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The assessment of management practices on rangelands exploitation using state and transition model in central arid regions of Iran

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Abstract: Rangeland management in arid and semi-arid regions requires comprehensive attention to ecological processes and consider the interrelationship of those processes. Considering discard the theory of climax and rangeland succession model in recent years especially in arid regions and shrub lands, the new theory known as the state and transition model is taken into consideration by natural sciences and environmental specialistsb in the world. In present study, state and transition model and its application in rangeland management will be discussed and wil be peresented a case study of Iran for more description. As a case study, Nir rangelands of Yazd province will be introduced. In this rangeland, both status of enclose and grazing livestock evaluated and grazing livestock has been introduced as threshold of these two conditions. Rangelands of arid regions are biologically fragile and in the case of little degradation, a long time will be needed for compensation. The definition of different situations, thresholds, transitions and indicators will help managers to follow change trend among different plant communities and establish an ideal community. But due to very slow and very small changes in arid regions rangelands, use of models in these areas is not possible.

Keywords: Model, state and transition, Nir of Yazd, threshold, arid region

İran'ın orta kurak bölgelerinde eyalet ve geçiş modelini kullanarak mera yönetim uygulamalarının değerlendirilmesi

Özet: Kurak ve yarı kurak bölgelerde mera yönetimi ekolojik süreçlere kapsamlı bir dikkat ve bu süreçlerin birbirleriyle olan ilişkisini göz önünde tutmayı gerektirir. Özellikle kurak bölgelerde, klimaks ve mera süksesyon modelinin terkedilmeye başlanması ile beraber, devlet ve geçiş modeli olarak bilinen yeni bir teori son yıllarda doğa bilimleri ile uğraşan uzmanlar tarafından uygulanmaya başlamıştır. Bu çalışmada, devlet ve geçiş modelini konu alan mera yönetimi uygulaması ele alınacak ve daha fazla açıklama için İran'ın Yazd eyaletinde bulunan Nir meralarında yapılan bir örnek çalışma sunulacaktır. Kurak bölgelerde yer alan meralar biyolojik olarak hassas ve kırılgandırlar, dolayısıyla bozulmaları durumunda, toparlanmaları için uzun bir süre gerekli olacaktır. Meralarda oluşacak geçişler ve değişimler yardımıyla yöneticiler farklı bitki toplulukları arasında değişim trendini takip ederek ideal bir bitki toplumu kurabilmektedirler. Ancak kurak mıntıkalardaki değişimin yavaşlığı buralarda model kullanmayı oldukça sekteye uğratmaktadır.

Anahtar Kelimeler: Model, devlet ve geçiş modeli, Yezd-Nir, eşik, kurak bölge

1.INTRODUCTION

In the past, the balance of rangelands condition was presented in the form of climax theory and rangeland succession model by Clements (1916). According to succession model, each of rangelands has a peak (Clements, 1916). In recent years, much evidence was found that rejected accuracy of this model for arid regions and shrublands. With the decompression of livestock grazing in these regions, not achieved

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expected climax in theory. State and transition model was presented as a new theory that using succession model considered inefficient in arid and semi-arid regions (Westoby et al., 1989). Westoby et al model is a descriptive model based on unbalanced theory that considers survey of multiple paths in the vegetation cover dynamic (Arcker, 1989; Friedel, 1991; West and Young, 2000). State and transition model with collecting hifting patterns and plant community dynamics of rangelands ecosystems can be helpful in predicting response of these communities to environmental biotic and abiotic management factors. The components of this model include the state, transition and threshold (Stringham et al., 2003). For a better understanding of the presented model by the researchers, is trying to integrate and present its concepts with a graphical model. The smallest location scale in state and transition model is called "ecological site". An ecological site has an ecological trend by following a specific process. The outcome of this particular process is viewing a situation. The state situation include of particular vegetation that has occupied the land under certain conditions and over time may be transferred to another state from current stable state. The states are status of vegetation covers that have more stability in existing conditions (Stringham et al., 2003). Transitions are routes that passed one rangeland from pre-state to after-state (Milton et al., 1994). Westoby et al were the first people that applied atate and transition expression as non-equilibrium theory in order to production of model. The authors defined the State as a stable plant community that simply cannot be reversed within a linear succession. The transition among the States triggered often by multiple interventions include natural disasters (such as fires or climate events) or management practices (grazing, culture, fire, etc.). Transitions may be occur by a series of natural events such as fire or flood. It may also occur during a broad period of time as the gradual changes in weather patterns or repetitive stress such as frequent fires. For understanding management processes and ecological effects on the ecosystem, created models that can be named state and transition models in this range. This model peresents a high potential of understanding of ecosystem response to natural and human disturbances and changes so that ecosystem dynamic will present as understandable form for manager (Stringham, 2003). The aims of the presented study are (Baghestani Maybodi et al., 2007) an overview of the state and the transition model and its components, (Heady and Child, 1999) a case Study of conceptual model based on the model in one of the arid regions, (District, 1998) investigate the efficiency of using the stete and transition model in the management of arid regions. This research is a review study to peresent a obvious view about changes of states in rengelands of arid and semi-arid regions and describe a key model names of state and transition model for these region.

