International Journal of Environmental Science and Technology (2022) 19:3845–3858
https://doi.org/10.1007/s13762-021-03513-w

ORIGINAL PAPER

Ecosystems multiple-use management: an approach based on change in economic, social, and ecological values of plant communities

A. Khosravi Mashizi[1] · M. Sharafatmandrad[1] · S. Naghavi[2]

Received: 5 February 2021 / Revised: 28 May 2021 / Accepted: 23 June 2021 / Published online: 4 July 2021

Abstract
Multiple-use management of spatially heterogeneous arid ecosystems faces many challenges. In this study, an approach is introduced for multiple-use management of arid ecosystems in Esfandaqeh rangelands, south east of Iran. The ecological, social, and economic values of plant species were, respectively, determined using field data, the number of people consumption, and the market price for a given species. Determined ecological, social, and economic values were then weighted based on experts' opinion, and the total sum of weighted values was considered as the total value of each species. The value of plant communities was estimated with respect to their plant composition. Changes in plant communities due to different uses were plotted based on state and transition model. According to the results, the grazing intensity was lower in plant communities with diverse uses compared to the less diverse ones. There were significant relationships between species diversity and plant communities' values ($P < 0.01$), but some communities with low species diversity had high total value due to the presence of important species such as *Pistacia atlantica*. Total community value increased with raising the ecosystem potential for multiple use. The highest community value belonged to the upstream shrubland with no trade-off between plants collecting and grazing due to the presence of medicinal and edible plants. There were degraded states where spot management is needed to restore them to a balanced state. The developed approach for multiple-use management helps land managers for sustainable development and maximum use of arid ecosystems.

Keywords Economic value · Social value · Ecological value · Plant community

Introduction

Arid lands constitute a significant portion of globe' lands (about 41.3%) and are home to 2.1 billion people (Koohafkan and Stewart 2008). These lands have experienced numerous environmental and managerial disturbances altering their structure and function (Havstad et al. 2007; Quetier et al. 2007). Many arid ecosystems are threatened by unsustainable uses (Biggs et al. 2008), which lead to land degradation consequently. Degradation is a common concept that hinders land management from achieving multiple goals. Most arid ecosystems consist of a non-uniform species composition that requires heterogeneous management for their sustainable development (McGranahan and Kirkman 2013).

There are new paradigms on the basis that landscapes or ecosystems have multiple functions and the concept of single-purpose land use has recently changed (O'Farrell and Anderson 2010). Multifunctionality describes the capacity of an ecosystem to provide multiple socio-economic and ecological benefits to society (Hölting et al. 2019). Although this concept does not yet have specific implementation (Hölting et al. 2019), multiple-use management has been increasingly practiced in rangelands during the last two decades. Rangelands are multifunctional ecosystems providing multiple ecosystem services. Forage production is one of services that is very important in rangeland management. Traditional rangeland management focuses on forage production (Holechek et al. 2004), but in multiple-use management, the approaches focusing on forage production are not efficient and other uses are also considered. The

Editorial responsibility: J. Chen.

✉ M. Sharafatmandrad
mohsen.sharafatmandrad@ujiroft.ac.ir

[1] Department of Ecological Engineering, Faculty of Natural Resources, University of Jiroft, 8th km of Jiroft - Bandar Abbas road, Jiroft, Iran

[2] Department of Agricultural Economics, Faculty of Agriculture, University of Jiroft, Jiroft, Iran

management approaches designed based on multiple-use concept can increase plants vigor in rangelands and enhance locals' incentives to protect natural plant communities (Havstad et al. 2007). Therefore, forage-based management should be replaced with holistic rangeland management, in which forage production is treated the same as other ecosystem functions and receives no more value. Multiple-use management increases stakeholder income while sustaining the exploitation of rangelands (Sabogal et al. 2013). Furthermore, there is more social support for conservation multifunctional ecosystems where higher numbers of services are provided (Garcìa-Llorente et al. 2012).

On the one hand, rangelands are cohesive units that are ecologically, economically, and socially linked. On the other hand, they consist of a heterogeneous combination of plant species with different uses that should be considered in multiple-use management. The importance of plant communities is usually evaluated using three ecological, economic, and social aspects (Baskent 2018). In economics, ecosystems are valuable because human well-being is affected by their functions. Basically, the philosophical basis of valuation is humanism. According to this approach, the nature components are valuable as long as they somehow benefit humans. Utilitarianism is one of the humanist theories that the value of nature's functions is to the extent that it brings satisfaction to man (Rudolf et al. 2002). Numerous studies have examined plant species value in ecology, human societies, and economics (Reyes-García 2001; Kakudidi 2004; Gokhale et al. 2011). For example, García-Llorente et al. (2012) used monetary and non-monetary techniques to explore the relationship between landscape multi-functionality and social preferences in semi-arid ecosystem, or Zabala et al (2021) presented a novel economic valuation of services in agroecosystem. However, the value of species composition in plant communities has received little attention. Managers face many uncertainties such as the plant communities' dynamics. An important characteristic of ecological systems such as rangelands is that they consist of several different states (Walker et al. 1981). State and transition model illustrates the distribution and dynamics of plant communities and can help to predict the plant communities' response to environmental and management factors (Stringham et al. 2003). Under non-equilibrium model, plant communities are dynamic and transform into each other due to environmental disturbances (Tipton et al. 2018). The state and transition model reveals known and unknown features of an ecosystem that can be used for describing and restoring ecosystem (Heady and Child 1999), being very useful for arid ecosystems management (Bestelmeyer et al. 2017).

Although the concept of multiple-use management is receiving growing attention, the complexity of multiple-use management is increased due to the presence of diverse uses in ecosystems (Baskent 2018). This study examines the value of plant species based on three ecological, economic, and social aspects. Then plant communities are determined, and the value of plant communities under different uses is estimated through their plant composition. Therefore, providing a template for multiple-use management is an important part of rangeland management. The objectives of this study are (1) ecological, social, and economic valuation of plant species, (2) evaluation of the spatial distribution of plant communities and determining their value along landscape, (3) investigating the relationship between plant communities and different utilization types, and (4) designing a state and transition model based on change in plant communities' value under different management.

Materials and methods

Research site

The study was conducted in Esfandaqeh rural district, Jiroft County, Kerman Province, south east of Iran (56° 56′ to 57° 18′ E and 28° 39 to 28 52 N). Mean annual rainfall is about 200 mm. Rangeland is the main land use in the region. There are different vegetation types in the region, varying from *Pistacia atlantica* woodland in upstreams to *Artemisa aucheri* shrublands in downstreams.

Rangelands comprise approximately 90 million ha of Iran. They provide 6% of the gross national product and are the main source of income for many poor, rural residents (Farahpour 2002). They provide food and income for about 180,000 pastoral families, and about 1.4 million families depend indirectly on rangeland (FAO 2006). Rangelands are a common resource, and exploitation is allowed via the use of permits, and thus land tenure is public. Rangelands are traditionally exploited by two types of ranchers (individual and group).

Sampling approach and procedure

Plant communities were valued using the value of their species. Value of plant species is divided into three categories of ecological, social, and economic values (Sarukhán and Whyte 2005). Ecological value of species was measured based on field data and the importance of species in plant communities (Mandal and Joshi 2014). The social and economic values of species were estimated based on people's perception on species value in the social system in which the number of uses was selected as the social value (Reyes-García et al. 2006) and the contribution of plant species to household income was considered as the economic value (Reyes-García 2001; Reyes-García et al. 2006).

The vegetation survey was carried out using 192 nested quadrats of different sizes located in three sites to show the variability of plant species composition across studied landscape. In each site, 10×10 m quadrats were used to sample trees and shrubs and 1×1 m sub-quadrats were used to sample semi-shrubs and herbaceous plants. In each quadrat, plant species richness and canopy cover were measured and Shannon diversity index was then calculated. Furthermore, the intensity of different uses (e.g., grazing, fruit collecting, wood harvesting, plants collecting (edible and medicinal), and beekeeping) was qualitatively determined for each quadrat in five classes ranging from very high to very low.

