Effect of climate changes on the species composition and productivity of plant communities in the eastern Mediterranean region of Turkey

Vegetation Sub-Group
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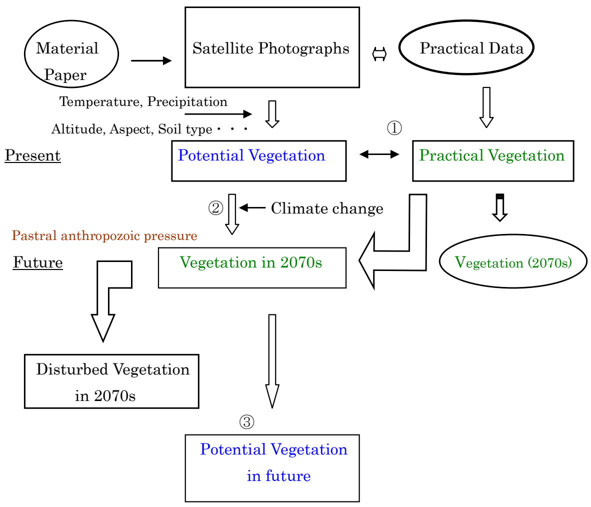
1. Introduction

Geographical distribution and productivity of plant communities are related to various factors. However major distribution of vegetation (climatic climax community) is most strongly associated with macroclimate (physical factors). Vegetation zones are determined mainly by thermal and water conditions in the reign.



① Difference between Practical and Potential vegetation in present
② Estimation of Vegetation in 1970s and compared with that in present
Productivity and spatial distribution of the vegetation
③ Estimation of Potential Vegetation in 1970s by Climate Change
In addition to ②, disappearance of boreal forests from Cukurova Basin

Fig.1 Research procedure

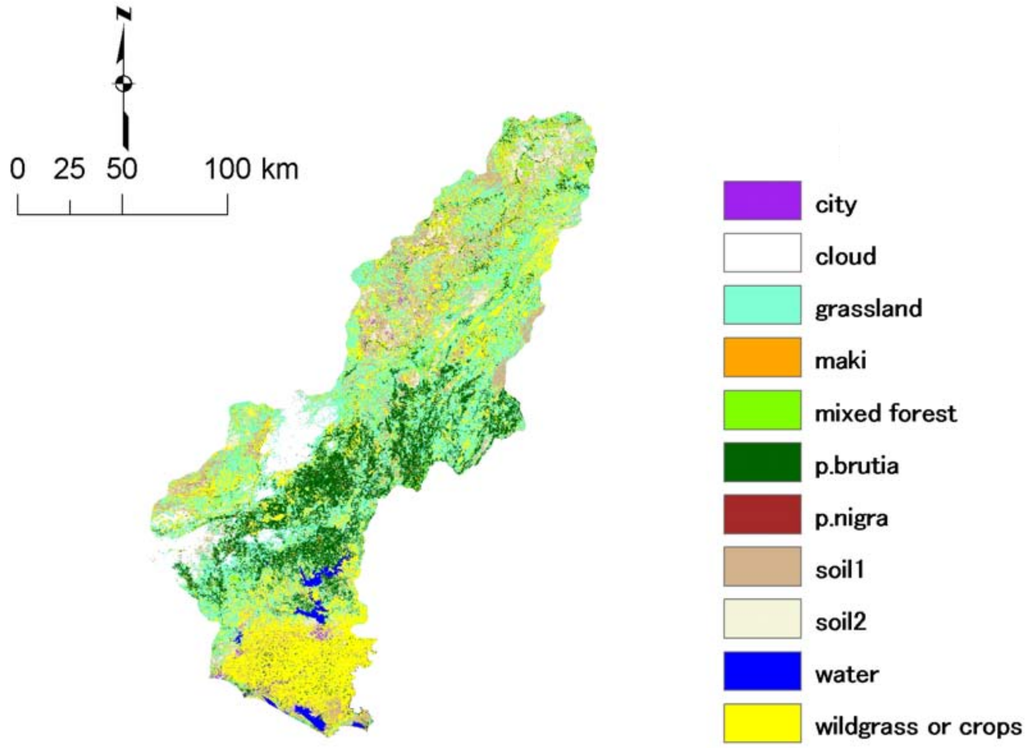


Fig.2 Present vegetation map of the study area (13 June 2000)

We estimated vegetation types, and their biomass and productivity in the eastern Mediterranean of Turkey from air temperature and precipitation.