2. MATERIAL AND METHOD

2.1 Conceptual definitions and research theoretical expression

2.2.1. Background of the state and transition model

Westoby et al., (1989) used state and transition model for the first time in vegetation cover management programs and vegetation dynamics. The authors belive that state is defined as alternative and stable plant community that state does not convert easily. Usually conversion between states begins based on the environment or human driving (Stringham, 2003). Needed concepts in this model are described as follows.

2.2.1.1 Ecological niche

Literally, ecological niche is "a special place", but in ecology, a niche is defined as role of the species or population in ecosystem. Niche involves many factors such as the kind of food and its access, kind of hunters, the range of movement, amount of patience, shelter, microclimate, and the time of the year that the organism has greatest activity, nesting and organism impact on other people. The ecological niche means the overall effect of a species or community on environment (Kumar, 2004). The ecological niche is a result of different habitat factors of species or population parameters (Hutchinson., 1957).

2.2.1.2 Ecoton

Ecoton is the boundary between different ecosystems. The border has different spatial and temporal dimensions and can be classified accordingly but ecoton is independent of location (Ward and Wiens. 2001; Farina, 2007). Ecoton can be a gradual boundary in different habitats. For a long time, it has been used for expression of a gradual frontier of plant communities, but today also has been considered the non-living environment and their processes.

2.2.1.3 Ecological threshold

Ecological threshold is a very important concept for natural resource managers (Nagelkerken, 2009). Ecological threshold is one concept that shows sudden changes or gradual in terms of performance an ecosystem (Yellowstone, 2012). Ecological thresholds is a point in the natural system (vegetation, aquatic environment, etc.), in which the main characteristics of the system changes drastically. For example, the wilting point for plants can be seen as the threshold that beyond of it, the plants begin to destroy. Friedel (1991) focus on the idea of environmental changes thresholds among relatively stable dominion. Threshold defined as boundaries in time and space between two dominions or conditions. (Friedel, 1991). When a threshold is violated, return to the previous situation without the provision of basic inputs in the timeframe is not possible for manager.

2.2.1.4. State and transition model

Based on presented model by Clements, if a plant community in an area with specific edaphic and climatic conditions pass evolution path, this community on track to reach its peak or climax will travel linear path. In the meantime, if we imagine a plant community under livestock grazing, with the elimination of grazing, its way will continue to its first climax again. But according to later studies, it was found that in the same climate and edaphic, several plant communities are able to live in a stable condition and have different developmental paths. In this condition, communities or "states" of the plant can be converted to each other. This conversion was usually quick and irreversible. The condition of these dynamics of plant communities, is called the "State and Transition" Model (Westoby et al, 1989; Yates and Hobbs, 1997). This model allows managers that with proper planning and long-term forecasts occurs event into a favorable change (Westoby and Walker, 1989).

States: defined as an alternative and sustainable plant community that cannot be return in a linear path to previous community (Westoby and Walker, 1989).

Transition: defined as the lines of passage from one state to another. Transition occurs based on human and natural events. The transition may occur suddenly such as flood; or may occur gradually such as drought impact or repeated stress due to livestock grazing (Melvin and Maximo, 2006). Different plant communities when is achieving their new state, will be stable (Melvin and Maximo, 2006). In this model, we need to define three characteristics. At the first, different plant communities conditions (composition, vegetation cover, making reference scenarios that demonstrate the best climate and edaphic condition) is defined. Second, different states based on its structure and functions as well as feedbacks between them are defined. Third, based on the state and transition model, thresholds, triggers and transition path between different states is determined (Bestelmeyer, 2009).

2.2.1.5. The conceptual model based on State and Transition Model

Based on the combination of all factors, the following conceptual model is presented that different plant communities are arranged in different ecological niches according to different needs. In this conceptual model, ecoton, ecological thresholds, two different states of plant and plant communities is presented. In this model, only 3 requirement sources is mentioned for plant communities and arrangement of these communities have been investigated based on these three sources. In this model, the ecological threshold

may be anything including fire, livestock grazing, land degradation and etc. Also, illustrated two-way graphs represent two-way transition. With the occurrence of a threshold, state A can deform to state B. This model can be seen as dynamic character because all of its inherent changes occur dynamically. Plant communities require many resources to live and survive in nature and rely to 3 sources in this model, it will be only for simplicity.

