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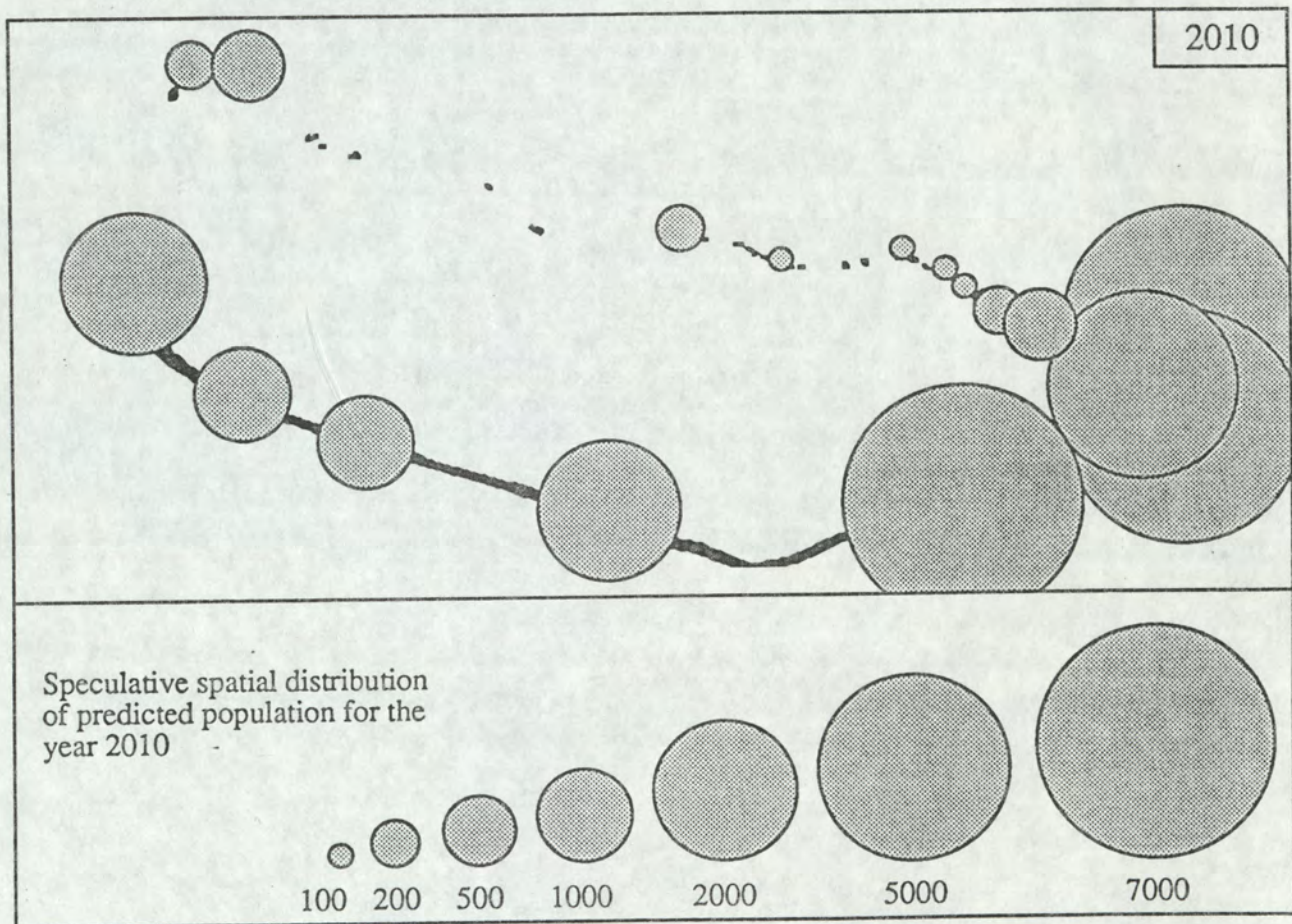
# PREDICTIVE MODEL OF THE EXPANSION OF THE INHABITED AREA ON MAJURO ATOLL UNTIL THE YEAR 2010 AND ITS IMPLICATIONS FOR HISTORIC PRESERVATION

by

*Dirk H.R. Spennemann*

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MAJURO, MAY 1990

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Report OTIA-TAG-MAR-42-10/90.

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INTRODUCTION

An increasing population requires an increasing amount of land area for habitation and for the disposal of the dead. Thus hitherto open land becomes increasingly converted to urban or suburban land. Such processes need to be kept in mind for any sensible management of the cultural and archaeological resources of a given area. This issue is of cardinal importance for the Cultural Resource Management on small atolls, where due to the limited land area available not only the modern habitation expansion occurs within strong spatial confines, but where also the prehistoric and early historic resources themselves have been spatially confined. The choice of the *prime* settlement locations is basically governed by environmental considerations (such as wind, wave action, protection from storms etc.), which have changed only little — if at all — since the beginning of human habitation in the Marshall Islands some 2500 years ago. Thus past and present settlement locations overlap, and, therefore, Historic Preservation Planning needs to have some understanding of future housing and settlement needs.

OBJECTIVES

The past decades have shown a dramatic increase of population on Majuro Atoll, and various scenarios on the future increase of the population have been presented (OPS 1989; Elderkamp 1990a). From the perspective of historic preservation, an increasing population will i) gradually infringe onto those areas as yet unsettled and ii) intensify in those areas already settled. In both cases increased destruction of archaeological and historical resources can be foreseen.