For social and ecological valuations, fifteen locals were first interviewed to get familiar with the plant species they use and their local uses. They were asked to list the name of all the useful plants they knew and their uses. Second, 86 locals were chosen for interview using stratified sampling method. The average age of participants was 46, and 63% were females and 37% were males. They were asked "do you know this plant?", "do you use it for food, medicine, firewood, construction, dye, tools, aesthetic, forage, or beekeeping?". To determine economic value of species, we asked each adult present in the household to report the name of all the plants that they had brought to the household.

Data analysis

Ecological, social, and economic values of plant species

The ecological value (EcV_e) or Importance Value Index (IVI) of plant species was determined using their frequency, density, and dominance as follows (Curtis and McIntosh, 1951; Mishra, 1968):

$$EcV_e = IVI = \frac{\text{Relative frequency} + \text{Relative density} + \text{Relative dominance}}{3} \quad (1)$$

where

$$\text{Relative frequency} = \frac{\text{Frequency of species } e}{\text{Frequency of all species}} \times 100 \quad (2)$$

$$\text{Relative density} = \frac{\text{Density of species } e}{\text{Density of all species}} \times 100 \quad (3)$$

$$\text{Relative dominance} = \frac{\text{Canopy cover of species } e}{\text{Canopy cover of all species}} \times 100 \quad (4)$$

Social value of plant species was calculated as follows:

$$SV_e = Uc_e \times \sum IUc_e \quad (5)$$

where SV_e is the social value of plant species e. Uc_e is the total number of uses reported for plant species e divided by the nine potential uses for species considered in this study (i.e., food, medicine, firewood, construction, dye, tools, aesthetic, forage, and beekeeping). IUc_e is the number of respondents who mentioned each use of the plant species e divided by the total number of respondents (Reyes-García et al. 2006).

Economic value of plant species was calculated as follows:

$$EV_e = \sum Oe_e \times \frac{Pe_e}{Pe_{mam}} \quad (6)$$

where EV_e is the economic value of plant species e. Oe_e is the number of respondents who had income for buying each use of species divided by the total number of respondents, Pe_e is the price of each use the plant species, and Pe_{max} is maximum price of species (Reyes-García et al. 2006).

Total value of plant species

As importance of ecological, social, and economic values of species is not the same for each species, analytic hierarchy process (AHP) was used to weight these values. Specifically, 12 ecological and economic experts were asked to express how two different criteria or alternatives are compared to each other in terms of their importance (Saaty 1980). The pairwise comparisons in a judgment matrix have been adequately consistent if the corresponding consistency ratio (CR) is less than 10%. Total value of plant species (TV_e) was calculated as follows:

$$TV_e = W_1 \times EcV_e + W_2 \times SV_e + W_3 \times EV_e \quad (7)$$

where W_1, W_2, and W_3 are relative weights of ecological, social, and economic values of plant species, respectively.

Value of plant communities

Value of plant communities (PCV) was measured using the abundance of their plant species (A_e) and total value (TVe) of species as follows:

$$PCV = \sum_{i=1}^{n} A_e \times TV_e \quad (8)$$

State and transition model

Changes in plant communities under different uses were displayed using the state and transition model. Plant communities or states were identified using clustering methods, and the relationship of plant communities with different uses (transition) was estimated using ordination method and the important uses in each state.

Plant communities

Two Way INdicator SPecies ANalysis (TWINSPAN, Hill 1979) was used to determine the distribution of plant communities as different states across landscape. Vegetation data were classified by two-way index species analysis, which is a hierarchical clustering method that uses differential species to describe and distinguish plant classes (McCune and Mefford 1999). In this study, plant communities resulted from TWINSPAN were considered as states of model.

Relationships between plant communities and different uses

Non-metric multidimensional scaling (NMDS) ordination procedure with the Bray–Curtis dissimilarity index is the most generally effective ordination method for determining drivers of ecological communities (McCune and Grace 2002). NMDS is an ordination method that displays a multidimensional dissimilarity matrix of data in a low-dimensional space. Less dissimilarity between data causes them to be closer to the NMDS space (Helm et al. 2017). NMDS was applied to reveal the relationship of plant communities with different uses. Pearson's correlation coefficients were used to assess the relationships between plant community value with diversity, richness, and different uses in plant community. One-way analysis of variance (ANOVA) followed by the least significant difference (LSD) tests was used to compare different growth forms in terms of ecological, social, and economic values. Furthermore, different exploitation patterns (solitary and group) of plant communities were determined and compared in terms of ecological, social, economic, and total value of plant species using independent t-test.

Results and discussion

Results

A total of 82 plant species in 28 families were observed in sampling plots (Table S1). There were substantial variations between different plant species in terms of ecological, social, and economic values (Table 1). *Amygdalus scoparia* (SV = 8.51), *Amygdalus wendelboi* (SV = 7.56), and *Pistacia atlantica* (SV = 5.7) had the highest social value in the region, respectively. The highest ecological values belonged to *Artemisia aucheri* (IVI = 0.113), *Astragalus gossypinus* (IVI = 0.090), and *Amygdalus wendelboi* (IVI = 0.060). *Pistacia khinjuk* (EV = 93), *Pistacia atlantica* (EV = 86), and *Juniperus polycarpos* (EV = 81) and *Acer monspessulanum* subsp. *persicum* (EV = 36) had the highest social value, respectively. Ecological, social, and economic values of species were estimated based on AHP (Table S2).

Comparison of different growth forms in terms of ecological, social, and economic values showed that shrubs and trees had the highest importance in terms of ecological and social values, and trees had the highest importance in terms of economic value (Table 2, Fig. 1).

TWINSPAN analysis resulted in 17 different plant communities (Fig. 2) which considered as states. Ecological, social, and economic values of different communities were estimated using plant species values and their abundance in each community (Table 3). Plant community dominated with *Thymus lancifolius* and *Lolium perenne* (total value = 8.513) and plant community dominated with *Peganum harmala and Salsola kali* (total value = 0.001) had the highest and lowest total value between 17 considered plant communities in the region. The intensity of different uses is shown in Table 4 (grazing, edible or medicinal plants collecting, fruits collecting, wood harvesting, and beekeeping). The highest grazing intensity was related to states 1, 3, and 4. States 13 and 14 were the most exploited ones in terms of plants collecting. The highest intensity of fruit collecting was observed in states 13 and 17. States 9 and 17 had the highest intensity of wood harvesting. States 10 and 12 had the highest intensities in terms of beekeeping.

Figure 3 shows the distribution of 17 states with regard to 5 different uses (grazing, plants collecting, fruits collecting, wood harvesting, and beekeeping). There were significant relationships between different uses and states 10, 12, 6, 5, 15, and 14. The highest association was observed between states 2, 7, and 17; wood harvesting, states 3, 9, and 13 and fruit collecting, states 1, 4, and 8 and livestock grazing, and states 11 and plant harvesting and beekeeping. Pearson's correlation coefficients showed that there was a significant relationship between the value of plant communities and Shannon's diversity, richness, and the multiple uses in plant community (Fig. 4).

The plant communities with solitary exploitation had greater ecological, social, economic values compared to group exploitation (Fig. 5).

