A FACTOR ANALYSIS OF RURAL VILLAGES IN WESTERN SAMOA

by DEPARTMENT OF HUMAN GEOGRAPHY

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I. Introduction

Social scientists have recognized the existence of relationships between the pattern of agricultural land use and environmental and historical cultural factors. Geographers and anthropologists have been particularly concerned with the man - land relationship, which in the past has lead to the notion of complete environmental determinism. The problem in the past has been that an individual researcher has observed that a particular relationship between the environment and choice of a crop exists, but he has been unable to gauge the significance of all factors of the environment upon the crop, or test to see if different variables do truely act upon the crop. The case for cultural or sociological causes has similarly been observed but not measured or tested to any degree approaching thoroughness.

The relationship between environmental and cultural factors as they affect the patterning of land use have been and are still being described by a number of means. The most popular has been the construction of a land use map. The problems accompanying facility to interpret from the land use map on any but a general or extremely specific scale are enormous. The land use map merely shows what the present situation is. It implies no correlations or opposites. Psychologists have shown that the human mind can fairly easily pick out similarities that occur within one or more maps, but the interpretation of the degree of similarity or the presence of opposites is a most difficult task.

In recognition of the problems of determining the degree or even presence of a relationship, social scientists have adopted statistical techniques where numerical data can be obtained. Regression analysis of two or more components has been the most popular technique. The problem is that most of the statistical methods currently in use can not analyze

the entire environmental - agricultural - societal system at one time, weighing the inter-relationships existant among all components. Until recently it was physically impossible, or nearly so, to conduct such an analysis. Today, with the advent of computers, the technique of factor analysis can be applied to determine the man - land relationships.

II The Technique of Analysis

Factor analysis was developed primarily by psychologists in connection with the determination of mental factors from scores on various psychological tests. The primary purpose of factor analysis is to reduce the original number of explanatory variables into a smaller number of independent factors in terms of which the whole set of variables may be understood. Factor analysis thus provides us with a simpler, more compact explanation of the regularities apparent in the empirical results.

Unlike regression analysis, which has one dependent and one or more independent variables, factor analysis makes all variables both independent and then dependent. Factorial analysis is a study of interdependence. Also, factor analysis does not provide explanatory variables that are observeable in magnitudes, but rather forms groupings of the variables into "clusters", known as factors. It should be noted that: 1) Those variables which are most closely intercorrelated are combined within a single factor. 2) The variables allocated to a given factor are those which are most nearly independent of those allocated to other factors. 3) The factors are derived in a manner which maximizes the percentage of the total variance attributable to each successive factor (given the inclusion of the preceding factors). 4) The factors are independent (uncorrelated with eachother).

A major aim of factor analysis is to determine the coefficients relating the observed variables to the common factors. These coefficients, which are referred to as factor loadings, describe the degree to which the

particular factor has been determined by a variable. The social scientist uses the factor loadings to describe the respective factors.

After the factor analysis has been completed, a furthur analysis of the individual cases, villages in this study, is made to determine the degree to which each village is characterized by each factor. The method of determining factor scores is somewhat akin to a regression line, although interdependence rather than dependence is determined.

III The Characteristic's of the SAMOA 7 Model.

As the reader will have surmized, a factor analysis points out interrelationships among various elements within a particular sample population. Unless one used all of the individuals within the population and all concievable variables characteristic to that population, the analysis would have to be called a model. The author has tried to choose data which will construct a model that best describes the varying types of inter-relationships between man and the land in rural villages of Western Samoa.

In 1956 quite a large amount of data on the land use practices of Western Samoa was gathered by Dr. Pirie. A national census in that year gathered extensive information on the characteristics of the population. A detailed Soil and Land Classification Survey was completed by the New Zealand Soil Bureau and published in 1963. All of the information necessary for a factor analysis model of the man - land relationships in a predominantly agricultural society in the humid tropics was available for the first time.

The first model drawn up (SAMOA 1) had 53 variables derived from 17 villages in Western Samoa. The model showed a few very interesting relationships, but there appeared to be too many population variables in the model, which appeared to mask out other significant factors. The next model, SAMOA 2, which deleted several of the redundant pop-

ulation variables, appeared more useful. However, the use of only seventeen villages was felt to be too small, and the choice of villages appeared to be too uniformly tradition - oriented, and thus not a true representation of all types of rural villages in Western Samoa. In the rest of the factor analysis models 48 villages were sampled. The data was gathered in a more uniform manner than was the case in the earlier factor analyses, and the units used to represent the data were chosen in a way to give the variable a proper weighting. For example, the variable "Distance to Apia" (the point of export and main town to Western Samoa) was given as bus and boat fare value rather than a linear distance value.

After the author had analyzed the new model with 35 variables and 48 villages (SAMOA 4), it was evident that there still existed several population variables that were closely related to two principle variables. It was found that the basic structure of the factor analysis model remained unchanged when only 29 variables were used for each of the 48 villages, and that the change in factor loadings on all of the factors made naming of the factors a more definite process. The clearest analyses of the man - land relationship using exact measurements for each village was found in this model, SAMOA 5.

A close analysis of the factors and factor loadings of SAMOA 5 showed that there was an emphasis upon the population size for each variable throughout the analysis. More specifically, the use of whole number values for each village component in a variable caused a high standard deviation of values among the variables. The high standard deviation appeared to affect the whole structure of the factor analysis in such a way that a large village versus small villages relationships appeared in nearly every factor. To remidy this, most of the variables were set as ratios to a few key variables. Variables describing population char-

acteristics were all expressed as ratios of the total village population, variables describing crop and land class type acreages were all expressed as ratios of the total village crop acreage, and dry and wet seasonal rainfall amounts were expressed as ratios of the total annual rainfall. The result of having the majority of the variables ratios was to lower the standard deviations of the variables, and thus put all of the villages on a comparable status. The retaining of a few key variables in the unit form assured that the important fact of village size would not be ignored, but rather placed in the proper perspective. The SAMOA 7 model has a large number of factors, and percent of variation accounted for by any one factor is not exceedingly high. This is in contrast to most of the results of factor analyses, but in our case it proves quite helpful. The large number of factors appears to show that several different "elements" exist in Western Samoan society.

