

Ecological-breaking zone originates and its ecosystems reconstruction in arid area

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Abstract—In the process of arid land exploitation, the landscape of desert is divided into three types. Oasis is rising, the area of uneffected area keeps its original state, the serious degenerated area where is only limited between oasis and desert, but not overall. Its relationship with the neighbor region, the zone of ecological-breaking region or ecological rift valley is not successive. Its ecological effect endangered the arid land overall. Rehabilitating vegetation is the basic measure for abatement. The authors proposed a new tactics that based on the properties of vegetation. Depending on the local water sources and partly regulating the composition of environmental factor to satisfy the requirement of desert community, the rehabilitate vegetation should be realized.

Keywords, arid area; ecological-breaking zone; ecosystems reconstruction.

1 Introduction

Because the population increase rapidly in the past decade, mankind have extend all spaces that can be settled. At present, the land that can be exploited for agriculture is only 7% of surface on the earth (Mihailo, 1978), and is distributed mainly over tropical rain forest and arid land. Obviously, tropical forest is unfit for large scale exploitation. The land of arid zone is relatively suit to reclaim, and possess the latent hope of exploitation and will become the last space to be exploited, but whether it can be the real hope of mankind depend on whether it can be sustainable balance of habitat while exploitation. In numerable facts in history and reality indicated that, exploitation usually induces serious environmental problem, even causes desert expansion. To explore the satisfactory way for both exploitation and sustainable development, will be seriously effect the arid land exploitation and human future.

2 The reason of ecological environmental deterioration in arid land

Since 1950s the world scale exploitation and desert extention run neck and neck, vegetation decline has been generally acknowledged as the reason and symbol of desertification. Because vegetation is controled by climate, recently analysing the reason of vegetation decline and desert rapidly extend, first from the climate, it is undoubtedly logical. Some facts

showed that earth's climate have not the sign of acute change recently. The climate recorded around Sahara desert and the water lever near the lakes can verify this point(FAO, 1985), so do north-west of China(Geng, 1986). But in the 1970s, the ecological disaster of Sahara is not simply caused by climate reason. From 1910 to 1915, Sahara had happened drought, the strength and process were very similar with which happend in 1968—1972. But the later, because the population increased rapidly, cause the pressure of environment is increasing. Then the disaster is more strength than the former obriously(FAO, 1985).

Some vegetation in Xinjiang have degenerated seriously, other sectors such as Manasi Lake basin region maintaining original state(Huang, 1987). In Mosuowan of Zhunger basin, before 1958 began to large scale exploited, the background of the original *Haloxylon ammon-dendron* desert is clear(Hu, 1963), now have divided into three types of landscape(Huang, 1991). Among them, oasis habitat has showed some improvement. Unaffected region that apart 60km from oasis sustained the state before exploited. The district between oasis and desert was effected but not transformed, has degenerated seriously.

At the process of earth evolution, vegetation degeneration and desert extend usually are directly interrelated with climate. But recently habitat deterioration was difficult to be concerned with the climate, even the Sahara ecological disaster in the 1970s, climate is only one of the reasons. It is not the dominant factor, the vegetation changed in Xinjiang and landscape divided in Mosuowan at the same time. Now the population increased rapidly to lead the pressure of environment increasing, should be the dominant reason of environment deterioration so rapidly.

The process of exploitation cause landscape divided show further that environment deterioration was controled not only by the strength of mankind activity but also by affect direction and goal. Proper plan can make exploiting region improvement, but plunder source to exploit will cause ecological system degeneration even disintegrate.

3 New progress on arid land study

Foregoing paragraphs have mentioned that the process of Mosuowan exploitation made single landscape divided into three types(Huang, 1991). Among them, oasis built up on the basis reforming primary vegetation. It have clearer improvement than desert in its construction and function, primary product capacity and habitat(Huang, 1989), it is at the state of ecological succession. The ecosystem is degeneration at the periphery of oasis that source have been excessive used but have not been reformed. Because the disturbance strength is weaken from near to far. When distant is far enough from the oasis, exploitation does not effect it, all of these cause such distribution. Among these, the ring region round the oasis closely degeneration is the most. Under the effect of limit of jointed system, the foundation of oasis will be shaken and run the crisis of decling . Usually, in the process of exploitation the oasis habitat had been improved, but have not been noticed by people, and sustained original desert was degeperation seriously and form a sharp contract with oasis , so that aggravated pessimism about exploitation cause decline and so form the one-side view.