The state and transition model of region rangelands represents the changes in the value of states due to different uses (Fig. 6). The vertical axis represents the relative total value of the states estimated according to value of their plant species. The horizontal axis shows the relative number of uses in each state. In this model, the change of states under the dominant use as the transition is separately displayed in each landscape. In mountain semi-shrubland, state 10 transits to states 11, 12, and 13, during which only the value of

Table 1 Social (SV), ecological (EcV), and economic values (EV) of plant species

	Plant usage									SV	EcV				EV
	Aes	For	Med	Hon	dye	Foo	Too	Con	Fue		De	Fr	Do	IVI	
A.mon							*	*	*	0.79	0.023	0.013	0.013	0.016	0.387097
A.cap	*									0.05	0.008	0.009	0.006	0.007	0
A.atr	*		*	*		*				0.43	0.003	0.005	0.009	0.005	0.043011
A.ira	*		*	*		*				0.12	0.002	0.003	0.001	0.002	0.002903
A.jes	*		*			*				0.23	0.004	0.002	0.001	0.002	0.002366
A.sta	*					*				0.06	0.003	0.004	0.001	0.002	0.029247
P.atl		*	*		*	*	*	*	*	5.2	0.033	0.008	0.070	0.037	0.924731
P.Khi		*	*		*	*	*	*	*	5.7	0.020	0.030	0.010	0.020	1
A.ori	*									0.02	0.006	0.008	0.003	0.005	3.23E-05
B.cyl	*		*	*						0.34	0.004	0.003	0.002	0.003	0.004204
B.per	*		*	*		*				1.76	0.002	0.001	0.003	0.002	0.002344
B.fal	*		*	*						0.43	0.005	0.002	0.001	0.002	0.075269
D.auc	*	*	*	*			*		*	0.87	0.020	0.010	0.009	0.003	0.003946
D.ass	*		*							0.03	0.001	0.004	0.006	0.022	2.15E-05
E.bun	*	*	*	*						0.08	0.003	0.004	0.001	0.002	4.3E-05
F.ovi	*	*	*				*		*	1.03	0.003	0.001	0.005	0.003	0.000258
F.vul	*		*	*						0	0.005	0.060	0.002	0.022	5.38E-05
P.cor		*								0.06	0.005	0.006	0.002	0.004	2.15E-05
P.che	*	*		*	*					0.08	0.003	0.004	0.002	0.003	0.006817
C.off										0	0.010	0.030	0.060	0.033	6.45E-05
A.san	*		*	*		*				1.23	0.030	0.010	0.020	0.020	4.3E-05
A.aus	*		*	*						0.03	0.032	0.003	0.001	0.011	9.68E-05
A.auc		*	*							0.89	0.130	0.100	0.110	0.113	0.000237
A.per		*	*							0.65	0.001	0.003	0.032	0.011	7.53E-05
C.pyc		*	*							0.05	0.020	0.010	0.030	0.020	2.15E-05
C.oxy					*					0.04	0.011	0.003	0.002	0.005	4.3E-05
C.ovi	*	*	*							0.34	0.005	0.040	0.030	0.020	5.38E-05
C.int	*		*	*						0.41	0.002	0.070	0.040	0.037	8.6E-05
C.pyr		*								0.35	0.010	0.010	0.009	0.009	9.68E-05
C.vul										0	0.005	0.020	0.004	0.009	2.15E-05
E.can										0	0.032	0.021	0.022	0.025	5.38E-05
G.tou	*					*				0.12	0.002	0.001	0.003	0.002	0.000355
H.int	*	*							*	0.54	0.002	0.001	0.003	0.023	6.45E-05
L.gal		*	*							0.11	0.010	0.008	0.003	0.007	4.3E-05
O.car	*		*							0.28	0.003	0.008	0.007	0.006	2.15E-05
S.ori		*								0.76	0.010	0.020	0.010	0.013	7.53E-05
P.auc	*		*							0.13	0.010	0.010	0.030	0.016	3.23E-05
T.son	*	*								0.16	0.020	0.030	0.020	0.023	1.08E-05
B.int	*		*	*	*	*			*	0.98	0.040	0.050	0.020	0.036	2.15E-05
A.pro										0	0.040	0.020	0.010	0.023	6.45E-05
A.lin		*								0.04	0.008	0.008	0.003	0.006	7.53E-05
E.ves	*	*								0.02	0.004	0.003	0.001	0.002	8.6E-05
E.sis	*	*								0.08	0.008	0.009	0.005	0.007	1.08E-05
I.pac		*	*							0.09	0.006	0.008	0.003	0.006	2.15E-05
L.dra	*	*	*							0.07	0.009	0.006	0.002	0.005	3.23E-05
M.che	*		*							0.32	0.020	0.003	0.001	0.008	3.23E-05
A.gla	*									0.06	0.004	0.002	0.003	0.003	4.3E-05
D.ori	*	*								0.08	0.003	0.001	0.003	0.002	0.000247
N.muc										0.07	0.004	0.001	0.002	0.002	0

Table 1 (continued)

	Plant usage									SV	EcV				EV
	Aes	For	Med	Hon	dye	Foo	Too	Con	Fue		De	Fr	Do	IVI	
S.kal										0	0.002	0.001	0.001	0.001	0
C.arv	*	*								0.16	0.004	0.005	0.003	0.004	0.000183
J.pol								*	*	0.54	0.003	0.004	0.006	0.004	0.870968
E.int									*	0.13	0.002	0.005	0.001	0.002	0.000935
E.fal	*									0.02	0.001	0.004	0.003	0.003	0
E.ged	*									0.05	0.001	0.003	0.001	0.001	0
A.lyc	*	*	*	*			*			0.97	0.009	0.006	0.007	0.005	0.010398
A.gos	*	*	*	*			*			0.86	0.090	0.090	0.080	0.086	0.009419
M.sat	*	*	*			*				0.54	0.006	0.002	0.003	0.003	0.000118
O.cor		*								0.58	0.002	0.001	0.007	0.003	6.45E-05
T.pra	*	*	*	*						0.62	0.001	0.003	0.008	0.004	0.000204
T.rep	*	*	*							0.48	0.002	0.003	0.007	0.004	0.000409
F.ase		*								0.03	0.002	0.006	0.003	0.003	5.38E-05
J.rgi		*								0.01	0.001	0.002	0.004	0.002	0.000204
M.lon	*	*	*	*						0.36	0.001	0.001	0.005	0.002	0.006065
S.scl	*		*	*						0.42	0.001	0.001	0.002	0.001	0.003688
T.lan	*	*	*	*						0.38	0.002	0.001	0.005	0.002	0.080753
Z.cli	*	*	*	*						0.42	0.001	0.002	0.003	0.002	0.044516
T.bif	*	*		*						0.31	0.003	0.001	0.005	0.003	0.003355
M.syl	*	*	*	*						0.08	0.001	0.003	0.004	0.002	0.004151
A.chl	*									0.05	0.007	0.002	0.001	0.003	7.53E-05
A.cri	*	*								0.01	0.001	0.002	0.001	0.001	0.000118
B.tec										0	0.001	0.001	0.001	0.001	0
B.squ										0	0.001	0.002	0.005	0.002	0
L.per	*	*								0.07	0.006	0.004	0.002	0.004	0.000366
Pt.auc	*	*		*			*		*	0.25	0.005	0.005	0.001	0.003	0.000118
R.rib	*	*	*		*	*				0.12	0.003	0.002	0.001	0.002	0.000333
A.sco	*	*	*	*		*	*	*	*	8.51	0.060	0.020	0.070	0.050	0.002301
A.wen	*	*	*	*		*	*	*	*	7.65	0.070	0.030	0.090	0.060	0.003484
T.arc	*	*	*	*			*	*	*	3.24	0.008	0.003	0.006	0.005	0.033785
D.sta		*					*	*	*	1.26	0.007	0.001	0.001	0.003	0.04228
E.per	*									0.05	0.006	0.003	0.007	0.005	2.15E-05
P.har			*							0.01	0.001	0.001	0.002	0.001	1.08E-05

Ecological value (EcV) is calculated using plant species De: Density, Fr: Frequency, and Do: Dominance. Different uses are shown as Aes: Aesthetic, For: Forage, Med: Medicinal, Hon: Honey, Foo: Food, Too: Tools, Con: Construction, Fue: Fuel

Table 2 The results of ANOVA among five life forms (tree, shrub, semi-shrub, grass, and forb) based on social, ecological, and economic values

	df		Mean square		*F*	*P* value
	Within group	Between group	Within group	Between group		
Social value	78	4	12.507	1.582	7.906	0.00
Ecological value	78	4	0.865	0.134	6.455	0.00
Economic value	78	4	2205.738	104.645	21.078	0.00