The present short report attempts to provide some projections to understand the extent of the land area of Majuro Atoll required for the future demand on land for

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¶ This report is to be quoted as: Dirk H.R.Spennemann, 1990, *Predictive model of the expansion of the inhabited area on Majuro Atoll, Republic of the Marshall Islands*. Report prepared for the Historic Preservation Office, Majuro, Republic of the Marshall Islands. Report OTIA-TAG-MAR-42-10/90.

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housing. The current projections shall only be carried out until for the next two decades, that is until the year 2010. The projections on the extent of future requirements on burial space have been presented in a separate report (Spennemann 1990a).

Because the analysis presented here is based on several assumptions, which will be discussed below, the results of the analysis will be fairly coarse-grained. This, also, is the intention of the present prediction. For preservation purposes, accurate predictions, were they even possible, are not necessary, as long as the magnitude and relative speed of the future development and the spatial distribution can be outlined.

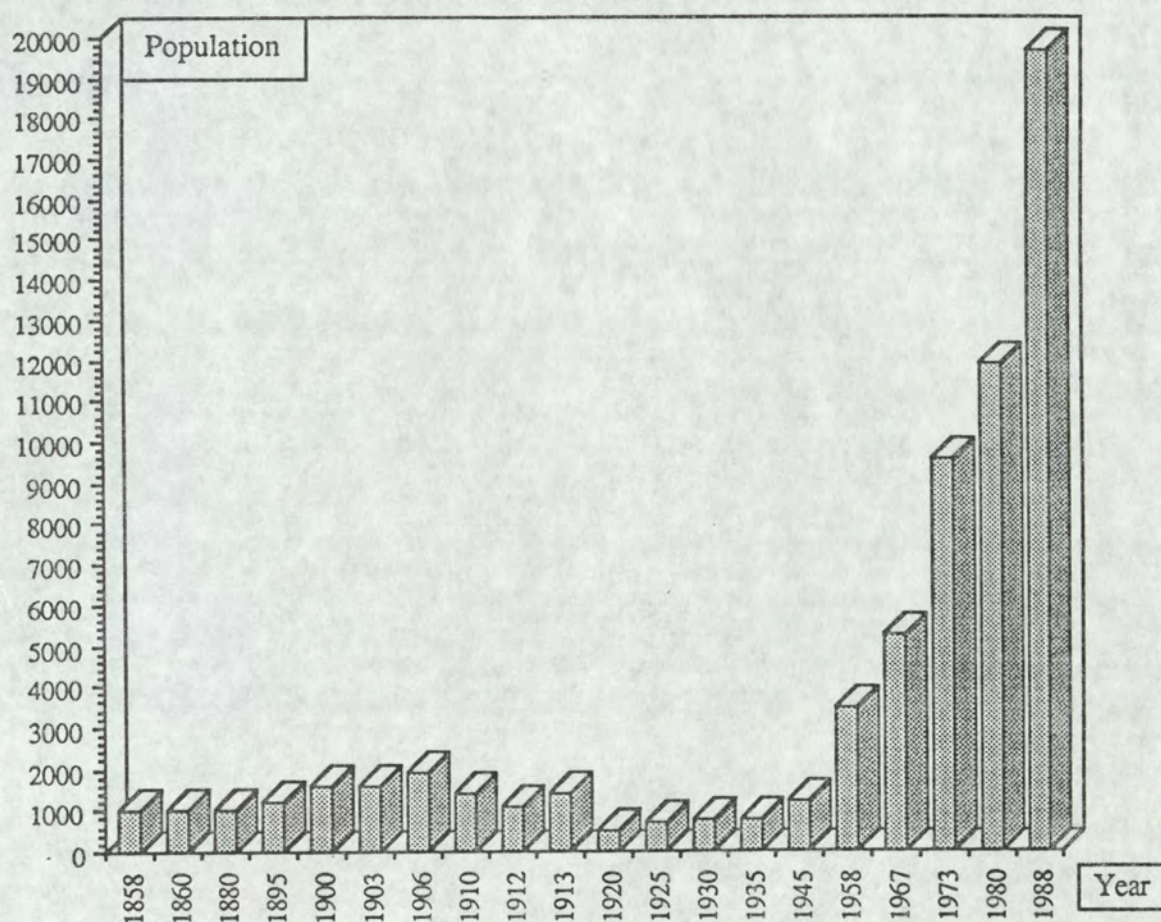


Figure 1 Overall growth of population of Majuro Atoll, 1858 to 1988.

### POPULATION

It has become a well recognised factor that the population of Majuro has risen substantially over the past 40 years (figure 1): while the total population of Majuro was as little as 1,237 persons in 1945, the population rose to 3,415 people in 1958, 5,250 people in 1967, 9,536 people on 1973, 11,893 people in 1980 and even 19,664 people in

SPENNEMANN, PREDICTIVE MODEL OF EXPANSION OF INHABITED AREA ON MAJURO ATOLL

1988 (see compilation in Spennemann 1990b). Apart from a simple population increase due to biological population dynamics such as an ever larger base population, increased fertility, reduced infant mortality and extended life expectancy, inward migration to Majuro has been a contributive factor.