IV The Variables

The first nine variables describe characteristics of the population. Variable 1. Total Village Population, is one of the primary variables, showing the major size differences existant within the villages of Samoa. Variable 2. Ratio of Matai: Total Population describes the degree to which a village is governed in the traditional manner. The matai is the head of the Samoan extended family group. Variables 3, 4, and 7, Ratio of Part Samoans: Total Population, Ratio of Persons of European Status; Total Population, and Ratio of Paid Employment: Total Population, show the degree to which a village has a landless component. Under Samoan law, only pure Samoans are allowed to use the village land. These variables would, therefore show the proportion of the population in a village forced to seek wage employment for a living. Variable 5 , Ratio of Children not in school: Total Population points out an element of poor administrative standards within a village. Variable 6, Ratio of Males 15-50 in Customary

Agriculture: Total Population, is an important variable which describes the degree to which a village is able to produce food. Variable 7, Ratio of Males 20-24: Total Population, is a variable that should describe a village's prime "man power pool". Variable 9, Ratio of People working inApia: Total Population, is in important variable which helps point out the "field effect" of Apia, the main town.

The rainfall variables 10, 11, and 12, are important environment variables. They help differenciate between windward and leeward slopes and show areas that have a definite maximum wet season or have a relatively even rainfall distribution throughout the year.

Variable 13, Number of cases per Head per Year of Bananas Exported is an important factor that points out the degree to which a village has a surplus of this primary subsistance crop. Similar values for copra exports should have been included in the factor analysis, but unfortun ately were unavailable. Virtually all cacao is exported, so that a correlation between crop acreage and exports probably exists, however the element of productivity per acre is, unfortunately, lacking.

Variables 14, 15, 18, 19, 20, 21 and 29, all describe the agriculture of the villages. Variable 14, Total crop Acreage is a principal variable which shows the difference in village sizes. Variable 15, Ratio of Cropland: Village Population, gives some notion of the land pressure existant within the villages. Variables 18, Ratio of Cocomut acreage, 19, Ratio of Cacao acreage, 20, Ratio of Banana acreage, and 21, Ratio of Taro acreage, all describe the major types of crops grown in the villages. Variable 29, coefficient of Intercultivation is a variable which measures the degree to which an area is grown in two or more crops.[1]

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1. For a detailed explanation see B. J. Farrell's discussion on p. 187, Fox and Cumberland, Western Samoa.

Variables 22 through 28 refer to the principle land classes described by A. C. S. Wright in the soil survey of Western Samoa. Class I land is a river bottom land, frequently supplied with fresh silt deposits. Class II land is very dry soil, somewhat comparable to the low humic latosols of the Hawaiian Islands. Class III land is a soil group, a little moister than the Class II land, but occurring on the leeward side of the island of Upolu. This class of land is also marked by soils of lower natural fertility than Class II soils. Class IV a,land is usually located on windward slopes of the islands. It is a fertile humic latosol. Class IV b and c Land is also a humic latosol, but of a much lower productive capacity, primarily due to shallowness of the soil. Class V land encompasses very humid soils in the upland regions, and corresponds to the hydrol humic latosols of the Hawaiian Island. Class X land includes all steeplands; that is, all lands having a slope greater than 30 degrees.

V The Factors

Factor I

Here is a factor emphasizing small rural villages with high rainfalls evenly distributed throughout the year. There is a very favorable cropland/capita ratio, and a tendency to have a large percentage of the cropland in taro and small proportions of cocao. In addition, there are few people working inApia or of the part samoan status - the most likely wage workers. The soil emphasis is upon wetland and upland soils - excellent for taro and bananas.

The antithesis would point out large villages with a relatively large percentage of the people working in Apia. There is definitely a population pressure on the land, and a preference for growing cacao in these drier areas.

The factor scores point up this factor quite well.

Factor II

Here we find an emphasis upon traditional rural Samoan villages,

little influenced by Apia and cash wage earning in general.

The antithesis would point out villages that were affected strongly by the centripedal influence of Apia. These villages would be essentially no longer of the traditional structure.

Scores concur with the thesis, but less well with the antithesis.

Factor III

Here we find definitely small villages, with fairly low land/capita ratios. Many of these villages would appear to have a high percentage of their land under coconuts, but this is not so important as when one considers that high coconut acreages are characteristic for all villages.

The antithesis would point out quite large villages with quite favorable cropland/capita ratios.

The factor scores point the above mentioned relationships quite well.

Factor IV

The all important element here is that the villages have a high degree of inter-cultivation of large amounts of their land in cocoa and bananas, whereas little land in coconuts and root crops. Other variables which show positive emphasis upon banana exports and % of matai and vegative emphasis upon percentage of males in customary agriculture appear to be carried along by the stronger loadings.

Factor scores show a very interesting pattern, which appears very dependent upon a high coefficient of intercultivation value for villages having high scores.

Factor V

The distance to Apia factor, and high annual rainfall associated with mesophytic plus humic soils appear to be the most overriding elements for this factor. Villages with high positive loadings seem to be fairly large, have high proportions of the children not in school, high banana production for export, and either a large proportion of the workers in Apia or engaged in agriculture, or both.

The antithesis would show villages far from Apia, with low annual rainfall, and a high proportion of rainfall during the wet season. In additoin, cropping emohasis would not be on bananas in most villages. Also, the villages on the whole, would have good educational facilities.

Scores come out well

Factor VI

Here we would have villages with low annual rainfall , much of their rain coming in the rainy season. Because of the dryness, there would be little banana cash cropping or taro growing. The villages appear to have a fairly large proportion of children not in school.

The antithesis would point out areas with high rainfalls and river bottoms in agriculture. High banana production for export and taro for subsistence would appear to be predominant features of the agriculture.