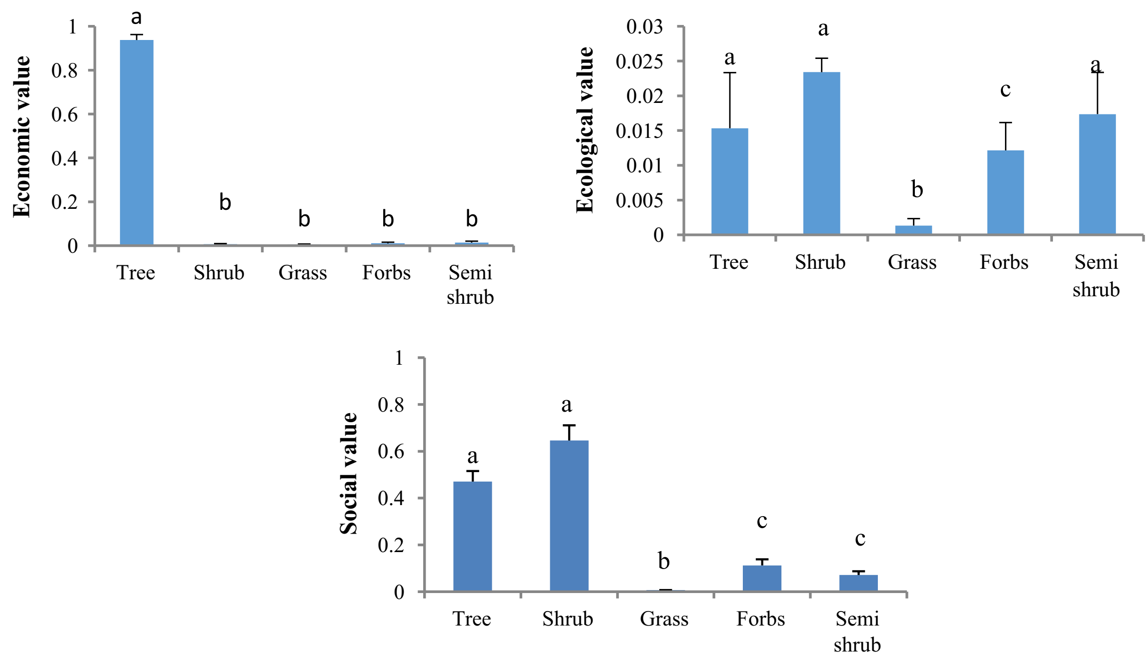

Fig. 1 Mean comparison of different growth forms in terms of social, ecological, and economic values. Values are mean ± SD. Significant differences obtained by the post hoc test are showed by the superscripts a, b, and c ($P < 0.05$), and the same letters indicate no significant difference

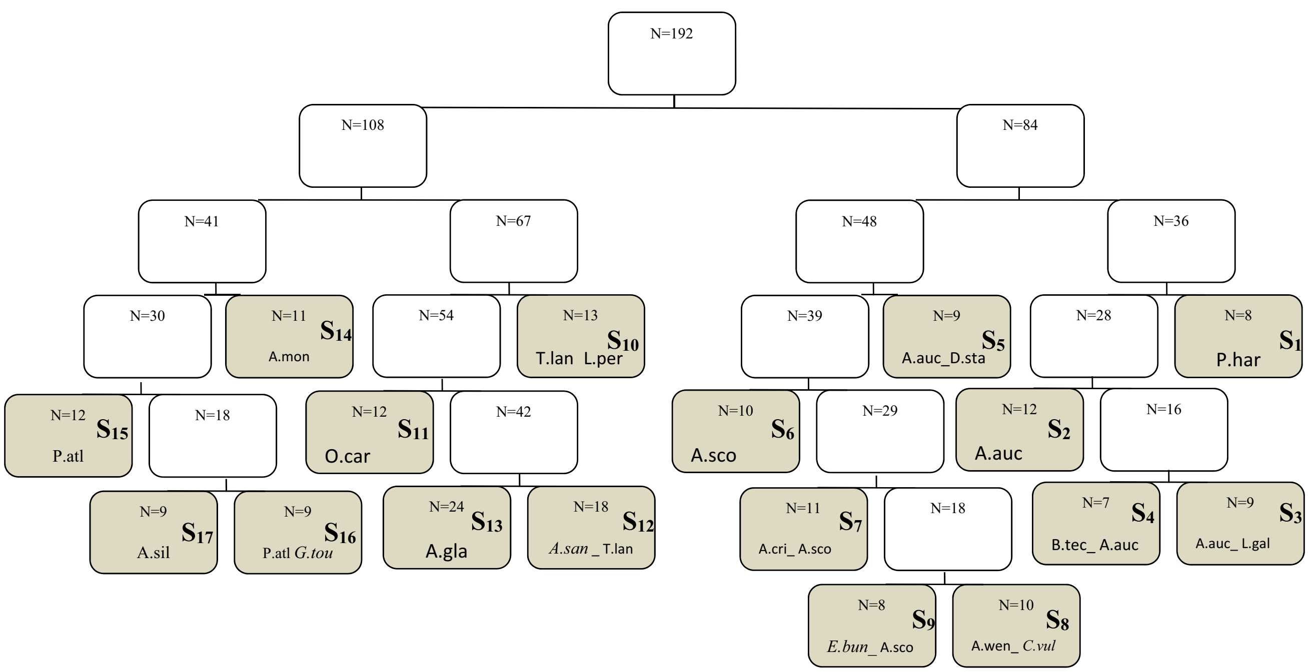

Fig. 2 The resulted plant communities based on TWINSPAN. The 17 terminal nodes, filled with gray color, are paired with their corresponding community abbreviations and state number. The number shown in each box is the total number of plots belonging to a particular node. Abbreviations of the species and their corresponding scientific names are described in Table S1

Table 3 Description of 17 plant communities (states) and their ecological, social, economic, and total values

Landscape	Stats	Description	Ecological value	Social value	Economic value	Relative total value
Plain semishrubland	S_1	Sparse annual invasive forbs (*Peganum harmala, Salsola kali*)	0.003	0.000586	6.93001E-05	0.000117
Plain semishrubland	S_2	Dense semi-shrubs (*Artemisia aucheri*)	0.095	0.011282	0.043659044	0.031716
Plain semishrubland	S_3	Sparse semi-shrubs (*Artemisia aucheri*) and invasive forbs (*Lactuca glauciifolia*)	0.123	0.00674	0.003742204	0.010924
Plain semishrubland	S_4	Sparse annual invasive grasses (*Bromus tectorum*)	0.005	0.000147	6.93001E-05	0.000235
Plain semishrubland	S_5	Dense semi-shrubs (*Artemisia aucheri*) and scattered shrubs (*Daphne stapfii*)	0.126	0.009377	0.121968122	0.072008
Mountain shrubland	S_6	Dense shrubs (*Amygdalus scoparia*)	0.06	0.545788	0.498198198	0.524374
Mountain shrubland	S_7	Dense grasses (*Agropyrum cristatum*) and scattered shrubs (*Amygdalus scoparia*)	0.05	0.265934	0.070686071	0.165864
Mountain shrubland	S_8	Semi dense shrubs (*Amygdalus wendelboi*) and forbs (*Cirsium vulgare*))	0.04	0.193407	0.127512128	0.159403
Mountain shrubland	S_9	Sparse annual invasive forbs (*Euphorbia falcata*) and shrubs (*Amygdalus scoparia*)	0.01	0.071795	0.023562024	0.046635
Mountain semi-shrubland	S_{10}	Dense semi-shrubs (*Thymus lancifolius*) and grasses (*Lolium perenne*)	0.231	1	1	1
Mountain semi-shrubland	S_{11}	Semi dense spiny invasive forbs (*Onopordon carmanicum*)	0.076	0.332601	0.246708247	0.288617
Mountain semi-shrubland	S_{12}	Sparse annul forbs (*Achillea santolinoides*) and semi-shrubs (*Thymus lancifolius*)	0.097	0.641758	0.4996535	0.573006
Mountain semi-shrubland	S_{13}	Semi dense semi-shrubs (*Acanthophyllum glandulosum*)	0.076	0.209524	0.090783091	0.150123
Mountain forest	S_{14}	Dense trees (*Acermonspessulanum*) and forbs (*Allium atroviolaceum*)	0.087	0.063004	0.146916147	0.108657
Mountain forest	S_{15}	Dense trees (*Pistacia atlantica*)	0.045	0.375092	0.964656965	0.675085
Mountain forest	S_{16}	Semi dense trees (*Pistacia atlantica*) and spiny invasive forbs (*Gundelia tournefortii*)	0.021	0.23956	0.314622315	0.275813
Mountain forest	S_{17}	Dense semi-shrub (*Astragalus lycioides*) and scattered trees (*Pistacia atlantica*)	0.08	0.122344	0.083160083	0.104546

state 12 has not passed the threshold value and the other two states are substantially changed. In mountain forest, state 15 transits to states 11 and 16, both of which have exceeded the threshold of plant communities' value. In mountain shrubland, state 6 changes to states 7, 8, and 9, among which state 9 had the highest loss of value. In plain semi-shrubland, stable state 5 also shifts to states 3 and 4, during which the value of plant communities decreases, although the changes are less intense than other plant communities.