Our study focus is to analyze impact of climate changes on geographical vegetation and its structure in semi-arid region of Turkey by air temperature and precipitation in present and future (Fig.1).

2. Vegetation types and community structure

1) Present vegetation

Practical present vegetation types were estimated using by satellite photographs (LandsatETM+13 June 2000) and actual survey data, and we drew vegetation map in the eastern Mediterranean region of Turkey （Fig.2）. A large part of flat areas in 0-600m above sea level was almost occupied by crop field, and natural vegetation was remarkably destroyed and replaced *Pinus brutia* forest with *Maquis* elements as dominant community.

Potential vegetation in present (Fig.3) was estimated from Thornwaite p/e Index (PEI,Thornthwaite 1931,1948)(see Appendix I,II) and Warmth Index(WI,Kira 1945,1976) calculated

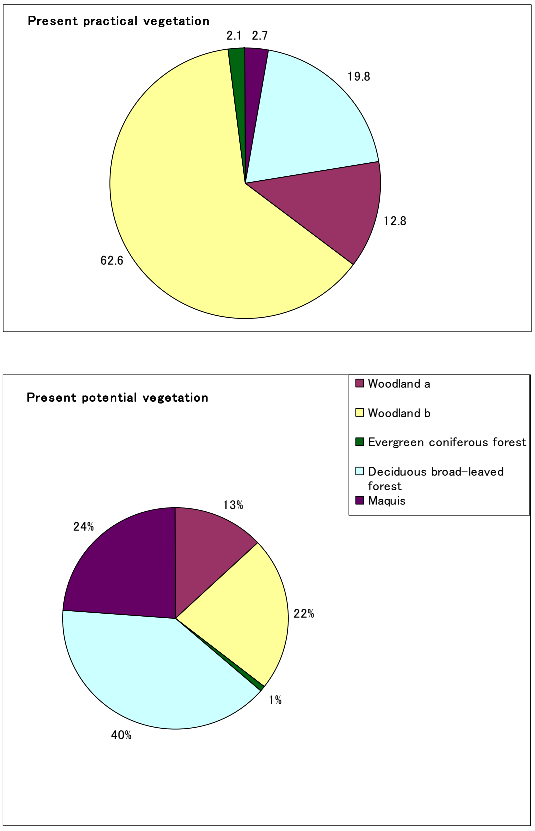


Fig.3 The percentage of area occupied by five vegetation types in practical and potential present.

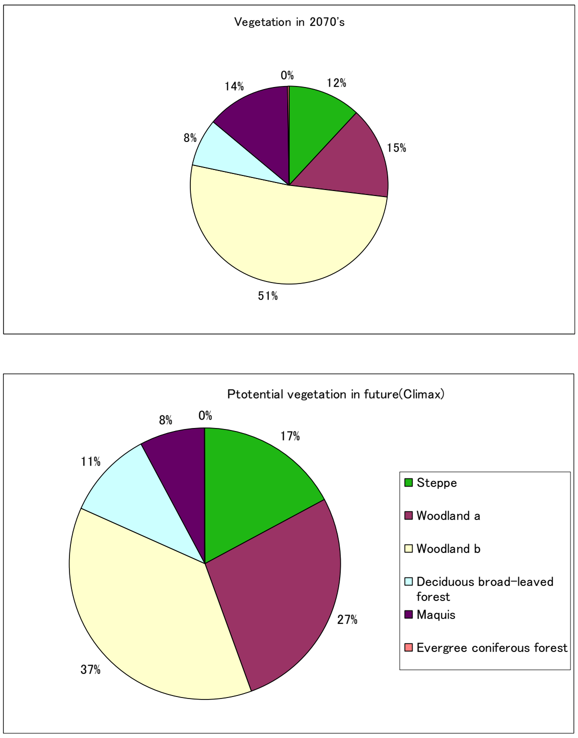


Fig.4 The percentage of area occupied by each vegetation type in 2070's and climax stage (Potential vegetation in future).