Table 1: Projections of population of the Marshall Islands, of Majuro Atoll, and of the number of households per year from the year 1989 to the year 2010. Abbreviations: pphh = persons per household

Year	Projected population		Predicted N <sup>o</sup> of Households		
	RMI	Majuro	8.8 pphh	7.5 pphh	9.5 pphh
1989	44407	20453	2324	2727	2153
1990	46188	21274	2418	2837	2239
1991	48041	22127	2515	2950	2329
1992	49969	23015	2615	3069	2423
1993	51977	23940	2721	3192	2520
1994	54069	24904	2830	3321	2621
1995	56216	25893	2942	3452	2726
1996	58499	26944	3062	3593	2836
1997	60851	28027	3185	3737	2950
1998	63301	29156	3313	3888	3069
1999	65844	30327	3446	4044	3192
2000	68415	31511	3581	4202	3317
2001	71341	32859	3734	4381	3459
2002	74267	34207	3887	4561	3601
2003	77193	35555	4040	4741	3743
2004	80119	36902	4194	4920	3884
2005	83829	38611	4388	5148	4064
2006	87516	40309	4581	5375	4243
2007	91203	42008	4774	5601	4422
2008	94890	43706	4967	5828	4601
2009	98577	45404	5160	6054	4779
2010	102837	47366	5383	6316	4986

The *census of population and housing 1988* (OPS 1989) contains projections for the development of the Marshall Islands population. The following approximation is based on the figures supplied for the total population as well as for the crude death rate.

Since the projections were initially run for the total of the Marshalls population, some adjustment was needed to cater for the needs of the present analysis. It is therefore assumed that the proportion of the population of Majuro Atoll in relation to the population of the Marshall Islands as a whole will remain stable at the 1988 rate of 1 : 2.17 or 46.06% of the total population.

This assumption, however, does not hold true because of inward migration to Majuro from the outer islands. Although apparently fairly limited compared to the overall biological population increase, the scale of this inward migration, which can be seen from the Census (OPS 1989: 222 Table 61), cannot be overlooked. Therefore, any assumption of a stable proportion will produce a conservative estimate which is in the interest of this study so as to avoid excessive statements which cannot be upheld.

#### NUMBER OF PERSONS PER HOUSEHOLD

In the historical perspective, the Japanese census of 1938 (30 June) counted 1,758 Marshallese households<sup>1</sup>, which translates on a nationwide basis to a density of 5.71 persons per household. For comparison, the nationwide density was 8.4 in 1973, 8.0 in 1980 and 8.8 persons per household in 1988 (MISA 1988:28;127). The household density seems to have increased after World War II, a rise which corresponds well with an increase in the number of children and the reduction of the average age of the population.<sup>2</sup>

Using demographic data derived from various census observations the number of persons per household (pphh) can be calculated. In the demographic history available for this study, the following figures can be found for Majuro Atoll (table 2).

Table 2 Average number of persons per household in the Marshall Islands and on Majuro Atoll.

Year	persons per household		Source
	Marshalls	Majuro	
Census 1930		4.2	Ryenkevich 1981
Census 1938	5.7		MISA 1988
Census 1958	6.8		Nucker 1959
Census 1973	8.1	8.4	Johnston 1973
Census 1977	8.6	9.1	OPS 1980
Census 1980	8.0	7.8	MISA 1988
Census 1989	8.8	8.6	OPS 1990

As can be seen, the number of persons per household is gradually increasing, indicative of the increased number of children.

<sup>1</sup> Plus 199 Japanese households and 4 foreign (i.e. Western) households. Based on some pages of a World War II document held at Alele Museum, giving details on the Marshall Islands, based on information culled from Japanese Government publications and people who had been there during the Japanese period (OPNAV 1944).

<sup>2</sup> A corollary to this observation is the fact that the ratio adults (>14) versus children (≤14 years) has dramatically shifted towards the children from 82.8:17.2 in 1903, and 77.0:23.0 in 1930 to 53.1:46.8 in 1988 (Majuro Data compiled in Spennemann 1990b).

As will be addressed in more detail below, the population density of Majuro Atoll is not even through the atoll (table 4). In centres of high population concentration, such as Djarrit or Delap, the number of persons per household is higher than the atoll- or the nation-wide average, being 9.2 and 9.3 pphh respectively for Djarrit and Delap. On Ebeye, where the population concentration is even higher, the average number of persons per household was 10.2 in 1980 and 9.8 in 1988. (Elderkamp 1990a).

#### CALCULATING THE NUMBER OF HOUSEHOLDS

The question arising is whether the trend towards a greater number of persons per household will continue, or whether, possibly with increased population control measures and increased financial power, the number will actually decrease — a trend which is observable throughout the Pacific region. Given that at present there is a very large number of children under the age of 15, it can be anticipated that: (i) the number of households will increase steadily; (ii) that for the next five to ten years there may be a tendency of increased concentration, the number of persons per household rising to 9.5 or even 10.5; and (iii) thereafter a disproportional relaxation of that concentration may take place, corresponding with an increase of households.

Since the predictions calculated here are only destined to provide at a figure on the order of magnitude of the problem, a linear progression is assumed, using the present nationwide rate of 8.8 pphh as the baseline. However, in order to cater for the two other possibilities, reduction and increase in number of persons per household, the predictions were also run at a lower (7.5 pphh) and at a higher rate (9.5 pphh).

#### CALCULATING THE LIVING SPACE OF ONE HOUSEHOLD

For the calculation of the living space taken up by one household, it proved highly impractical to measure a statistically relevant number, such as 50 or 70 households. However, rather than taking an arbitrary figure, such as ten households per acre (0.404686 ha), as adopted by Elderkamp (1990b)<sup>3</sup>, an approximation based on real figures was attempted. Therefore, the average size was arrived at by the following calculation: taken was that island of Majuro Atoll, which has the highest population density, Djarrit (0.389 km<sup>2</sup>). From the total area the space taken up by roads, cemeteries and unused land was deducted:

	total area Djarrit:	0.389 km <sup>2</sup>
—	roads <sup>4</sup> :	0.028 km <sup>2</sup>
—	cemeteries <sup>5</sup> :	~0.015 km <sup>2</sup>
—	unused land <sup>5</sup> :	~0.005 km <sup>2</sup>
<hr/>		
=	land used for housing:	0.341 km <sup>2</sup>

<sup>3</sup> And based on local informants who mentioned that about 10 households could be squeezed into one acre.