Discussion

In the most landscapes, plant communities are not distributed evenly and may have different ecological, economic, and social values. Therefore, each plant community has a certain potential for different uses depending on its vegetation composition. Plant communities have experienced different types of degradation based on their dominant use. Such plant communities, which are faced to uneven disturbances, may need to be spot managed (Fuhlendorf and Smeins 1999), so that their management should be consistent with the distribution of anthropogenic disturbances (Fuhlendorf and Engle 2001).

Table 4 The mean ranks (±SD) of five uses (grazing, collecting of plant and fruit, wood harvesting, beekeeping) in 17 states

States	Grazing	Collecting of plants	Collecting of fruit	Wood harvesting	Beekeeping
S1	4.87±0.21	1	1	1	1
S2	3.76±0.12	1.5±0.67	1	4.65±0.21	1
S3	4.22±0.63	1.43±0.04	1	2.54±0.53	1
S4	4.98±0.06	1	1	1	1
S5	2.34±0.42	1.65±0.12	1	2.13±1.1	1
S6	2.15±0.27	1.65±0.43	2.54±0.87	2.13±0.21	3.32±0.15
S7	3.19±0.54	2.45±0.65	3.37±0.43	3.72±0.43	3.13±0.12
S8	3.73±0.67	2.76±0.83	2.83±0.31	2.76±0.54	3.87±0.32
S9	3.98±0.45	2.16±0.25	3.78±0.61	4.31±0.12	2.65±0.76
S10	2.85±0.87	2.56±0.98	2.78±0.65	1	4.78±0.32
S11	2.87±0.54	3.67±0.53	3.73±0.42	1	3.87±0.23
S12	3.65±0.43	3.01±0.14	2.76±0.98	1	4.43±0.79
S13	3.76±0.12	4.87±0.13	3.98±0.84	1	2.45±0.52
S14	3.45±0.64	3.65±0.15	1	2.87±0.13	1
S15	3.03±0.18	2.08±0.05	3.01±0.54	2.87±0.65	1
S16	3.89±0.24	2.05±0.08	3.32±0.68	2.67±0.87	1
S17	3.54±0.29	2.16±0.98	3.89±0.44	4.01±0.76	1

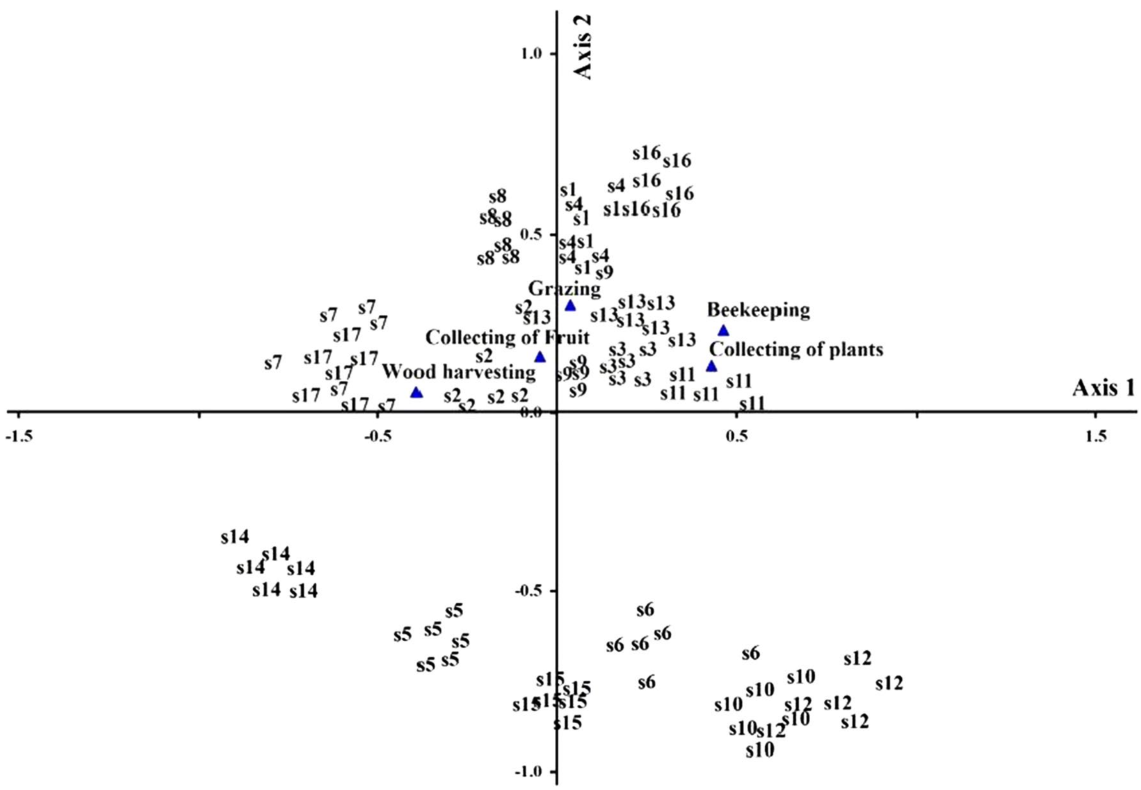

Fig. 3 Non-metric multi-dimensional scaling (NMDS) ordination plot for 17 states with 5 different uses (grazing, wood harvesting, beekeeping, collecting of plants and fruit)

Previous studies on the impact of solitary and group exploitations on rangelands condition and people income have shown that group exploitation is one of the continuous actions to alleviate poverty and have mentioned the solitary exploitation as the cause of adverse effects on rangelands (Maggs and Hoddinott 1999; Adhikari et al. 2004). In this study, however, the two types of exploitation (solitary and group) also had different effects on the condition of plant