From the climate data at present provided by Climate Sub-group for ICCAP (K-1 Model Developers 2004).

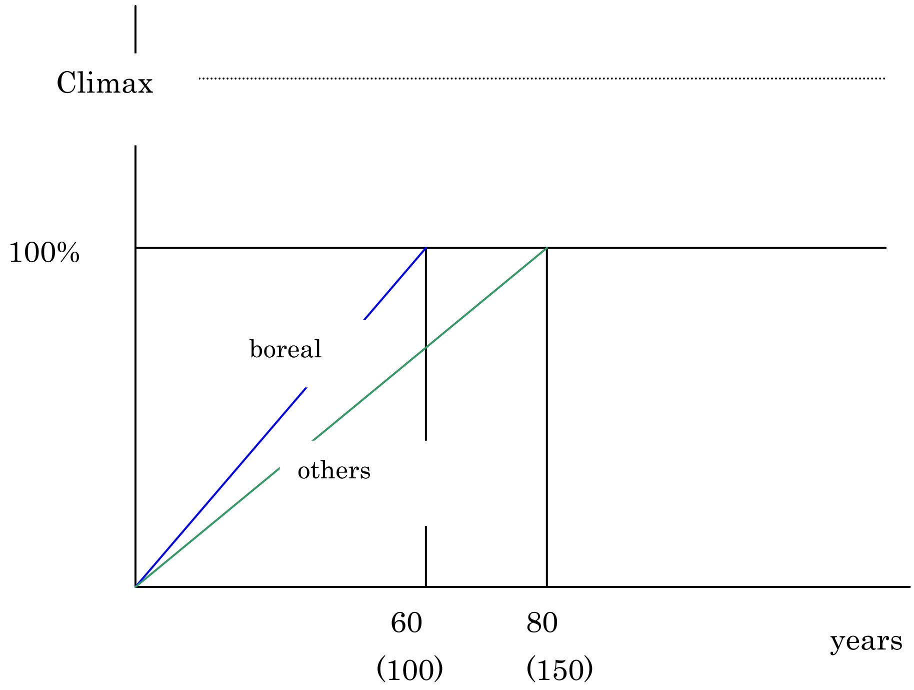
Areas of Maquis and Deciduous broad-leaved forest in present potential vegetation were smaller than in present practical one. Maquis area in the potential vegetation was used as crop field now and Deciduous broad-leaved forest area occupied by secondary forest of *P.brutia* (Woodland b). Sub-alpine forest (Evergreen coniferous forest) was distributed between ca.1000m(～1500m) and 2000m(～2500m) above sea level

□ <u>Secondary Succession</u>

(Sano et al. 2003), but this vegetation may lay downward the original position estimated from WI and P/e index because of the edaphic complexity (lime stone) (San et al. 2003).

2) Vegetation in 2070's

We estimated vegetation in 2070's from WI and P/e Index using by the climate data provided from the Climate Sub-group of ICCAP (K-1 Model Developers 2004) in this area (Fig.4). Vegetation in 2070's was not perfectly shifted to climax one under the estimated climate conditions. Recover of original vegetation from disturbed or destroyed one may demand 60-80years (Fig.5).



□ Climate Change (Disperse, Moving)

Boreal forest: □+20 years

Others :□+30(50) years

Ex. Others in 2070's 70/(80+30) = 70/110 (changed vegetation !)

Fig.5 Hypothetical scheme of recovering of disturbed or destroyed vegetation.

In addition to recovering time, 20-30 years will be demanded to establish the other new vegetation caused by physical elements as climatic changes. There will be about 100 years to be changed a large part of vegetation to the other vegetation type in a certain area. According to dynamics of vegetation analyzed by collecting data (Table 1) and Fig.5, present vegetation will remained in one third of the area where should be changed to other vegetation types in climax stage, and the areas of Steppe and Woodland a were smaller than those of potential one (climax stage). On the other hand, areas of Woodland b and Evergreen coniferous forest became larger.