<sup>4</sup> Based on information obtained from the Department of lands, Ministry of Resources and Development.

<sup>5</sup> Estimated by the author.

6813 people lived on Djarrit (Rita) in 1989, which, at an atoll-wide rate of 8.8 pphh, is equivalent of 774.2 house-holds. Based on the estimated land area used for housing (0.341 km<sup>2</sup>) and the number of households, we arrive at a figure of 440.5m<sup>2</sup> ground space for each household.<sup>6</sup> Using the actual figure of 9.2 pphh for Djarrit, we arrive at 740.5 households, which are equivalent of 460.5 m<sup>2</sup> for each household. It is interesting to note that Elderkamp's arbitrary figure of 10 households per acre equals a ground space of 404.6m<sup>2</sup> per household

#### PROBLEMS INHERENT IN THE WAY THE PREDICTIONS WERE HANDLED

Before discussing the results, a few words of caution should be inserted, discussing the way the predictions were handled.

The prediction of the population on Majuro Atoll has assumed a constant proportion, related to the nationwide increase. As has been mentioned above, there is substantial net in-migration to Majuro from the outer islands. It is possible that the in-migration will decrease, or that the migration will become negative, that is more people leaving Majuro than moving into Majuro. The latter scenario is feasible if the district centres of Wotje and Jaluit will become more attractive. However, on the present basis, it appears most likely that the proportion will remain stable, or that the population increase of Majuro will be larger - in which case the scenario presented below will be conservative.

Another major uncertainty in the prediction is the size of the households, both in view of persons per household and in view of ground space taken up by each household. The possibility has been mentioned that the number of persons per household may increase in the next decade, and then decrease substantially. This is due to the large number of children under 15 years old, who are unlikely to form new households in the next 5 or 10 years, based on the assumption that a household be formed by persons of 20 or more years of age. On the other hand, a substantial number of households consists of people where 20 to 25 year olds live in the same household as their parents, and it can be expected that these will form their own households as the number of persons per household increases. The assumption of a linear progression of the increase of the number of households will approximately level out these fluctuations.

The remaining, major problem inherent in the predictions is the assumption of the actual ground space taken up by the individual household. As has been argued above, the area figure used in the present prediction is based on the example of Djarrit. Elderkamp (1990b) used a figure which is 10% less than that used by the present author. Thus, the discrepancy between the area projections provided by the Office of Planning and Statistics and the present study will be approximately 10%. However, experience based on personal observations has shown that newly founded households, for example on the islands of Ajeltake or Rairok, tend to occupy a much

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<sup>6</sup> For those weak in the metric system of area measurements: 100m<sup>2</sup> = 1 are = 0.01 hectares = 0.0001 km<sup>2</sup>, where 1km<sup>2</sup> is equivalent of 0.3861 square miles or 247.1 acres.

greater ground space than households of comparative size (in pphh) in Djarrit. Therefore, for the initial settlement expansion, the larger figure proposed by the author (*i.e.* 440.5m<sup>2</sup>) appears to be even too conservative, but is definitely preferable to the figure provided by Elderkamp (*i.e.* 404.6m<sup>2</sup>). At a later stage, however, a concentration of the settlement area can be anticipated, similar to the development in Djarrit over the past 40 years, which will create an overall smaller average household size (in relation to ground space).

Table 3 Predicted number of additional households 1990-2010 and the ground space taken up by them based on the assumption of an average household size of 440.5m<sup>2</sup>.

Year	Additional households			newly needed land (ha)		
	8.8 pphh	7.5 pphh	9.5 pphh	8.8 pphh	7.5 pphh	9.5 pphh
1989	0	0	0	0.00	0.00	0.00
1990	93	110	86	4.11	4.83	3.81
1991	190	223	176	8.38	9.84	7.76
1992	291	342	270	12.82	15.05	11.88
1993	396	465	367	17.45	20.49	16.17
1994	506	594	468	22.28	26.15	20.64
1995	618	725	573	27.23	31.95	25.22
1996	738	866	683	32.49	38.13	30.10
1997	861	1010	797	37.91	44.49	35.12
1998	989	1161	916	43.56	51.12	40.35
1999	1122	1317	1039	49.43	58.00	45.79
2000	1257	1475	1164	55.35	64.96	51.28
2001	1410	1654	1306	62.10	72.87	57.53
2002	1563	1834	1448	68.85	80.79	63.77
2003	1716	2014	1590	75.59	88.70	70.02
2004	1869	2193	1732	82.34	96.62	76.27
2005	2063	2421	1911	90.89	106.65	84.20
2006	2256	2648	2090	99.39	116.63	92.07
2007	2449	2874	2269	107.89	126.60	99.95
2008	2642	3101	2448	116.39	136.58	107.82
2009	2835	3327	2626	124.90	146.55	115.69
2010	3058	3589	2833	134.72	158.08	124.79

