or less accurately the availability of forage produced by trees each year. This vernacular tree management is also found in various parts of the world, although with less clearly defined patterns of time, rules and techniques

(Andersen *et al.*, 2014; Petit and Mallet, 2001; Singh *et al.*, 2015).

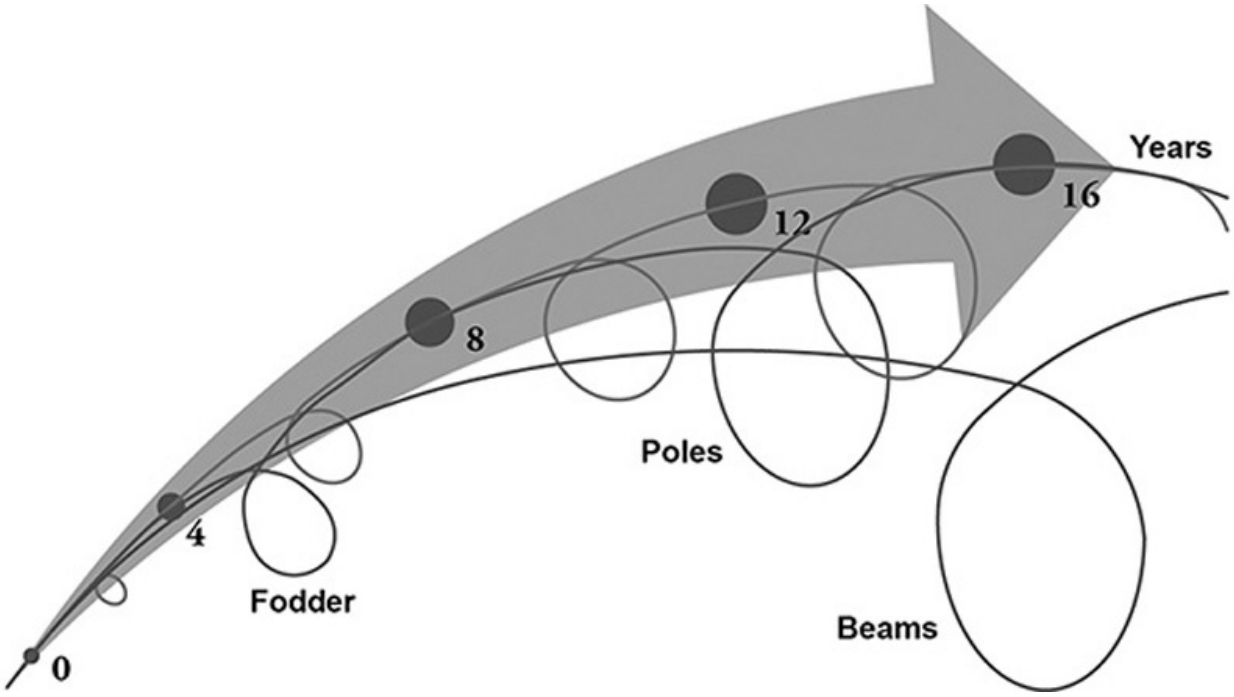

Figure 12-4: Ash tree exploited for fodder and poles and beams shaped for wood construction.

The accelerated ‘extended’ time of tree regeneration management

One of the most remarkable aspects of tree management know-how and practices found in this region is related to the regeneration of overgrazed trees, and the protection of new seedlings or resprouts. Locally, the practice is called ‘*tahboucht*’ and consists of building stone walls around the small trees to protect them against browsing, until they are above the maximum reach of sheep and goats (1.5-2 m tall). The protected coppice can then grow normally by developing twigs from the collar of the tree. Only the most vigorous and straight resprouting twigs are then conserved (3 to 12) and are lopped to enhance the diameter growth of the twigs. The stems are then moved and attached as close together as possible. As they grow, they will become joined together through a process of anastomosis, and become a single large trunk composed of several stem compartments (Figure 12-5). According to the local inhabitants, the aim of

this practice is to enhance the tree's productivity and longevity. In fact, measurements of leaf production during the four-year cycle of tree exploitation showed that leaf biomass production increased by about 30% compared to non-anastomosed trees (Genin *et al.*, in progress).

Even if this practice has begun to die out today (only 15% of the panel we interviewed declared that they to still practise '*tahboucht*'), it has had a strong impact on the current physiognomy of ash tree stands, and is a perfect illustration of the richness of traditional ecological knowledge with regard to the conservation and restoration of the resource.