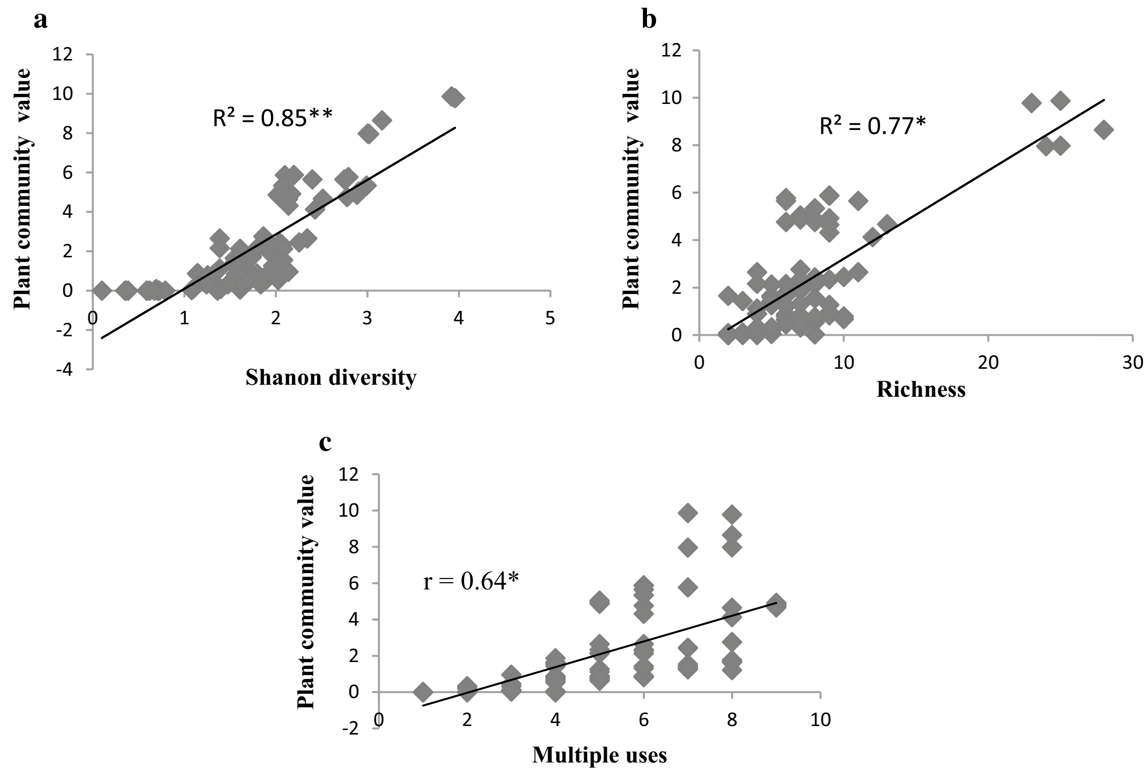

Fig. 4 The relationships between plant community values with **a** Shannon's diversity index, **b** richness, and **c** multiple uses. Pearson's correlation coefficient is indicated in the figure (*: $P<0.05$)

communities. In the highlands where the variety of landscape uses was higher, the status of solitary exploited rangelands was better than the group exploited rangelands. In the lowlands, where the rangeland uses were less diverse and the dominant use is livestock grazing, the status of group exploited rangelands was better than the solitary exploited rangelands. Solitary exploitation was the best in landscapes rich in plant species because of fewer exploiters, better comprehensive management, and less competition for exploiting.

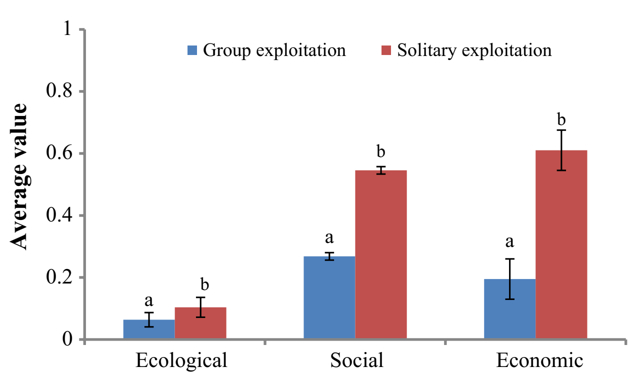

Fig. 5 Social, ecological, economic, and total values of plant communities with solitary and group exploitations. Values are mean ± SD. Significant differences obtained by the post hoc test are showed by the superscripts a and b ($P<0.05$), and the same letters indicate no significant difference

Plant communities' diversity and their value

We have found that species diversity enhances the value of plant communities through increasing multiple use of landscapes. Former studies indicated that biodiversity has a positive impact on ecosystem functions and consequently ecosystem multiple use (e.g., Mace et al. 2012; Balvanera et al. 2006; Worm et al. 2006; Quijas et al. 2010; Cardinale et al. 2012). In areas where species richness is higher, the number of uses from plant communities is higher and has higher value. The cost of value loss due to exploitation in these communities is higher than those areas where the number of uses is limited.

All plant species contribute to ecosystem functioning, but their values are not the same for ecosystems and social systems (Kakudidi 2004). Sometimes, a key species alone can significantly enhance the value of plant communities (Quijas et al. 2012), and removal of such species can severely decrease the value of plant communities. Although *Pistacia atlantica* forests are not very diverse in species, they are of great value because of the presence of valuable species *Pistacia atlantica* in this community. *Pistacia atlantica* is

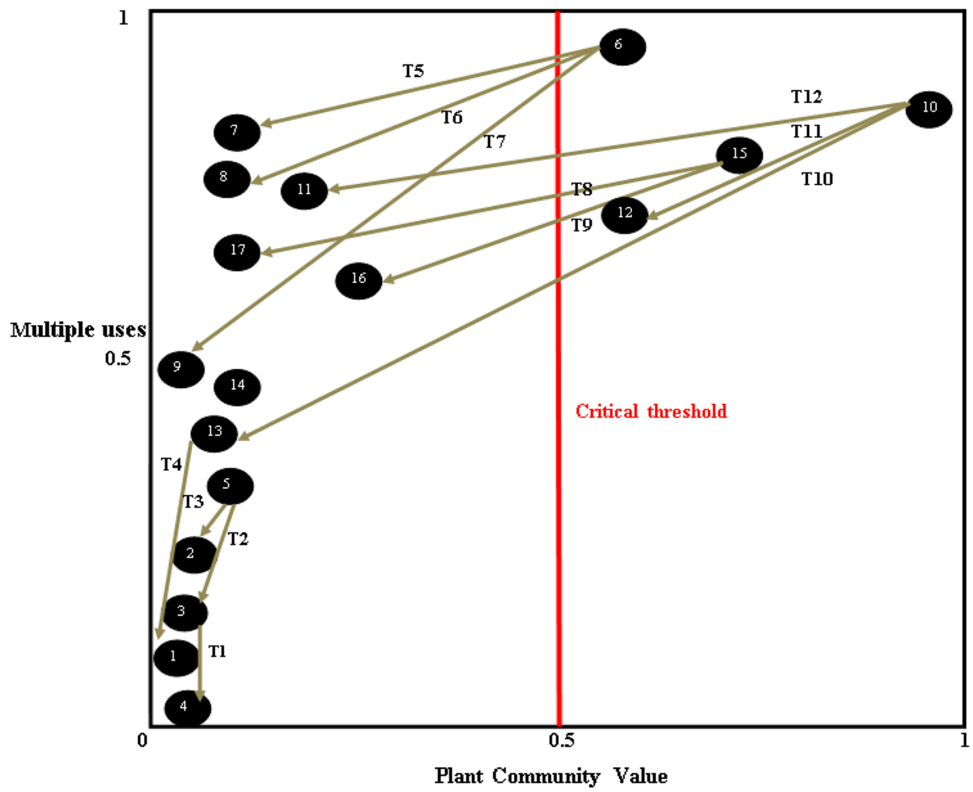

Fig. 6 State and transition model for the region rangelands. T1: intense grazing and wood harvesting; T2: intense grazing; T3: wood harvesting; T4: land use changes; T5: wood harvesting; T6: intense grazing; T7: intense grazing and wood harvesting; T8: wood harvesting and fruits collecting; T9: intense grazing; T10: intense grazing, plants collecting, and fruits collecting; T11: intense grazing; T12: plants collecting and fruits collecting

one of the economic trees that grows in the Mediterranean regions (Bozorgi et al. 2013). In addition to providing forage for livestock and wild animals, and production edible seeds and gum, this species is valuable in terms of genetic reservoir, natural attractions, ecotourism, soil and water conservation, and flood control (Bozorgi et al. 2013; Mahjoub et al. 2018). Fruit of this species has been traditionally used as medicine and food (Razavi 2005). This plant is an important source of gum that is used in pharmaceutical and industrial applications (Sharifi and Hazell 2011). Wild almond (*Amygdalus scoparia*) alone has promoted the value of plant communities. Wild almond fruits are a source of nutrients and oils that are of great importance for human health and food (Abbey et al. 1994). Wild almond flowers appear in late winter to early spring before the plant leaf emergence, giving a very beautiful view of the tree, which are important for attracting honeybees and producing honey.

Different uses and plant communities

As well as heterogeneity of plant communities, diversity of uses may face ecosystem managers with more challenges. Multiple uses were differently declined plant communities value and created new states. Based on suggested state and transition model, plants collecting and wood harvesting had more negative impacts on the plant communities' value compared to grazing. In the upstream shrublands, plants collecting and grazing decreased the plant communities' value by 71% and 44%, respectively, and wood harvesting and grazing decreased communities' values by 85% and 59%, respectively, in *Pistacia atlantica* woodlands. Conversely, wood harvesting and grazing decreased the value of downstream shrub communities by 56% and 85%, respectively, through low ecological, social, and economic values of shrub species *Daphne stapfii*. Therefore, impact of grazing on plant communities' value is reduced by increasing the number of uses in plant communities.