Factor scores show the above mentioned relationship quite well.

Factor VII

The antithesis would point out villages with relatively large portions of their croplands cropped in Cacoa, bananas and taro, and little in coconuts. In addition a high percentage of children would not be in school.

The thesis would show villages with a high proportion of their acreage in coconuts, and wetlands of poorer fertility (Class IV b &c).

Factor scores are a bit confusing on this one, although they do point out the points made above.

Factor VIII

Here we find villages with slightly below normal annual rainfall, but with a good proportion of rainfall during the wet season. The villages may have a high proportion of the males working as farmers, and grow-

ing a large part of their land in cocao.

The antithesis points out traditional villages with moderately good rainfall and a large proportion of steepland soils being cropped.

The factor scoes are not as clean cut as they were in other runs, but the influence of steepland soils remains.

Factor IX

Here we have large villages with a large proportion of males, age 20-24 engaged in either agriculture or wage work in Apia. The villages may have poor man/land ratios and appear to have a low proportion of traditional matai administration and a high proportion of children not in school.

Scores point out the above assumptions nicely.

VI The Villages

The factor scores for each of the villages enables the reader to pick out villages that are most affected by a particular factor. We can say, for instance, that Amaile appears particularly affected in a positive manner by factor I and that Nofoalii appears affected in a negative manner. This allows us to say that Amaile is a small rural village on the windward coast with a subsistence agriculture system, whereas Nofoalii is a large village on the leeward coast with a deemphasis upon growth of subsistence root crops. We can interpret the factor scores for each village on every factor, and thus arrive at some idea of how the village has been characterized by the entire factor analysis. However, a better interpretation of the way in which a village has been characterized by the factor analysis model would be to multifoly the factor loadings of each variable in a factor by the factor score for each village. The sum of all the products for each variable would enable one to characterize each village in the factor analysis model. It should be pointed out that this is useful merely as an interpretive tool and represents no statistical relationship. Table II shows a preliminary analysis of thirteen

villages using the technique described above.

VII Conclusions

The factors derived from the factor analysis have given some quantitative insights into the nature of the relationships between social characteristics, environmental factors, and agricultural practices. The mapping of th factor scores has given us some insight into the spatial distribution of the major characteristics pointed out by the model. However, there is room for improvement in both the choice of variables andth manner in which the variables were measured. The author plans to improve upon the factor analysis model and bring it up to date (use 1966 date) when he is in Western Samoa this year. Study in the field should prove whether or not the factors described do, in fact, exist.

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	FACTORS								
	I 23.9%*	II 15.6%	III 14.2%	IV 10.9%	V 9.6%	VI 7.3%	VII 6.5%	VIII 6.3%	IX 5.9%
village Population	-.41		-.63		+.23				+.47
, Matai: Population		+.21		+.33				-.47	-.43
Part Samoans: Pop.	-.20	-.83							
, European Status: Pop.		-.79			+.30			+.21	
, Children not in school: Population					+.55	+.29	-.41		+.31
, Males in Customary Agr.: Population		+.57		-.24	+.22			+.25	+.43
, Paid Employment: Pop.		-.85	-.22		-.27				
, Males 20-24: Pop.									+.83
, Apia Workers: Pop.	-.32	-.70			+.22				+.25
, Dry: Total Rainfall	+.83							+.33	
, Wet; Total Rainfall	-.48	-.37			-.51	+.22			
Annual Rainfall	+.72				+.38	-.39		+.24	
f Cases/Head/Year: Bananas				+.22	+.46	+.64			
Crop Acreage			-.91						
, Cropland: Village Pop.	+.70		-.28						-.41
Dist. Cropland to Village			-.86				-.22		-.24
nd/or Boat fare to Apia		+.20			-.91				
, Coconut; Total Acreage			+.29	+.30			+.59		
, Cacao; Total Acreage	-.42			+.63			-.28	+.39	
, Banana; Ttoal Acreage				+.81	+.21		-.29		
, Taro: Ttoal Acreage	+.32			-.40		-.62	-.22		
, Class I: Total Acreage						-.75	+.22		
, Class II: Total Acreage					-.83		-.39		
, Class III: Total Acreage	-.60	-.33			+.33	+.37			-.25
, Class IVa: Total Acreage	+.68				+.31		-.24		
, Class V: Total Acreage	+.70					+.35	+.24		
, Class V: Total Acreage								-.89	
, Class IVb&c: Total Acreage		+.28	-.24				+.69	+.27	+.23
ficient of Intercultivation				+.82					

* percent variation account for by the factor

Variables	FACTORS								
	I 23.9%*	II 15.6%	III 14.2%	IV 10.9%	V 9.6%	VI 7.3%	VII 6.5%	VIII 6.3%	IX 5.9%
1. Total village Population	-.41		-.63		+.23				+.47
2. Ratio, Matai: Population		+.21		+.33				-.47	-.43
3. Ratio, Part Samoans: Pop.	-.20	-.83							
4. Ratio, European Status: Pop.		-.79			+.30			+.21	
5. Ratio, Children not in school: Population					+.55	+.[illegible]	-.44		+.31
6. Ratio, Males in Customary Agr.: Population		+.57		-.24	+.22			+.25	+.43
7. Ratio, Paid Employment: Pop.		-.85	-.22		-.27				
8. Ratio, Males 20-24: Pop.									+.83
9. Ratio, Apia Workers: Pop.	-.32	-.70			+.22				+.25
10. Ratio, Dry: Total Rainfall	+.63							+.33	
11. Ratio, Wet; Total Rainfall	-.48	-.37			-.51	+.22			
12. Mean Annual Rainfall	+.72				+.38	-.39		+.24	
13. No. of Cases/Head/Year Bananas				+.22	+.46	+.64			
14. Total Crop Acreage			-.91						
15. Ratio, Cropland: Village Pop.	+.70		-.28						-.41
16. Max. Dist. Cropland to Village			-.66				-.22		-.24
17. Bus and/or Boat fare to Apia		+.20			-.91				
18. Ratio, Coconut; Total Acreage			+.29	+.30			+.59		
19. Ratio, Cacao; Total Acreage	-.42			+.63			-.28	+.39	
20. Ratio, Banana; Ttoal Acreage				+.81	+.21		-.29		
21. Ratio, Taro: Ttoal Acreage	+.32			-.40		-.62	-.22		
22. Ratio, Class I: Total Acreage						-.75	+.22		
23. Ratio, Class II: Total Acreage					-.83		-.39		
24. Ratio, Class III:Total Acreage	-.60	-.33			+.33	+.37			-.25
25. Ratio, Class IVa:Total Acreage	+.68				+.31		-.24		
26. Ratio, Class V: Total Acreage	+.70					+.35	+.24		
27. Ratio, Class V: Total Acreage								-.89	
28. Ratio, Class IVb&c: Total Acreage		+.28	-.24				+.69	+.27	+.23
29. Coefficient of Intercultivation				+.82					