There should be pointed out, the phenomenon that the single landscape divided into three types, especially at the region that the history of development was short, was visible evidently. Mosuowan could be one of the typical case. When the history of development was longer, the original desert had been destroyed again and again, or the time of development was shorter but on its nearby have built up new oasis, the original desert would vanish. Finally, only remained the oasis and seriously degenerated area around the oasis. In the region that the history of development was longer the late circumstances was existence general. So people always neglect the overall understanding of the problem that was leaded by development.

According to the study on relation between vegetation and desert environment, at the end of 80s, we first point out the phenomenon that exploitation result in landscape divide (Huang, 1991). It will conduce to recognize about the truth of exploitation overall in lately, so that it will benefit to draft relevant countermeasure in time.

It is the important premise of sustainable development whether we can keep habitat stable at the process of exploitation. In order to save the length of article, we will not make further analysis about the part of arised oasis and original desert, but emphatically probing the problem of the area around the oasis that exploiting result in habital serious degeneration and then endanger overall situation. The region lies between oasis and uneffected natural desert, named the area around the oasis because it is situated at the outside of oasis. In the process of original desert was development, it happened at the same time with oasis but development was heterogeneity, showing the feature that vegetation declining, ecosystem crumbling and fixed sand dune activating again.

It is the reason of serious degeneration that excessive herding and cutting firewood in the outside of oasis. Some authors (Zhang, 1989) have defined the range, where is from the border of oasis extend to 40—60km, and the worst is the region from 0—4km. We agree with the conclusion. Results of study in 1993 showed that at Mosuowan reclamation area, the ring region close to oasis 0—4km, vegetation covery from 30% before exploitation dropped to 2%—3%, recorded desert plants from 108 species to 65 sp. (Huang, 1989; 1991). The serious situation of this region is the result of two action overlapped. The remaining plants of this region and many kinds of individual reduced in numbers notable or visible accidental, but individual species, such as *Salsola spp.*, *Atriplex dimorphostegie* increase greatly, moreover, form famile, *Eremophyrum orientalis* and so on, is extremely reducing by ingestion. The grasses of the region are formed based on prevernal ephemeral plants. So herding is controlled by desert lack of the point of drinking for domestic animals, the limit of herding is not beyond 10km from the border of oasis, the distinct effect of herding only limit in the radius. Near the border of herding, herb changes obviously. *Eremophyrum orientalis* increase evidently and became dominant species of grasses gradually, the other kinds of individual evident increase also. At the same time, *Salsola spp.* and *Atriplex dimorphostegic* became fragmentray. Near oasis, *Salsola spp.* and *Atriplex dimorphostegic* occur the mainly position. The moisture content in mixed freshgrass is 75% in the sample,

at 5km is 72.5%, at the placeway of 12 km where *Eremophyrum orientalis* is mainly species, is 55% (Table 1). From the changing of moisture content, we also can understand the changing of grasses composition from near oasis to far. The shrubs of this region, at the same time, are effected by hurding and cutting firewood, the remained shrubs, because the young

Table 1 Record of grass sample plot *

Sample plot	Cove degree, %					
	I	II	III	IV	V	VI
Mean	33.9	25.1	20.34	28.85	60.0	44.6
<i>Eremophyrum orientalis</i>	+	+	0.91	3.77	42.67	42.77
<i>Atiplex dimorphostegie</i>	9.78	3.5	2.15	+	+	4.23**
<i>Salsola spp.</i>	16.1	6.5	3.27	+		6.54**
<i>Torularia sp.</i>	2.05	10.0	0.5			
<i>Lappula semiglabra</i>	+	+	1.73	8.73		
<i>Senecio subdentatus</i>		+	0.52	4.38	8.33	1.15
Moisture content in fresh grass, %	7.51	72.5			55	

* : From 72 samples (1x1m²), the sample distributing in spotted grassland and cover degree 20%-50% in that place.