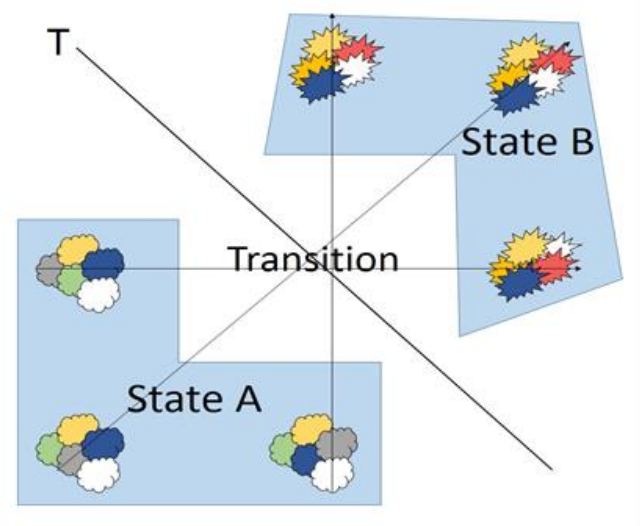

Figure 1. Conceptual Model of the state and transition model
Şekil 1. Asıl ve bağlantı modelinin konsept modeli

2.2.1.6. Case study

Nir rangeland is located in Yazd province of central Iran as an arid region. Baghestani Maybodi et al (2007) studied vegetation cover characteristics in two statuses of the exclusion and natural management. In this research, authors used from two decades data (1986-2004). Three 7.5-hectare experimental plots were selected inside and outside of the exclosure. Exclosure site had not been grazed from 1986 to 2004. The adjacent site was continuously grazed at the same time. Cover estimated on quadrates and forage yield were measured by clipping and weighting method. The results of this study showed that cover, density and yield of Salsola rigida and Stipa barbata increased significantly inside exclosure ($p<0.01$), but it was not significantly different in Artemisia sieberi ($p>0.05$). Cover, density and yield of Scariola orientalis , Launaea acanthodes and Noaea mucronata were greater in grazed area, but only the yield of first species, density of second species and cover and density of third species were significantly high ($p<0.05$). Palatability of Artemisia sieberi is low in the composition of existence plants and is less affected by grazing pressure. Salsola rigida is very palatable and damaged severely due to grazing more than the permitted period, and has been eliminated approximately in this region. Complete removal and replacement of three non-palatable (Scariola orientalis, Launaea acanthodes and Noaea mucronata) by desirable species during 19 years exclosure not been achieved. By increasing the amount of rainfall in the region, vegetation cover percentage especially Stipa has increased in the combination of annual production. On the other hand, the abundance of grass reduced severely with the drought occurrence. While, shrub plants have been fewer changes in similar conditions. Therefore, shrubland is major nature form of this region. Two-decade protection showed that vegetation trend is very slow in arid rangelands. Amount of occurred changes is around 1% that is indicating slow pace of changes in the arid and semiarid regions. The results of this research are presented in Table 1.

3. RESULTS AND DISCUSSION

In the presented case study, two conditions of livestock grazing and enclosure is explained in Nir rangeland of Yazd province. In this case study, the amount of occurred changes in vegetation cover is about 1 percent that is indicating a long time of different conditions changes of the vegetation cover during the period of 19 years. Any damage to these ecosystems, and the transition from reference to other states, will be required a lot of inputs and management for relief and reconstruction and creating meaningful change in vegetation cover (Knapp, 1992).

Poor species (*Scariola orientalis*, *Launea acanthodes*, *Noaea mucronata*) have not been lost in plant composition of exclosure region after 19 years and showed that manager aim is achieving to other condition than this state and must be planned for other conditions. If rangeland is located in the poor condition and in the early successional stages, only by eliminating or reducing grazing, would not go ahead to the desired conditions. Lack of attention to this issue, will make understand mistake in the process of vegetation cover changes in management (Milton and Hoffman, 1994; Laycock, 1991). To practical state and transition model in rangeland management, should be determined ideal rangeland based on objective observations and experiences at the first. However, with defining a key indicator to achieving ideal condition and periodical monitoring of these indices, manager is able evaluate changes of rangeland and perform managerial practices (Bestelmeyer, 2003).

In the mentioned rangeland, change of vegetation cover in palatable and non-palatable species is one of the appropriate indicators. It is noteworthy that only vegetation cover changes would not be representing the change of rangelands condition and it is necessary to considered many issue. One advantage of using this model in arid regions is the sensitivity of these regions to resources harvesting and degradation. According to different scenarios state and transition model, is recognized change trend among different states, change stage and threshold. With determining causes instead of viewing the impacts, proper diagnosis of events is easy and in this case, attempt to change management practices or management level (Project, 2006).