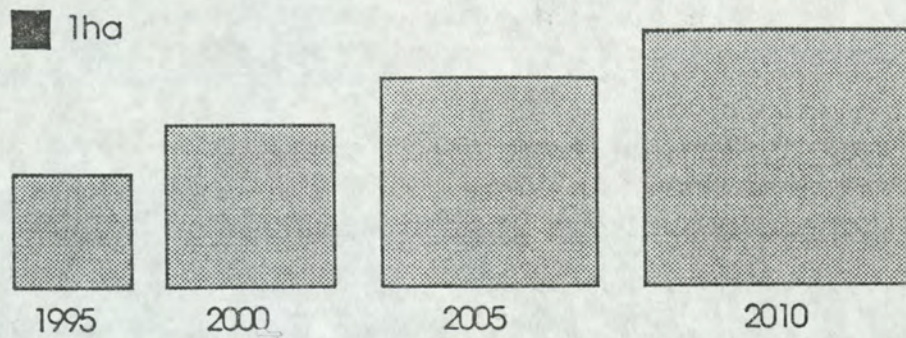


Figure 2 Additional area required for housing

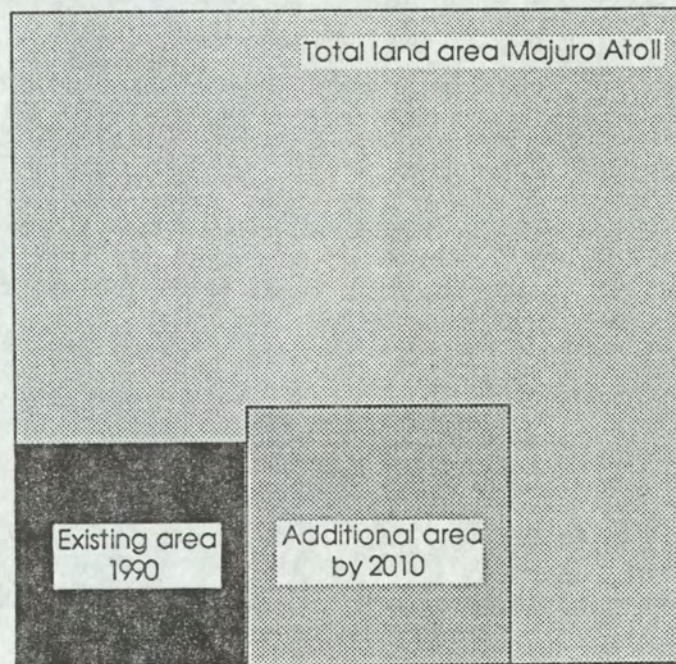


Figure 3 Total land area of Majuro Atoll compared with inhabited areas of 1989 and predicted settlement extension by 2010.

### RESULTS - GENERAL

From the historic preservation point of view, the figures arrived at are quite frightening regardless whether we take the figures arrived at by the present prediction based on 440.5m<sup>2</sup> per household (table 3), or whether we use the Office of Planning and Statistics figure of 404.6m<sup>2</sup> per household (subtract ~10% from the figures in table 3).

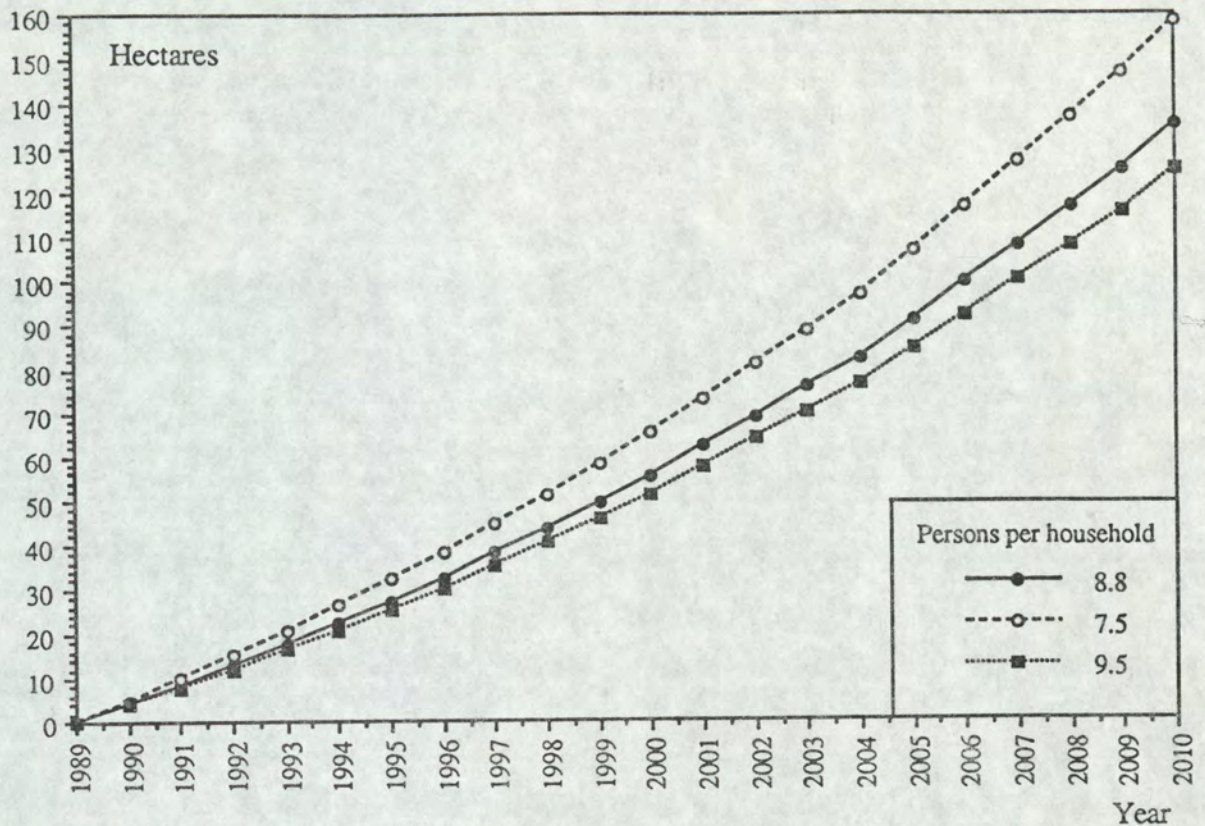


Figure 4 Increasing area taken up by future households

If the number of persons per household remains stable at the rate of 8.8 pphh, then there will be 1257 new households by the year 2000 which will take up over 55 hectares of new land; by the year 2010 there will be 3058 new households, requiring over 134 hectares of new land. The even more conservative prediction, using a household size of 9.5 pphh, arrives at 51 ha by the year 2000 and 125 ha by the year 2010.