Our results showed that there was a synergy relationship between medium grazing, plant collecting, and fruit collecting in communities with the highest value. Wild edible plants are of great importance to human societies by providing food for humans and animals and generating extra income sources for locals. The importance of edible plant species is growing day by day due to their health benefits and others advantages (Garcia-Herrera et al. 2014). Diet selection of livestock depends on the quality and composition of plant communities (Rook et al. 2004; Dumont et al. 2007). When the plant community is rich in aromatic and medicinal plants, the livestock usually tend to go for the more nutrient species (van Braeckel and Bokdam 2002). In upstream shrublands, livestock prefer palatable grasses such as *Lolium perenne*, causing its removal from plant community in state 12. But this community still has an acceptable value because grasses are just used as forage and have lower economic and social value. On the other hand, valuable medicinal and edible plants in this community (such as *Thymus lancifolius, Ziziphora clinopodioides, Bunium persicum*) generally contain essential oils, and livestock are not attracted to them compared to *Lolium perenne* and annual legumes.

However, over-collecting of edible and medicinal plants has greatly reduced the value of upstream shrub communities. So the intensity of plants collecting had a greater impact on the value of plant communities compared to overgrazing in upstream.

Multiple-use management and different plant communities

Multiple-use management is difficult to implement because all uses must be adapted with landscape potential to providing multiple functions (Maxwell et al. 2019). Planners and decision makers must combine all uses to enhance complementary relationships and minimize competitive interactions between different uses (McGranahan and Kirkman 2013). States that are in acceptable condition in the region (e.g., states of 6, 10, 12, and 15), are a good guide to maintain the value of plant communities along with their sustainable use. Based on states 10 and 12, ecosystems with solitary exploitation are of the highest value because there is less competition between people for exploiting. On the other hand, light grazing increases plants growth and vitality through removing old and dead parts of plants (Noy-Meir 1993), providing a better condition for plants growth and consequently their exploitation. Since grazed grasses and forbs are also not collected by people, there is no trade-off between grazing and plants collecting in states 10 and 12 located in upstream. However, in downstream where plant diversity is low and multiple uses are limited, medium grazing intensity had the least negative impact on the value of *Artemisia aucheri* plant communities under group exploitation. Shrubs such as *Artemisia aucheri* are forage plants that have a greater contribution to ecological, social, and economic values in downstream. Therefore, if the grazing intensity is severe, ecosystems will be more damaged. In plant communities where key species play an important role in community (e.g., states 6 and 15), management should be primarily focused on their conservation.

Management strategies are needed to restore degraded states (e.g., 1, 2, 3, 4, 7, 8, 9) and to return them to acceptable previous states. Although plants collecting plays an important role in the livelihood of locals (Karabak 2017), it should be reduced in states such as 11 and 13. Therefore, the goal of ecosystem management must be in order to conserve medicinal and edible species, as this is the way to maximize long-term economic and social benefits. Since many of these edible and medicinal plants are traded locally, it is very important to commercialize these products for international markets (e.g., for pharmacological purposes) to improve revenue of local people (Karabak 2017). Decreasing grazing pressure can cause the system to restore to stability in overgrazed states (Bestelmeyer et al. 2004), while restoration dynamics is facilitated by local abiotic conditions such as elevation, rainfall, soil texture (Lopez et al. 2013; Tietjen 2016). Upstream communities due to receiving higher rainfall can be restored by decreasing grazing intensity, but it is not enough for downstream areas where environmental condition is harsh; therefore, biological rehabilitation is needed. The results suggest that trees and shrubs are key species that have higher social, economic, and ecological values than other species and can be used to restore states with lowest value (e.g., states 1 and 4).

Conclusion

This study provided a new method to facilitate the management of ecosystems with multiple and intense uses. The combined social, economic, and ecological values of plant communities provide an appropriate indicator to show changes of plant communities under different management plans. The state and transition model simplified the complexities of multi-functional ecosystem with uneven managements. States with the highest community value, where intensity of multiple uses is adjusted to ecosystem potential and there are synergy between multiple uses, are priorities for regional conservation. States with lowest community value are critical areas where the intensity of adverse uses must be minimized. Our finding can provide important information for sustainable management of complex arid ecosystems.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s13762-021-03513-w.

Acknowledgements The authors wish to thank all who assisted in conducting this work.

Authors' contributions AKM involved in conducting of interview and preparing questionnaires, fieldwork, filling questionnaires, general data collection, and writing the manuscript. All authors wrote, read, and approved the final manuscript. MS involved in the study design, laboratory work, fieldwork, filling questionnaires and general data collection, and writing the manuscript. SN involved in preparing questionnaires, economic evaluation, and writing the manuscript.

Funding This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Availability of data and materials The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Conflict of interest The authors declare that they have no conflict of interest.

Ethics approval and consent to participate All experimental protocols were approved by Review Board of Faculty of Natural Resources, University of Jiroft, Iran. All methods were carried out in accordance with relevant guidelines and regulations. Informed consent was obtained from all participants.

References

Abbey M, Noake M, Belling GB, Netsel PJ (1994) Partial replacement of saturated fatty acids with almonds or walnuts lowers total plasma cholesterol and low-density-lipoprotein cholesterol. Am J Clin Nutr 59:995–999

Adhikari B, Difalco SC, Lovett J (2004) Household characteristics and forest dependency. evidence from common property forest management in Nepal. Ecol Econ 48:245–257

Balvanera P, Pfisterer AB, Buchmann N, He JS, Nakashizuka T, Raffaelli D, Schmid B (2006) Quantifying the evidence for biodiversity effects on ecosystem functioning and services. Ecol Lett 9:1146–1156

Baskent EZ (2018) A review of the development of the multiple use forest management planning concept. Int for Rev 20(3):296–313

Bestelmeyer BT, Herrick JE, Brown JR, Trujillo DA, Havstad KM (2004) Land management in the American Southwest: a state-and-transition approach to ecosystem complexity. Environ Manag 34:38–51

Bestelmeyer BT, Johanson J, Levi M, Lopez D, Peinetti R, Rumpff L, Shaver P (2017) State and transition models: theory, applications, and challenges. In: Briske D (ed) Rangeland systems. Springer series on environmental management. Springer, Cham

Biggs R, Simons H, Bakkenes M, Scholes RJ, Eickhout B, Van Vuuren D, Alkemade R (2008) Scenarios of biodiversity loss in southern Africa in the 21st century. Glob Environ Chang 18:296–309

Bozorgi M, Memariani Z, Mobli M, Salehi Surmaghi MH, Shams Ardekani MR, Rahimi R (2013) Five Pistacia species (P. vera, P. atlantica, P. terebinthus, P. khinjuk, and P. lentiscus): a review of their traditional uses, phytochemistry, and pharmacology. Sci World J. https://doi.org/10.1155/2013/219815

Cardinale BJ, Duffy JE, Gonzalez A, Hooper DU, Perrings C, Venail P, Narwani A, Mace GM, Tilman DA, Wardle D, Kinzig AP, Daily GC, Loreau M, Grace JB, Larigauderie A, Srivastava DS, Naeem S (2012) Biodiversity loss and its impact on humanity. Nature 486:59–67

Dumont B, Rook AJ, Coran CH, Rover KU (2007) Effects of livestock breed and grazing intensity on biodiversity and production in grazing systems. 2. Diet selection. Grass Forage Sci 62(2):159–171

FAO. 2006. Country pasture/forage resource profiles in the Islamic Republic of Iran. H. Badripour, 34p.