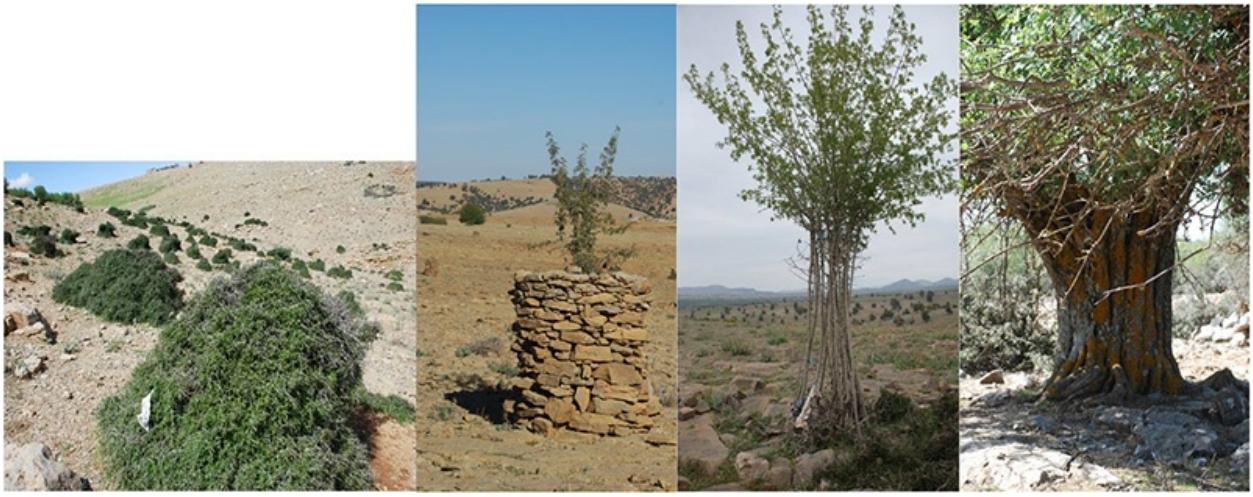

Figure 12-5: Sequence of protection of overgrazed ash tree using the '*tahboucht*' technique and shaping of resprouts to promote trunk anastomosis.

Discussion and conclusion: 'ecological' versus 'humanized' ancient forests

The case we have presented here is a remarkable example of the full integration of a native forest ecosystem within an agro-forestry system, where the divide between forest and agricultural area is tenuous, as commonly found in the Mediterranean biome (Michon, 2015). This is an example of what some scholars call 'culturally modified living trees' (Turner *et al.*, 2009), which emphasize the richness of human adaptations to the environment, as well as to the inherited

ecological knowledge and management practices related to heritage approaches "in terms of resilience" developed by Berkes *et al.* (2003). The local expertise implemented here requires skill and knowledge with regard to trees' ecophysiological functioning, the climate and agro-pastoral seasonality, techniques for tree pruning and pollarding, and ensuring regeneration in a context of high pastoral pressure. This knowledge was built up over time to take advantage of the rare available resources. Shaping forests and trees, together with preserving the forest nature of ecosystems, are traditional practices with long historical trajectories, commonly found in various environments, from the tropics to temperate and semi-arid areas (Michon *et al.*, 2007; Genin *et al.*, 2013; Siebert and Belsky, 2014). The techniques used are very old: for example, pruning for harvesting fodder is evidently an old tending practice, depicted as early as the New Kingdom of Egypt (1539-1075 BC) (Andersen *et al.*, 2014). Petit and Watkins (2004) mentioned that pollarding and shredding trees were widespread and common practices in Britain until the 18th century. Trees were an important source of fodder and their branches were regularly lopped so that sheep and cattle could eat their twigs and leaves. The branches could be used for firewood and other purposes. Boreal forests were also intensively exploited for fodder, by trimming, pollarding and lopping living trees (Slotte, 2001). Another positive effect is the increased longevity of pollarded trees (Mansion, 2010). Ancient European oaks are one well-known example, and this phenomenon may be explained by the fact that pollarding contributes to a tree's ability to sustain substantial biomass (Rackham, 2003). Longevity in dryland trees protects viable populations during recruitment 'bottlenecks' (Andersen *et al.*, 2012), and continued renewal of branches by pruning prolongs the production of viable seeds.

As claimed by Bhagwat *et al.* (2012), the long-term ecological knowledge that today's 'pristine' forests might have been yesterday's agricultural fallows should be applied to the concept of the 'naturalness' of landscapes and biodiversity conservation approaches. Evidence of long-term uses and shaping of forests is found worldwide and provides insights into the interest of reconsidering the place of human beings, and the diversity and particularity of their impact, even in the context of ancient forests (Willis *et al.*, 2004; Miller *et al.*, 2006).