TABLE II

Variables	Asaga	Falealupo	Sllailus &Siuta	Taga
1. Total village Population	-29.7		+34.9	
2. Ratio, Matai: Population	+32.9		-24.0	
3. Ratio, Part Samoans: Pop.			-26.2	-28.8
4. Ratio, European Status: Pop.		-21.1	-20.6	-36.9
5. Ratio, Children not in school:Pop.	-29.6	-38.8		-29.0
6. Ratio, Males in Customary Agr.:Pop.	-34.4	-15.5	+41.2	+13.6
7. Ratio, Paid Employment: Pop.		+19.0	-21.9	-21.9
8. Ratio, Males 20-24: Pop.	-42.2		+36.9	
9. Ratio, Apia Workers: Pop.	-18.2		-11.2	-30.5
10. Ratio, Dry: Total Rainfall		-26.0		
11. Ratio, Wet; Total Rainfall	+12.9	+50.7	-11.7	
12. Mean Annual Rainfall		-49.3		-10.8
13. No. of Cases/Head/Year		-32.5		-13.0
14. Total Crop Acreage			+20.7	
15. Ratio, Cropland:Village Pop.	+20.8	-21.9	-11.7	
16. Max. Dist. Cropland to Village	+12.2			
17. Bus and/or Boat fare to Apia	+22.9	+64.2		+32.7
18. Ratio, Coconut; Total Acreage	-10.1		+19.9	+19.2
19. Ratio, Cacao; Total Acreage	+21.2	+13.1		
20. Ratio, Banana: Total Acreage	+21.9	-14.8		-15.4
21. Ratio, Taro: Total Acreage	-13.4	-10.0		
22. Ratio, Class I: Total Acreage				
23. Ratio, Class II:Total Acreage	+20.9	+58.6		+10.8
24. Ratio, Class III: Total Acreage			-21.3	-20.8
25. Ratio, Class IVa: Total Acreage		-42.9		-16.6
26. Ratio, Class V: Total Acreage		-21.9		
27. Ratio, Class X: Total Acreage			-18.8	
28. Ratio, Class IV b & c: Total Acreage	-11.7		+45.6	+32.2
29. Coefficient of Intercultivation	+27.2			

TABLE II cont.

aile	Fusi	Lotofaga	Nofoalii	Saanapu	Samatau	Savaia	Tiavea	Leauvaa
		-11.3	+59.6		+16.2			+73.4
	+23.3		-15.1			+10.9		+17.7
0.4		-26.6	+37.6				-34.8	+36.2
0.9			+29.9				-20.2	+29.2
		+12.8	+25.4			+16.1	+12.7	+51.7
7.6	-14.0	+17.0					+30.7	-11.4
7.2		-24.0	+27.3				-35.4	-23.8
			+16.9					+21.4
9.5		-22.7	+50.1		+12.6		-28.5	+57.1
1.4	-10.6	+34.1	-50.6		-32.8		+25.0	-68.4
2.3		-38.8	+35.7		+22.8	-14.9	-38.6	+35.6
7.2		+38.4	-47.0		-36.0	+11.1	+30.5	-55.0
		+10.7			-12.6	+20.7		+48.9
5.4			+29.5					+27.3
4.0		+28.8	-42.4		-27.7		+21.1	-60.2
8.4			+16.5					+22.1
		-16.9	-24.4			-26.6	-14.1	-33.9
				+11.8				-53.3
9.9		-17.3	+25.6		+16.6	+20.9	-38.4	+90.3
8.0	+20.3					+32.9	-15.4	+102.4
1.0	-10.0	+13.2	-36.7		-25.0	-13.2	+19.6	-72.0
			-20.8		-14.8			-27.3
		-19.3	-16.8			-24.2	-19.2	-15.8
5.2		-23.4	+57.7		+30.5		-21.5	+71.2
5.3		+34.7	-34.7		-26.5		+27.4	-34.4
6.5		+28.8	-33.0		-20.7		+21.1	-58.2
	+28.5							
7.6				+13.8				-20.7
8.2	+21.6					+27.1	-20.3	+58.6