That place away oasis I, 1-2 km; II, 5km; III, 7km; IV, 10km; V, 12km; VI, 40km; + is cover degree little and plants rare; ** mean from 13 samples but it is only in a sample

Table 2 Brush record of part sample plot in outside of oasis

Sample plot *	Distribution of brush height, %		
	I	II	III
≥199.5	21.2	3.75	41.18
≥149.5	27.27	13.75	10.29
≥99.5	24.24	28.75	11.76
≥49.5	18.18	31.25	16.18
<49.5	9.10	22.5	20.59
	Distribution of canopy area of brush, %		
≥149.5	42.42	10.00	16.18
≥124.5	15.15	3.75	14.71
≥99.5	3.03 10.10 13.34		
≥74.5	12.22	21.21	16.06
≥49.5	6.06	25.0	14.71
≥24.5	21.21	16.25	20.59
≥24.5	0	13.75	4.41
Mean cover degree of brush			
in sample plot, %	2.28	5.59	8.56

* The place is the same as to Table 1

branches and leaf was ingested, made lots of low-branch happened. We take *Haloxylon ammodendron* as example, near the oasis, the low-branch increased, height became short, in the same height, its crown breadth are bigger than the zone far from the border (Table 2). The material *Haloxylon ammodendron* are damaged by mice (Table 3) that proposed a question to explain the problem. The expression that shrubs are cut show off the changing of density, age and coverage. Far from the border 60km, the desert still remained vast former *Haloxylon ammodendron*. The trees' age is more than 100 years, its height can reach 4.5m, crown breadth can reach 8m×8m, and the coverage of this area can reach 30%. Near the oasis only find rare young trees.

Table 3 Influence of *Haloxylon ammodendron* for rat damage

Type	Brush height, m	Diameter at butt end, cm	Number of branching		
			50cm	100cm	150cm
Rat damage	2.23(6)	8.6	17.7	29.3	15.7
Contrast	2.36(11)	10.4	5.9	10.3	14.7

Notes: The data from the group near height of brush, number in bracket is the statistic plants; number of branching is the diameter of branch ≥ 0.5 cm on the same level height

The statistical data of biomass have obvious different, the annual biomass in oasis cover 5135.3kg/ha, natural desert is 295.5kg/ha, the area around the oasis (in 2—5km) is 112.5kg/ha (Fig. 1).

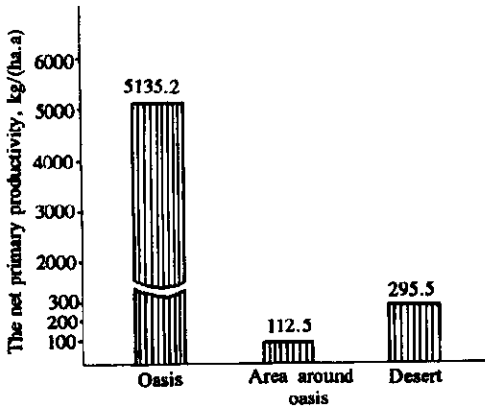


Fig. 1 The net primary productivity of oasis, the area of around oasis and desert

Serious dealing of the area around oasis will spread to oasis and natural desert through border effect, so that its nature is different from ecotone we usually understand. It is not the region that joint oasis and desert, and gradually advance is nonexistent. So, it is not the place the two transform toward each other, but is the ecological breaking-region or ecological rift valley (Fig. 2, 3) between oasis and desert. It is differ from oasis and natural desert on construction, vegetation quality, primary product capitale or habitat quality. Its existence will cause both of oasis and natural desert to tend decline through border effect, so the area around the oasis is the focus of habitat

deterioration at the moment, and should emphatically hardness.