3. Biomass and productivity

Total biomass and productivity of this area in present and 2070's were estimated from satellite photographs, reported materials (Cannel 1982, Tamai et al. 2004,2005) and relationship of leaf biomass and relative light intensities measured in many stands of this area (Tamai 1974). Leaf area index in each

Table 1 Succession in Watershed of Cukurova Plain

Elevation	Present	After 30 yrs	After 50 yrs	Climax
0– 50 m	*P.halepensis, P.brutia* with Maquis	*P.brutia :recession*	Maquis	*Quercus infectoria*
		Maquis	*Phryigana*	
		Phryigana	*P.brutia*(re)	
50– 600m	*P.brutia*	*Q.coccifara*	*Q.coccifara*	*Quercus infectoria*
	Q.infectoria	Maquis	Maquis	
	Q.coccifera	*P.brutia*	*P.brutia*(re)	
600– 1000m	*P.brutia* mixed with *Corinus, Sorbus,*	do	do	*P.brutia* mixwd with them (*)
	Fagus, Carpinus, Acer (*)			
1000m–	*P.nigra, Abies cillicica,* *Cedrus libani*	*A.cillicica*	*A.cillicica*	*A.cillicica*
			higher northface: *P.nigra*	
			rocky south or west face:*Juniper*	

vegetation type was also calculated from satellite photographs and biomass estimated in the world (Cannel 1982).

We made two scenarios to estimate biomass in 2070's and future, which were estimated as the same biomass per unit area in each vegetation type as those in present (Case I) and those of 1.5 times as much as present biomass per unit area (Case II).

Case I:

Biomass in present and 2070's were estimated and shown in Fig.6.

Biomass of evergreen coniferous forest in present, most of which was dominated by *Pinus nigra,* was remarkably high though its area was very small, and it depended on higher average biomass per unit area. Biomass value of Woodland a in present was due to relatively high average biomass of this vegetation type in this area. On the contrary, biomass of Woodland b showed lower though its area was the largest among five vegetation types in present here. Biomass of Evergreen coniferous forest in 2070's was remarkably low, compared with that in present and it caused by decrease of the area in the 2070s. Higher biomass of Woodland a and Maquis reflected increase of their distribution areas.

Biomass of total for five vegetation types in 2070's was 45% of that in present. Decrease of the total biomass in 2070's was due to increase of area for Steppe, which was lower biomass per unit area and decrease in area of Evergreen deciduous forest with higher biomass.

Total net production in this area was estimated and show in Fig.6.

Net production patterns among vegetation types look to be almost reflected similar to biomass patterns. However difference in net production of this area among vegetation types became smaller than in biomass. For example biomass of Woodland a in 2070's was about two times of Maquis, but difference of

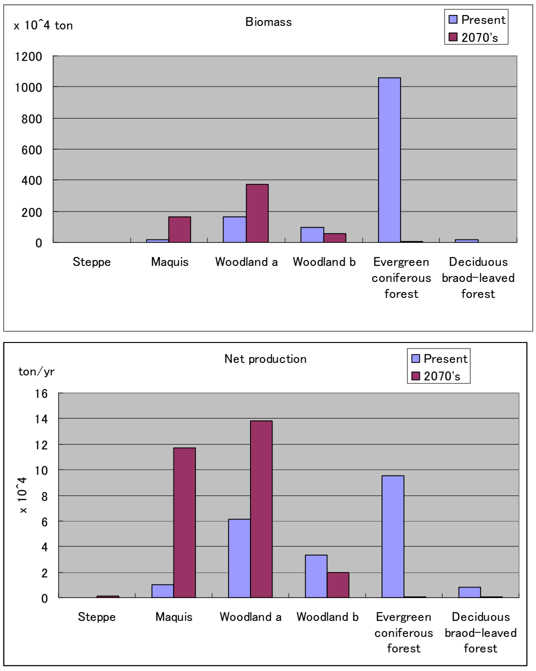


Fig.6 Biomass and net production of each vegetation type in present and 2070's.

the net production was only 1.1 times between them.