The links between people and forests are thus very old and based on mutual adaptation, shaping and transformation (Moran and Ostrom, 2005). The forms of interactions are diverse, and the classical divide between forestry and agriculture is much too clear-cut and cannot describe the diversity and complexity of

situations worldwide. There is a continuum between ‘nature’ and ‘culture’ (Descola, 2005) in the physiognomy of current forests which may be insufficiently considered in the study of ancient forests. Consequently, biological aspects, though essential, should not be the sole criteria used to define ancient forests, but should be seen in parallel with the status and ancientness of traditional knowledge associated with forest use patterns.

As argued by McNeely (2004), ancient forests do not necessarily mean ancient tree stands, because ancient forests can be exploited over time. The opposite question deserves to be asked: could the presence of ancient trees indicate ancient forests? In our case, it is very difficult to determine the age of these forests due to a lack of maps and historical data. Objectively speaking, we cannot really postulate that these are ancient forests, because of the lack of objective proof and because of the obviously high human impact on both tree stands and the overall ecosystem. However, some indicators can be taken into account: a native forest species which has never been seen nor planted; the presence of very old (and still productive) trees; the permanence of wooded areas, which constitute key territories for the livelihood of local societies; and the particular cognitive perception of forests which are not separated from human beings, but on the contrary are part of the domestic sphere of the local community’s livelihood.

We can thus introduce the concept of the ‘culturally modified ancient forest’ (Bobiec, 2012), which could usefully expand the ancient forest debate, in the sense that there is a particular mix of natural indicators, associated with transformation, shaping and structural aspects which are characteristic of long-term interactions between trees, forest ecosystems and humans (Figure 12-6). These forests also play a role 1) with regard to biodiversity *sensus stricto* (Bhagwat *et al.*, 2008), 2) with regard to the security and development of human livelihoods (Moran and Ostrom, 2005), and 3) as a source of inspiration for the renewal of natural resource management methods in a changing world. Finally, they constitute a social ecological heritage as part of human and world patrimony.

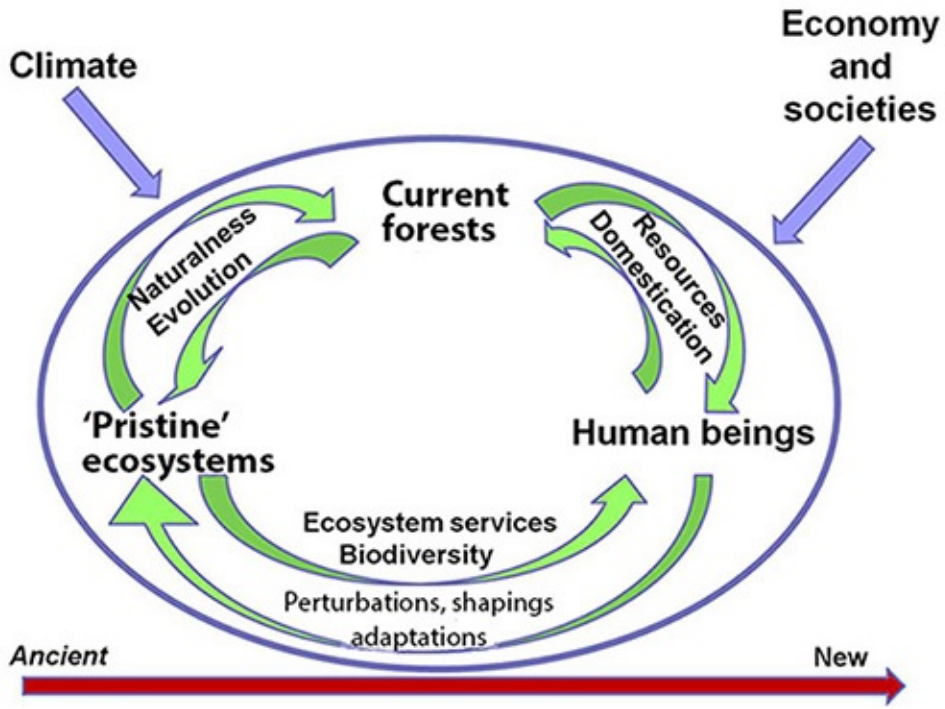

Figure 12-6: Temporalities and relationships between forests, natural ecosystems and human societies.

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