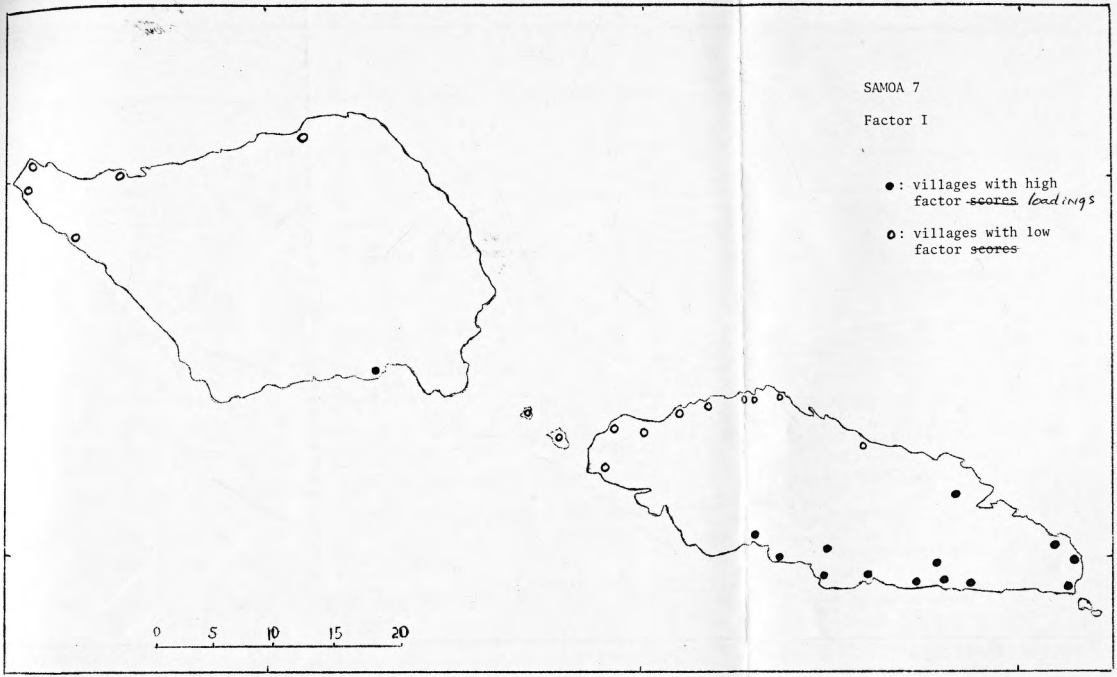
Villages Used in the SAMOA 7
Factor Analysis

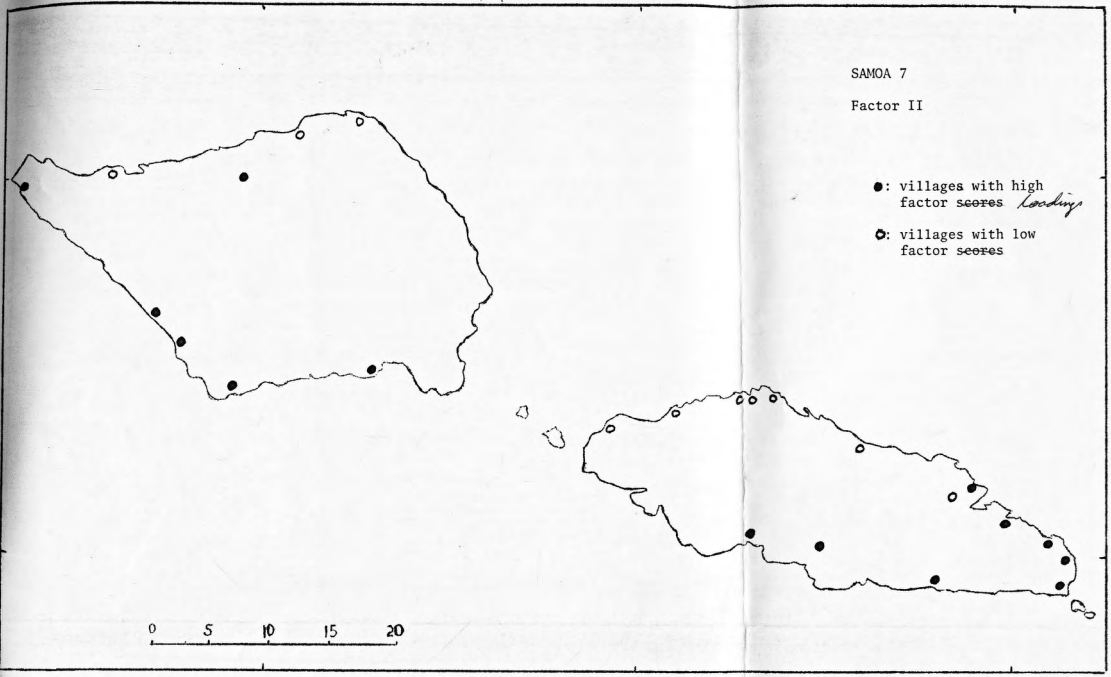
Savaii:

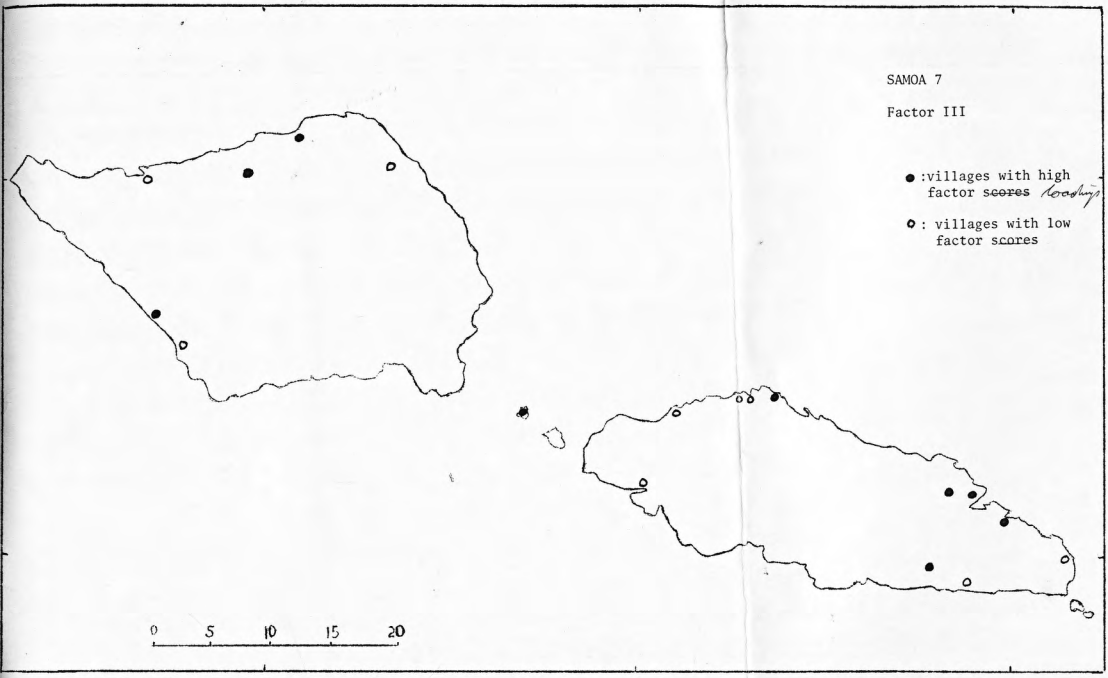
Asau
Asau
Aopo
Falealupo
Falelima
Matavai
Safotulafai
Salailua & Siutu
Samaleulu & Patamea
Satoalepai
Satufia
Taga
Tufutafoe
Vaipúa
Vaisala