Total net production of this area in 2070's was 1.3 times of that in present. Biomass of this area in 2070' decreased while the net production increased, compared with those in present, and so biomass in future may gradually increase in the area investigated.

Net production of Maquis in 2070's increased and was 11 times of that in present. Increase of the production of this vegetation type mostly depended upon an increase of the area (five times) and its productivity.

<u>Case II:</u>

Biomass and net production in 2070' were estimated when net production of each vegetation type except Evergreen coniferous forest increased 50% of that in present. Productivities of species in evergreen coniferous forests where we actually measured in this area were higher and almost same as the productivity in the other place (Cannel 1982), and then we did not increased productivity of Evergreen coniferous forest to estimate its biomass and productivity in Case II (Fig.6).

Proportion of biomass and net production among vegetation types in Case II were scarcely different from that in Case I because of smaller area occupied by Evener green coniferous forest.

Total biomass of and net production of Case II in this area were 67% and 200% of those in present, respectively.

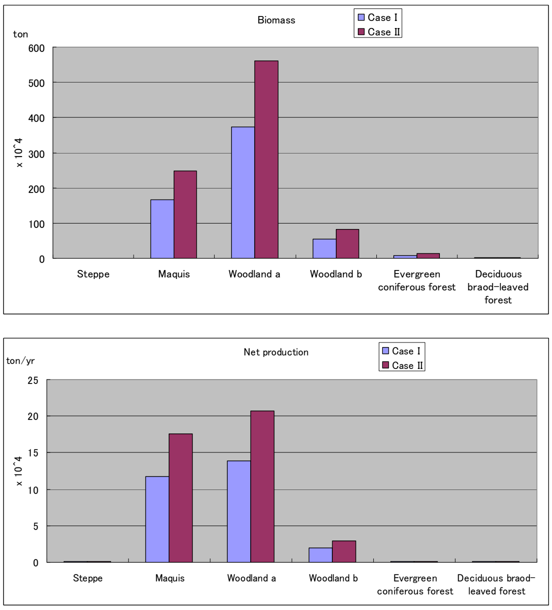


Fig.7 Biomass and net production in Case I and Case II.

4. Conclusion

Practical present vegetation was remarkably changed from potential one by anthropozoic pressure, especially in lower level areas.

Climate changes were not strongly affected on area occupied by each vegetation type in this area except Evergreen coniferous forest. Every vegetation type in future will shift from present area to more northern or higher areas in altitude. The area of Steppe will increase and Evergreen coniferous forest will decrease.

Biomass in this area will decrease, compared with that in present, but net production will increase in 2070's.

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Appendix I

Thornthwaite *p/e* Index (PEI) and Warmth Index (WI) calculated from the
climate data in present and the future (2070's) provided from the Climate Sub-group of ICCAP (Kimura et al.2006).
The definition of each index is as follows;

Thornthwaite *p/e* Index :

$p/e = 0.164\{p/(t+12.2)\}^{1.11}$ PEI= $10\Sigma p/e$

PEI

T10: <16: Perarid

T20: 16-32: Arid

T30: 32-64; Semi-arid

T40: 64-: Humid

(Thornthwaite, 1931, 1948)

Warmth Index (WI):

WI=Σ(t-5) t>5□

W1: 15-45: sub-arctic zone, evergreen coniferous forest

W2: 45-85: cool-temperate zone, broadleaved deciduous forest

W3: 85-180: warm-temperate zone, evergreen forest

(Kira, 1976)

We combined these two indices for classification of potential vegetation.

T10W3 (13): Desert

T20W3 (33): Steppe

T30W2 (32): Woodland a

T30W3 (33): Woodland b

T40W1 (41): Evergreen coniferous forest

T40W2(42): Broadleaved deciduous forest

T40W3 (43): Maquis

Appendix II

Classification of potential vegetation from Thornthwaite Index and WI.