To put these figures into proper perspective, one should realise that the 134 hectares, or 1.34 km<sup>2</sup> taken up by the year 2010, using the 8.8 pphh scenario, is as much land, as the islands of Djarrit, Uliga and Delap taken together. The island of Rairok, at present still relatively thinly populated (3,251 persons/km<sup>2</sup>), will not be able to cater for all these new households, and the urban area will have to extend well past the airport.

Table 4 Distribution of population and population density (in persons per km<sup>2</sup>) on Majuro Atoll in 1988 (data after OPS 1989)

District	Population	Area (km <sup>2</sup> )	Population density
Jelter	24	0.233	102.96
Rongrong	245	0.355	690.47
Calalen	19	0.259	73.36
Biken	8	0.052	154.44
Enemonet	6	0.130	46.33
Denmeo	7	0.052	135.14
Bokrej	14	0.041	337.84
Drirej	16	0.130	123.55
Garra	9	0.034	267.30
Ejit	170	0.049	3,454.58
Enarau	3	0.016	193.05
Djarrit	6813	0.389	17,536.68
Uliga	2144	0.293	7,325.66
Dalap	5692	0.648	8,790.73
Rairok	2021	0.622	3,251.29
Ajeltake	556	5.180	477.41
Woja	224		
Arrak	118		
Laura	1575		

#### RESULTS - SPATIAL DISTRIBUTION

The projection of the population increase alone, however, does not provide any data to build on management strategies for archaeological sites. Having established that the population of Majuro has risen to a greater extent than that of other islands and having established that the population density will continue to rise, we will have to ask whether the population density will rise in certain parts of Majuro Atoll only, or whether it will rise across the board.

Table 4 gives the detailed breakdown of the individual districts of Majuro Atoll and their population densities in 1989. A simplified version of this table, only distinguishing between the rural areas and the urban areas of D-U-D, is given in table 5

The development trends since the 1930s have clearly shown that the D-U-D area has been increasingly attractive to people (see also figure 5), for the reasons of employment with the private and government sector, adequate shopping, schooling, health and other facilities, among them, for example, a relatively reliable water supply.