Table 1. Changes in vegetation cover during the 19 years of exclosure in Nir rangeland of Yazd
Tablo 1. Yazd Nir mera alanında 19 yıl boyunca oluşan vejetasyon örtüsündeki değişiklikler

Plant	**Cover (%)**			
	Exclosure (state B)	**Grazed (state A)**	**The prediction of state (proper management)**	**The prediction of state (continuation of recent degradation)**
Salsola rigida	3.4	0.1	8.1	0
Artemisia sieberi	3.1	2.3	6.7	1.5
Stipa barbata	3.1	0.3	7.1	0
Noea mucronata	0.6	0.9	0	3.1
Scariola orientalis	2.4	3.5	0.3	5.5
Launea acanthodes	1.6	2.7	0.4	3.5
Other perennial plants	2.2	1.9	22.1	1.2
The total of perennial plants	14.5	11.6	51.6	9.6
The total of annual plants	1.4	0.6	8.1	0.8
Vegetation cover of all plants	15.9	12.2	28.1	0.7
Litter	14.3	12.4	20	12

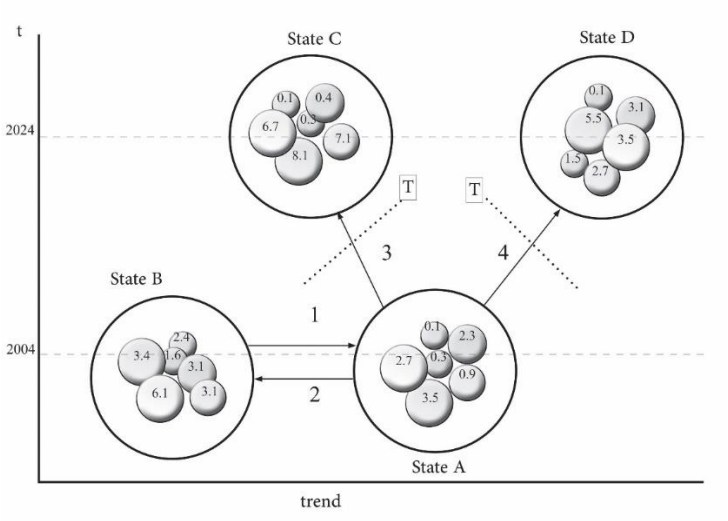

Figure 2. The conceptual diagram of the examined two conditions in exclosure rangeland of Nir during the 19 years
Şekil 2. 19 yıl süresince Nira'nın dış bölgelerinde incelenen iki koşulun kavramsal diyagramı

Figure guide

State A- Status of Vegetation Cover indicators in steppe rangelands of Yazd province in 2004 (livestock grazing Region)
State B- Status of Vegetation Cover indicators in steppe rangelands of Yazd province in 2004 (Exclosure Region)
State C- Status prediction of Vegetation Cover percentage of indicator plants in steppe rangelands of Yazd province in 024 (with proper management and regard to ecological strategic principles)
State D- Status prediction of Vegetation Cover percentage of indicator plants in steppe rangelands of Yazd province in 2024 (With the continuation of the current destruction and intense weaknesses in management and adverse impacts of climate changes)
1. Exclosure and elimination of grazing livestock
2. give up exclosure and again livestock grazing such as previous trend
3. Good management operations, adapt to climate change and full respect for all ecological principles
4. Continuation of the destruction, the negative effects of climatic conditions, poor management
T- Threshold

3. CONCLUSION

Predicting changes, tracking changes, facilitating understanding of the environmental conditions is the most important benefits of using the state and transition model in the rangeland management (Brown, 1994). Understanding a lot of changes in rangeland will be easy by using this model. Existence an experimental model, requirement many data and indicators, Interference expert opinions on determining the different status and the lack of studies in the field of range management are disadvantages of this model (Bagchi, 2012). In the conducted survey in Nir rangelands of Yazd, were evaluated two rangeland conditions in state and transition model frame. Using of the state and transition model with respect to gradual changes in rangelands of dry lands, will not be very practical. The monitoring of the defined indicators for evaluating rangeland, only in the long time would be held accountable and does not reflect short-term changes in soil and vegetation cover. Because change threshold is so low and its understanding will not be easy for expert and manager. For example in Studied rangeland, occurred changes in non-palatable plants are at 1 percent and a little of measurement error will cause rangeland manager have wrong interpretation and decisions. With respect to mentioned issues, the use of this model to assess minimum vegetation cover percentage in arid rangeland will be difficulties.

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