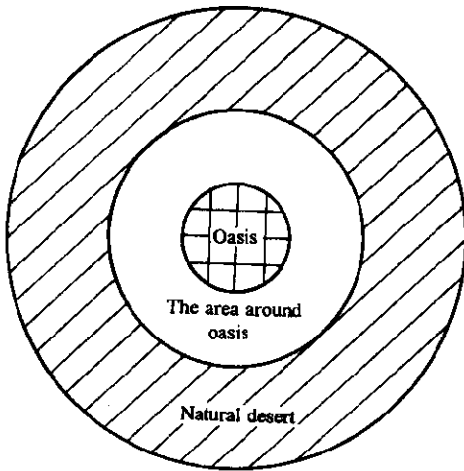


Fig. 2 The relationship position of oasis, the area around oasis and natural desert

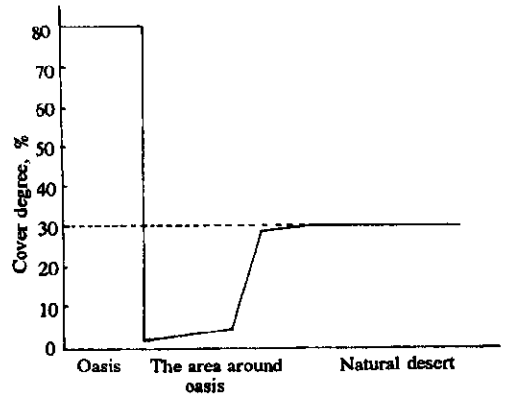


Fig. 3 The sketch map of cover degree about oasis, the area around oasis and natural desert

4 Analyses of currently prevention and cure measure in degeneration ecosystem

It has been affirmed that the sign of habitat degeneration and the reason of desertification (Zhu, 1982) is because the vegetation squander into degeneration. So to rehabilitate degradation ecosystem the first thing should rehabilitate vegetation, so that, stop the process of retrogressive secession to turn to the secondary succession. Now, rehabilitate vegetation most adopt irrigation afforestation or closed sands to facilitate afforestation.

At present, irrigate afforestation is the mainly way to make artificial vegetation, some large-scale project, such as famous "three-north shelterbelt system", green dam project (Liu, 1982) and so on use this way. The way had gained good effect at every situation, but the important objective is against grim environment. Oasis is in grim environment, as if a isolation city was pined down. So shelter forest system is the materialization of defense, its major duty is defended but if it can keep permanent cure need to observe and experiment in future. So it is unable to change the situation of habitat deterioration in arid land. It must be pointed out that the water deficient is the essention feature in arid land, it will control not only natural but also artificial vegetation. In order to keep artificial vegetation it must depend on irrigating and it certainly will fight for water source with oasis. Then it will limit the possible of large afforestation, besides, the trees that were planted mostly are mesophytic, and the existence of forest must use agricultural measure at present. So that it is impossible to harness degenerated ecosystem effectively.

Another useful method is closed sands to facilitate afforestation, it is the way isolation to prevent new disturb process and restored naturally. The way is simple and easy to do and fit for all kinds of environment, but it can not be controled. When the disturb was stopped, the process of retrogressive succession will stop too and turn to the process of secondary suc-

cession. Obviously, the worse of degradation, the more difficult to restore. It is only fantasy through closing sands to facilitate afforestation to facilitate afforestation too realize climax in some places. Even though so, closing sands too facilitate afforestation still has its value, elementary, it can restrain deterioration momentum and reduced resistance for harnessed.

5 Rehabilitation ecosystem of degradation depend on local environment and vegetation adaptability

To sum up, it is not difficult to draw the conclusion that using irrigation afforestation or closing sands to facilitate afforestation can not rehabilitate vegetation effectively or restore degenerated ecosystem. From the study on desert vegetation and environment. Especially, the study on life circle of population dynamic adapt to environment (Huang, 1988; 1991a) consider that using local plant's adaptability and natural established coenosium law, will effectively restore and rehabilitate desert vegetation. Following phenomenon will strength and explain this position.