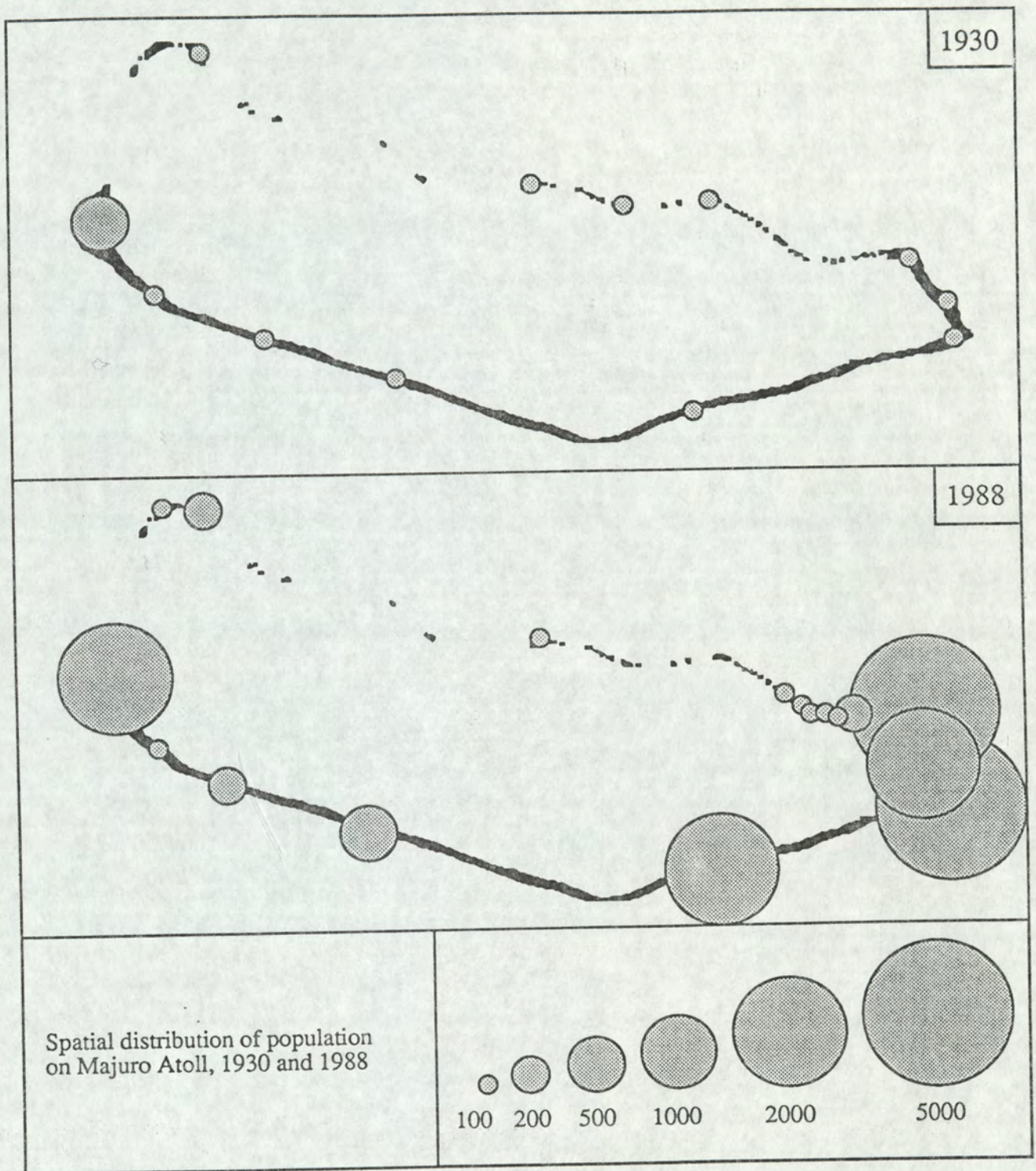


Figure 5

Table 5 Population distribution on Majuro Atoll, comparison of urban<sup>7</sup> versus rural areas.

Year	Population			Percentage		Mean annual increase (%)		
	Total	Urban	Rural	Urban	Rural	Total	Urban	Rural
1930	753	199	554	26.43	73.57	—	—	—
1935	782	179	603	22.89	77.11	0.77	-2.00	1.77
1947	837	0	837	0.00	100.00	0.93	-8.30	3.23
1958	3415	2387	1028	69.90	30.10	30.61	112.10	2.07
1967	5249	4149	1100	79.04	20.96	8.95	12.30	1.17
1973	9961	7506	2155	77.69	22.31	14.00	13.49	15.98
1980	11791	8583	3208	72.79	27.21	3.14	2.05	6.98
1988	19695	14707	4988	74.67	25.33	8.38	8.90	6.94

Before the Pacific War, the population centre of Majuro Atoll had been located on Majuro island, *i.e.* Laura. In addition, Majuro Atoll as a whole was less important throughout the Marshall Islands, as the district administration centre of both the German and the Japanese administrations was located in Jaluit. Following the establishment of a US Navy base and airfield in the D-U-D area in February 1944 elaborate facilities were constructed for the US wartime administration. Since Jaluit was held by a by-passed Japanese garrison until August 1945, and since large scale destruction of Jaluit had occurred due to continued US bombing, the administrative centre for all of the Marshall Islands was shifted to Majuro Atoll, particularly the D-U-D area.

A careful perusal of table 5 will show, that the population of the D-U-D area dramatically increased over the past years. While the D-U-D had been cleared of any resident local population during the operation of the base (1944-1946), the opening of the three islands for residential purposes brought about a substantial rise in the population. While the population in the D-U-D area increased annually well over 10% from 1947 to 1967, the increase in the rural areas was only between 1 and 2 % for the comparable time period. A beginning change in this pattern, however, occurred between 1967 and 1973, when the rural population increased for almost 16%, while the urban population increased for 13.5%, indicating that the rural areas began to grow as fast as the urban areas.

In the next intercensal period, between 1973 and 1980, the population in the urban areas increased only marginally (2%), while the population in the rural areas increased dramatically (6.98%). Part of this increase, however, is caused by tent cities erected on Rairok Island (classified as "rural") following the destruction by the tidal waves of 1979.

<sup>7</sup> The D-U-D area is regarded as urban, while the rest of Majuro is classified as rural. This is based on the population density and distribution of 1967 as the baseline. It is understood that the pre-World War II population centre was at Laura.