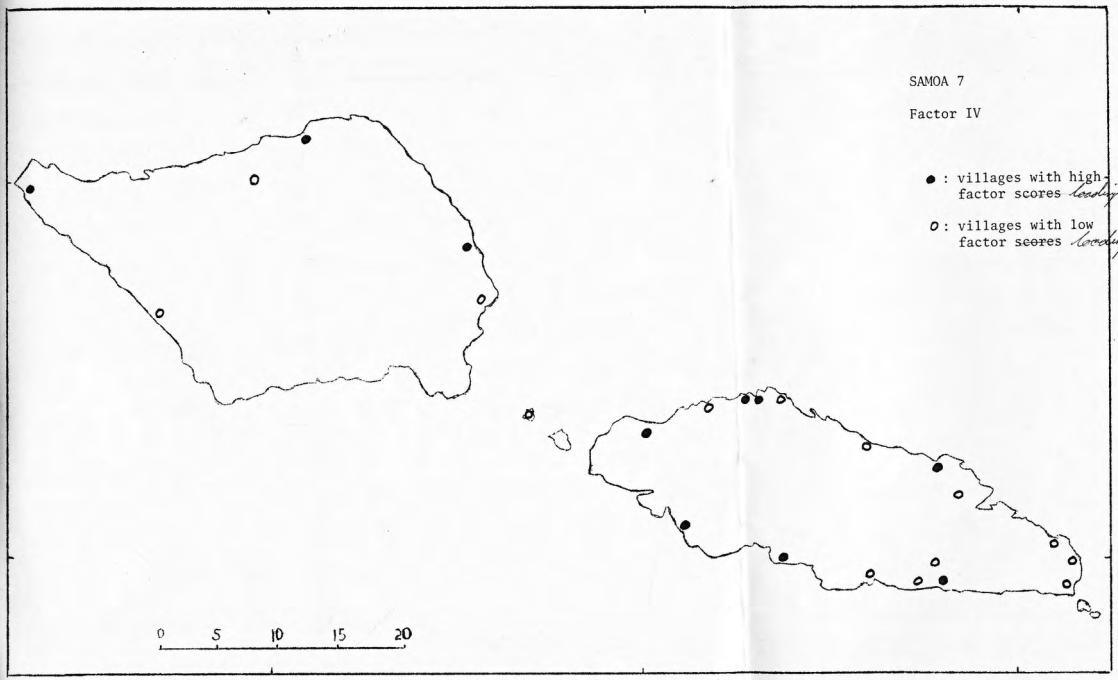
Upolu:

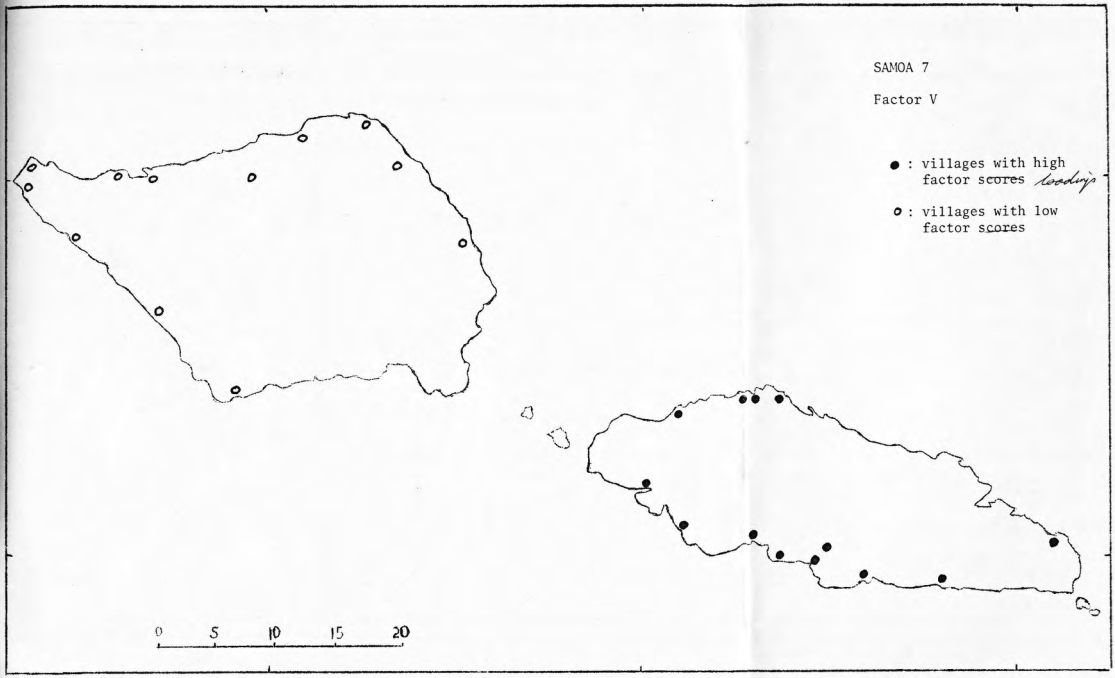
Amaile
Apolima
Fausaga
Falevao
Fusi
Laulii
Leauvaa
Levi & Lotosoa
Lotofaga
Lotofagā
Matautu
Mulifanua
Monono
Nofoalii
Poutasi
Puipaa
Saaga
Saanapu
Salamumu
Salani
Salimu
Samatau
Satalo
Satapuala
Sauago & Saletele
Savaia
Siumu
Siumiu
Solosolo
Tiavea
Tufulele
Uafato
Vailoa