Farahpour M (2002) A Planning support system for rangeland allocation in Iran: case of Chadegan Sub-region. Department of Soil Science and Plant Nutrition. Wageningen Agricultural University, Wageningen

Fuhlendorf SD, Engle DM (2001) Restoring heterogeneity on rangelands: ecosystem management based on evolutionary grazing patterns. Bioscience 51:625–632

Fuhlendorf SD, Smeins FE (1999) Scaling effects of grazing in a semi-arid grassland. J Veg Sci 10:731–738

Garcia-Herrera P, Sanchez-Mata MC, Camara M, Fernandez-Ruiz V, Diez-Marques C, Molina M, Tardio J (2014) Nutrient composition of six wild edible Mediterranean Asteraceae Plants of dietary interest. J Food Compos Anal 34:163–170

Garcìa-Llorente M, Martín-Lópeza B, Iniesta-Arandiaab I, López-Santiagoa CA, Aguilerab PA, Montesa C (2012) The role of multi-functionality in social preferences toward semi-arid rural landscapes: an ecosystem service approach. Environ Sci Policy 19–20:136–146

Gokhale Y, Pala NA, Negi AK, Bhat JA, Todaria NP (2011) Sacred landscapes as repositories of biodiversity. A case study from the Hariyali devi sacred landscape, Uttarakhand. Int J Conserv Sci 2:37–44

Havstad KM, Peters DPC, Skaggs R, Brown J, Bestelmeyer B, Fredrickson E, Herrick J, Wright J (2007) Ecological services to and from rangelands of the United States. Ecol Econ 64:261–268

Heady HF, Child RD (1999) Rangeland ecology and management. Routledge, p 540

Helm N, Essl F, Mirtl M, Dirnböck Th (2017) Multiple environmental changes drive forest floor vegetation in a temperate mountain forest. Ecol Evol 7:2155–2168

Hill MO (1979) TWINSPAN: a FORTRAN program for arranging multivariate data in an ordered two-way table by classification of the individuals and attributes. Cornell University Section of Ecology and Systematics, Ithaca

Holechek J, Pieper RD, Herbel CH (2004) Range management: principles and practices, 5th edn. Prentice Hall, Upper Saddle River

Hölting L, Beckmann M, Volk M, Cord FA (2019) Multifunctionality assessments—more than assessing multiple ecosystem functions and services? A Quantitative Literature Review. Ecol Indic 103:226–235

Kakudidi EK (2004) Cultural and social uses of plants from and around Kibale National Park, Western Uganda. Afr J Ecol 42:114–118

Karabak S (2017) Economic and socio-cultural importance of edible wild species. J AARI 27(2):26–38

Koohafkan P, Stewart BA (2008) Water and cereals in drylands. The Food and Agriculture Organization of the United Nations and Earthscan, Quebec

Lopez DR, Brizuela MA, Willems P, Aguiar MR, Siffredi G, Bran D (2013) Linking ecosystem resistance, resilience, and stability in steppes of North Patagonia. Ecol Ind 24:1–11

Mace GM, Norris K, Fitter AH (2012) Biodiversity and ecosystem services: a multilayered relationship. Trends Ecol Evol 27:19–26

Maggs P, Hoddinott J (1999) The Impact of changes in common property resource management on intrahousehold allocation. J Public Econ 72:317–324

Mahjoub F, Rezayat KA, Yousefi M, Mohebbi M, Salari R (2018) *Pistacia atlantica* Desf. A review of its traditional uses, phytochemicals and pharmacology. J Med Life 11(3):180–186

Mandal G, Joshi ShP (2014) Analysis of vegetation dynamics and phytodiversity from three dry deciduous forests of Doon Valley, Western Himalaya, India. J Asia-Pac Biodivers 7:292–304

Maxwell SL, Reside A, Trezise J, McAlpine CA, Watson JEM (2019) Retention and restoration priorities for climate adaptation in a multi-use landscape. Global Ecol Conserv 18:e00649. https://doi.org/10.1016/j.gecco.2019.e00649

McCune B, Mefford MJ (1999) PC-ORD. Multivariate analysis of ecological data. Version 4.0. MjM Software Design, Gleneden Beach

McCune B, Grace JB (2002) Analysis of ecological communities. MjM Software Design, Gleneden Beach, Oregon

McGranahan DA, Kirkman KP (2013) Multifunctional rangeland in Southern Africa: managing for production, conservation, and resilience with fire and grazing. Land 2:176–193

Noy-Meir I (1993) Compensating growth of grazed plants and its relevance to the use of rangelands. Ecol Appl 3:32–34

O'Farrell PJ, Anderson PM (2010) Sustainable multifunctional landscapes: a review to implementation. Curr Opin Environ Sustain 2:59–65

Quetier F, Thebault A, Lavorel S (2007) Plant traits in a state and transition framework as markers of ecosystem response to land-use change. Ecol Monogr 77:33–52

Quijas S, El J, Maass M, Schmid S, Raffaelli D, Balvanera P (2012) Plant diversity and generation of ecosystem services at the landscape scale: expert knowledge assessment. J Appl Ecol 2:929–940

Quijas S, Schmid B, Balvanera P (2010) Plant diversity enhances provision of ecosystem services: a new synthesis. Basic Appl Ecol 11:582–593

Razavi S (2005) Pistachio production, Iran vs. the world. In: IV international symposium on pistachios and almonds 726; 2005

Reyes-García V (2001) Indigenous people, ethnobotanical knowledge, and market economy. A case study of the Tsimane' Amerindians, Bolivia. Ph.D. dissertation, University of Florida, Gainesville

Reyes-García V, Huanca T, Vadez V, Leonard W, Wilkie D (2006) Cultural, practical, and economic value of wild plants: a quantitative study in the Bolivian Amazon. Econ Bot 60(1):62–74

Rook AJ, Dumont B, Isselstein J, Osoro K, Wallis DE, Vries MF, Parente G, Mills J (2004) Matching type of livestock to desired biodiversity outcomes in pastures: a review. Biol Conserv 119:137–150

Rudolf S, de Groot Matthew A, Wilson Roelof MJ, Boumans (2002) A typology for the classification description and valuation of ecosystem functions goods and services. Ecol Econ 41(3):393–408. https://doi.org/10.1016/S0921-8009(02)00089-7

Saaty TL (1980) The analytical hierarchy process: planning priority setting resource allocation. Hill Book Co, New York

Sabogal C, Guariguata MR, Broadhead J, Lescuyer G, Savilaakso S, Essoungou N, Sist P (2013) Multiple-use forest management in the humid tropics: opportunities and challenges for sustainable forest management. FAO Forestry Paper No. 173. Rome, Food and Agriculture Organization of the United Nations, and Bogor, Indonesia, Center for International Forestry Research

Sarukhán J, Whyte A (2005) Ecosystems and human well-being: synthesis (millennium ecosystem assessment). Island Press, World Resources Institute, Washington

Sharifi MS, Hazell SL (2011) GC-MS analysis and antimicrobial activity of the essential oil of the trunk exudates from *Pistacia atlantica Kurdica*. J Pharm Sci Res 3(8):1364–1367

Stringham TK, Krueger WC, Shaver PL (2003) State and transition approach modeling: an ecological process. J Range Manag 56:106–113

Tietjen B (2016) Same rainfall amount different vegetation how environmental conditions and their interactions influence savanna dynamics. Ecol Model 326:13–22

Tipton CY, Ocheltree TW, Mueller KE, Turk P, Fernández-Giménez ME (2018) Revision of a state-and-transition model to include descriptions of state functional attributes. Ecosphere 9:e02201

Van Braeckel A, Bokdam J (2002) Habitat selection of cattle and horses in the Lower Basin of the Biebrza National Park. In: Grazing as a conservation management tool in peatland. Report of a Workshop held on 22–26, April in Goniadz, Poland

Walker BH, Ludwig D, Hoiimg CS, Peterman RM (1981) Stability of semi-arid savanna grazing systems. J Ecol 69:473–498

Worm B, Barbier EB, Beaumont N, Duffy JE, Folke C, Halpern BS, Jackson JBC, Lotze HK, Micheli F, Palumbi SR, Sala E, Selkoe KA, Stachowicz JJ, Watson R (2006) Impacts of biodiversity loss on ocean ecosystem services. Science 314:787–790

Zabala JA, Martínez-Pazb JM, Alcon F (2021) Integrated valuation of semiarid Mediterranean agroecosystem services and disservices. Ecol Econ 184:107008