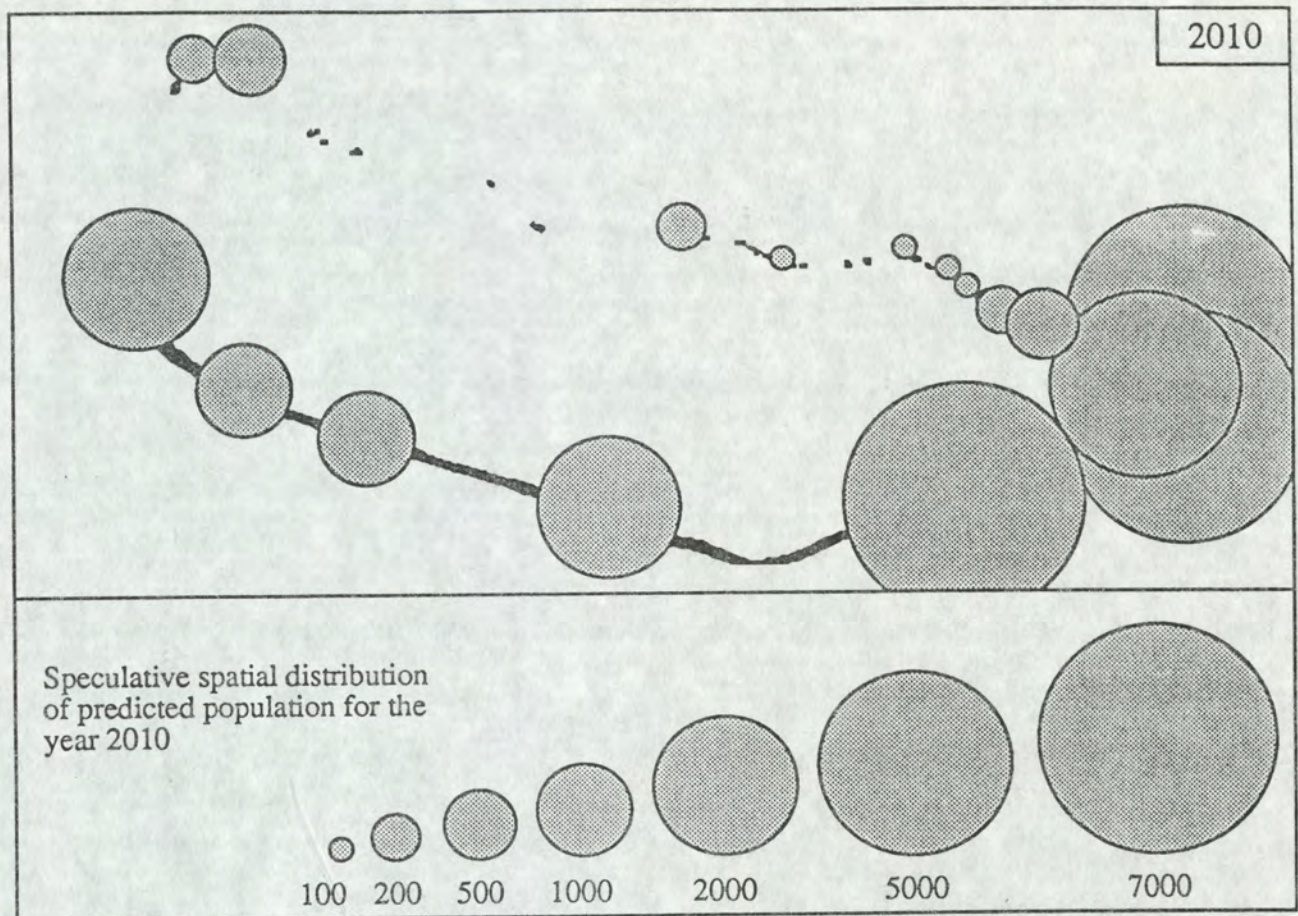


Figure 6

The following, and hitherto last, intercensal period, 1980 to 1988, showed again a greater increase in the population of the D-U-D area as opposed to the rural areas (8.9 versus 6.9%), although the growth in the rural areas has been substantial. This growth is mainly due to the opening up of new settlement areas on Rairok island, but also on Ajeltake.

The trend of an increasing population in the "rural" areas of Rairok and also Ajeltake will continue. At present, the airport, located at the extreme western end of Rairok, forms a psychological barrier for people. Given the increased population and the predicted increase in households, this barrier will fall. In addition, the area past the airport will be supplied with water from the Laura lens filed, whenever the water wells will go on line. It appears feasible that, ultimately, Laura may develop into a secondary centre, attracting a branch of a large Majuro retail store, such as Gibson's or RRE. This, in conjunction with the Laura and Ajeltake elementary schools may provide an additional nucleus for future settlement. Proposed Hotel

developments in the Ajeltake area may also provide employment and hence further incentives to live there.

In addition, the hitherto thinly settled islands of Jelte and Rongrong, just north of Laura, and the island of Calalin, located on the windward side of Majuro Atoll, are likely to see a substantial increase in population. The increase will be more dramatic on Jelte and Rongrong, where already a school as well as a continuous boat connection exists, than on Calalin, where the steady winds and exposure to the elements is greater.

A very speculative projection of the future population distribution is provided in figure 6.

#### IMPLICATIONS FOR HISTORIC PRESERVATION PLANNING

The predictive model, as outlined above, has a number of implications for the planning of Historic Preservation activities on Majuro Atoll:

- The predicted increase in habitation sites will be the greatest on Rairok and Ajeltake. However, here the island has been largely destroyed by cyclonic action during the 1905 and especially the 1918 typhoon. While the typhoon partially obliterated the archaeological sites, it also buried some of them, making them impossible to be seen from the surface.
- The predicted increase of households will also affect Laura, where a second centre of population and commercial activity may develop. In that case, the settlement will intensify along the lagoon side and will infringe on the inland areas, this threatening valuable archaeological sites.
- It can be foreseen that housing needs will become pressing and that — from the developer's and builder's point of view — very little time and effort will be lost on Historic Preservation issues.
- Therefore it appears pressing that the Historic Preservation Office, in conjunction with the Majuro Local Government, start work on housing regulations and permitting procedures, as well as regional zoning, as provided for in the *Marshall Islands' Revised Code of 1989*.<sup>8</sup> These should be well established by the time the pressure on new housing develops.

#### RECOMMENDATION

*It is recommended that the Historic Preservation Office of the Republic of the Marshall Islands, in conjunction with the Majuro Local Government, address the population increase over the next twenty years. It is recommended that both parties collaborate on housing and zoning regulations, as provided for in the Planning and Zoning Act. These zoning regulations should include a safeguard for the future well-being of archaeological and historical properties on Majuro Atoll.*

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<sup>8</sup> *Marshall Islands' Revised Code of 1989*. Title 10: Planning and economic development; Chapter 2: Planning and zoning;

## CONCLUSIONS

A predictive model for the increase of domestic households and the future space needs deriving from these has been conducted. It has been shown that, assuming a stable population, between 125 and 158 hectares of land will be transformed into urban land by the year 2010. It has been argued that this increase will predominantly take place on Rairok and Ajeltake, but is also likely to affect the settlement area on Laura, and possibly the hitherto thinly settled islands of Jelte, Rongrong and, to a lesser likelihood, Calalin.

The future housing needs will affect the well-being of the archaeological heritage of Majuro Atoll, and it has been recommended that the Historic Preservation Office, in close co-operation with the Majuro Local Government, work on housing and zoning regulations which will ensure the well-being of the future archaeological and historical properties.

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