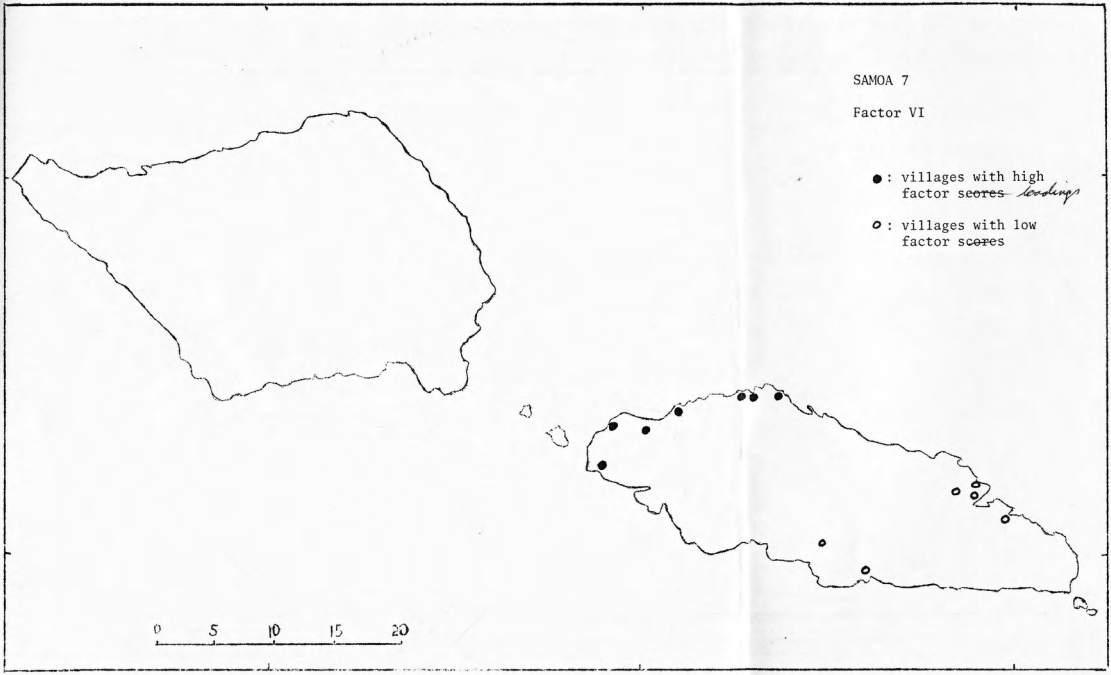

SAMOA 7
Factor I
●: villages with high factor ~~scores~~ loadings
o: villages with low factor ~~scores~~
0 5 10 15 20

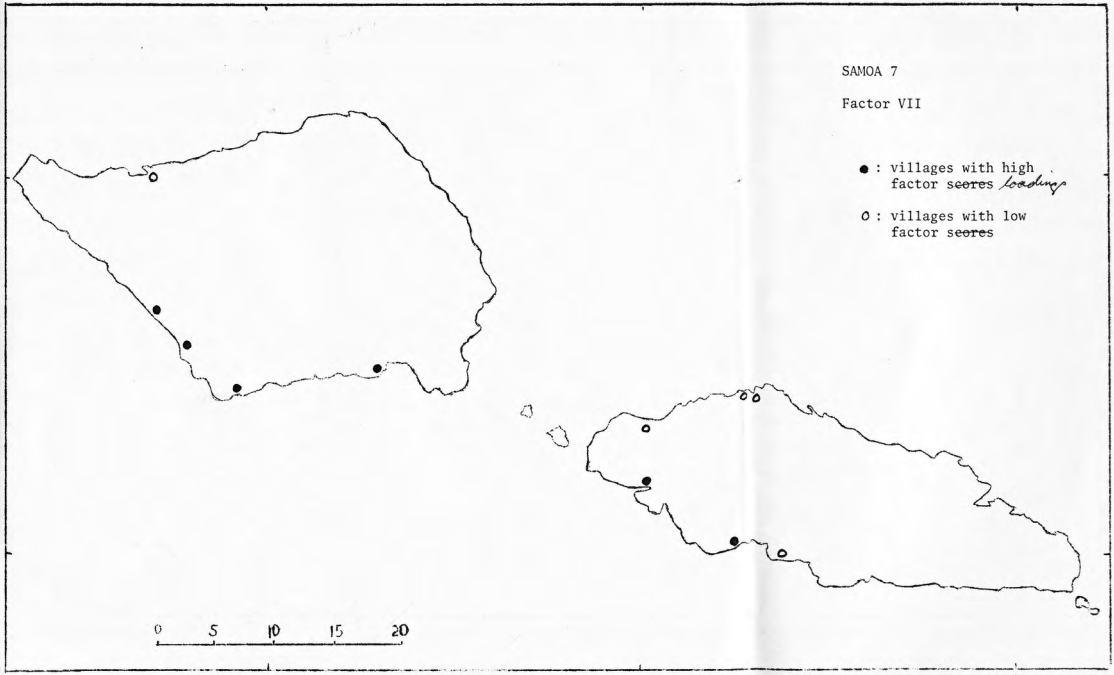

SAMOA 7
Factor II
●: villages with high factor ~~scores~~ loadings
○: villages with low factor ~~scores~~
0 5 10 15 20