5.1 Vegetation natural reproductive phenomenon

Although desert habitat is very severe, still reproduce diversify large-scale natural vegetation. Till this 50s, these main type of desert vegetation that *Haloxyylon ammodendron* area is 8×10^6 ha (Hu, 1963). *Tamarix*, 533×10^4 ha and reality desert forest *Populus euphratica* 53×10^4 ha in Xinjiang (Xinjiang Institute of Biology, 1978), wild plants that have been recorded are more than 200 species in arid basis; Talimn and Zhunger, there plants reproduce naturally and keep relative stability areal real. So to study and imitate the process of natural established coenosium posses important value for rehabilitate vegetation in the place where water deficient.

5.2 Same population's life circle dynamic

The information recently, notice some population's life circle dynamic adapt the changing site (Huang, 1983; 1986; 1988; 1991a; 1991b). Now, we give a brief introduction in the following:

5.2.1 *Tamarix spp.*

Tamarix spp. is capable of stopping drift sand to form high sand dune and fixing it, obviously, it posses important function for stable habitat. This plant usually grows by the river bank in group or scattering in others site. Since 1983, its seedling was found in little catchment pit in south slope of Tianshan Mountain where annual precipitation is only 80 mm (Huang, 1983), after observed in varied habitat, even at Gurbantonggut desert (Huang, 1983; 1986). All of these seedling depended accumulate precipitation in the pit. According to this, we have simulated least successfully. It verified the possible of using natural precipitation to afforest shrubs of *Tamarix* in desert.

5.2.2 *Populus euphratica*

It is the real trees make forest in desert. Its height can reach over 20m, its seedling was observed in flood land, adult trees general grows on sand plain. It shows that its life cycle completes under soil moisture strong change (Huang, 1988). The order, that wet is the first

and dry is the second and can not reverse. Suppose "I" represent surface is wet habitat, "II" represents surface is thick dry sand and the substratum exist groundwater that *populus* trees can use. "I" is the necessary condition for seedling and young forest, "II" is the condition sustained adult trees and its forest to exist. The results of the study showed that one place where exist "II" but lacked "I" and then have no woods or only survived old trees. On the contrary, if appear "I" but lacked "II", the place at most can sustain young trees and then die (Huang, 1991; Qin, 1959). So, when some places possess "II" were found and "I" was contented in a short time, the places will grow high tree and forest. Flood has very important affect on *populus*. Flood first make moist bank for seed sprout and seedling grow. Another function is to wet through the thick dry sand between groundwater and surface, supplying moisture for the growth process of the root from shallow stretch to groundwater (Heinrich, 1979). Obviously, the later was difficult to be replaced by other water source. So *populus euphratica* was limited in river bank. When the process was known, then the problem is possible to be solved. After calculation, the water demand to sustain one unit area of artificial forest can possibly make 30 times area of this forest (not include the groundwater for forest living).

5.3 The strategy of ecological restore

Strategies of restoring the degraded ecosystem must depend on science and technology, at the same time, carry out vegetation restore policy of "combine protect, utilize with rehabilitate vegetation", through the way of contract land to manage can promote its realize.

Carry out the policy that divide land into pieces to contract, fix right of using desert land, carry out "combine project, utilize with rehabilitate vegetation". Manager have the right to use vegetation source and the presupposition is protection. Gaining the consumer goods by the process of utilize and then accumulating fund for expand manage to restore vegetation continually, it is the core of the polity that rehabilitate and restore vegetation. We must strengthen scientific research system, using the newest scientific achievement and advanced technology to guide vegetation restore and ensure its enforcement. This work will continued in progress. The goal must be realized that exploitation and sustainable development in arid land.

6 Conclusions

Plants move to land from water since the paleozoic Era, it had suffered several times disasters in geological history, but at last, its indomitable adaptability again and again overcame desert successfully in the different geological period. At present, desert extend once again, the reason is not climate but mankind. Up to now, natural vegetation still exist in some place in arid land. There are powerful scientific technology and material resources. So long as conscientiously sum up the experience in ecosystem degeneration, mankind is possible to improve the situation and to rehabilitate degenerated ecosystem.

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