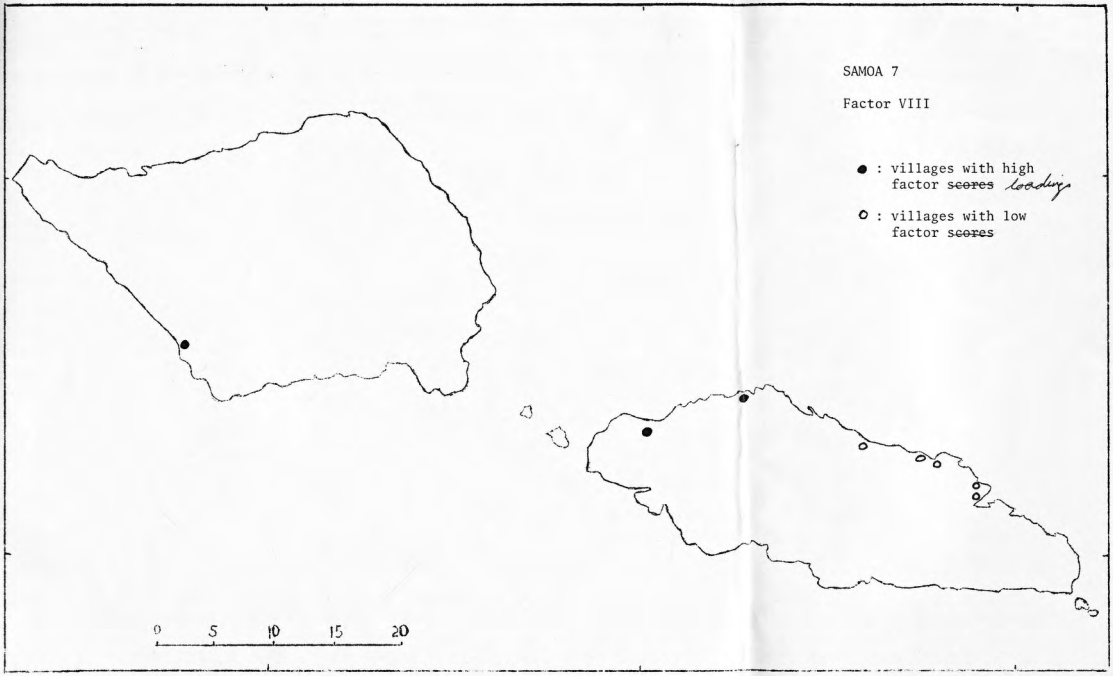

SAMOA 7
Factor III
● :villages with high factor scores loadings
o : villages with low factor scores
0 5 10 15 20

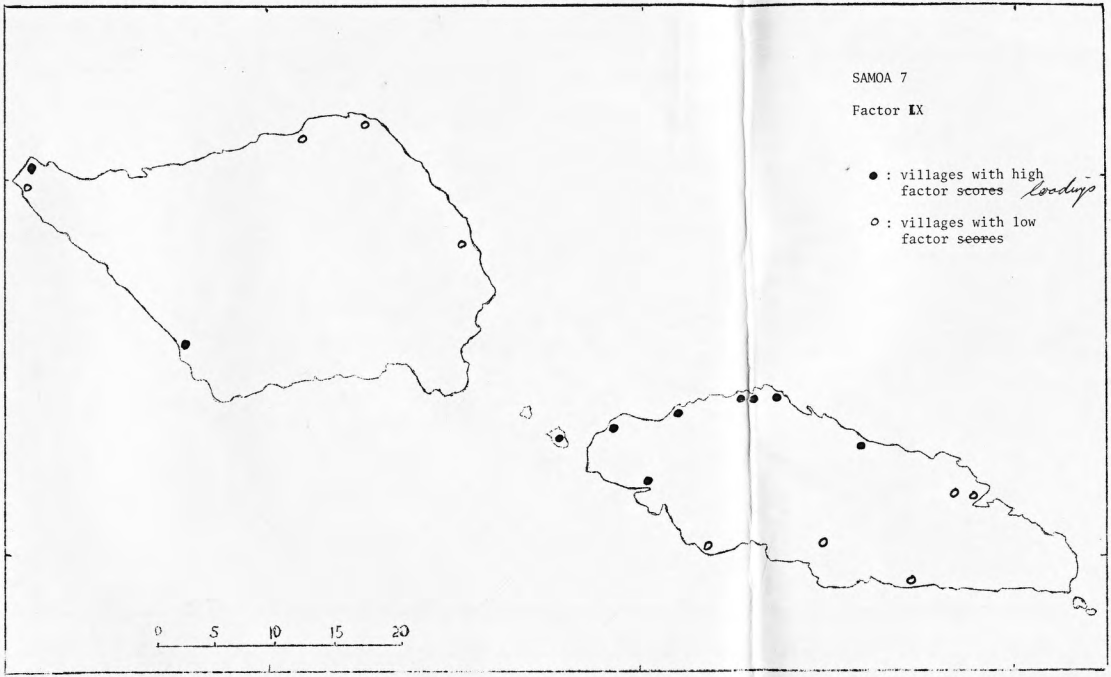

SAMOA 7
Factor IV
● : villages with high factor scores loadings
o : villages with low factor scores loadings
0 5 10 15 20


SAMOA 7
Factor V
● : villages with high factor scores loading
o : villages with low factor scores
0 5 10 15 20


SAMOA 7
Factor VI
●: villages with high factor scores loadings
o: villages with low factor scores
0 5 10 15 20


SAMOA 7
Factor VII
● : villages with high factor scores loadings
O : villages with low factor scores
0 5 10 15 20


SAMOA 7
Factor VIII
● : villages with high factor ~~scores~~ loadings
o : villages with low factor ~~scores~~
0 5 10 15 20


SAMOA 7
Factor IX
● : villages with high factor scores loadings
o : villages with low factor scores
0 5 10 15 20