Appendix 1

SAMPLE DESIGN

1.1 The Frame

Required data for sampling were obtained from the population and housing census 2006. The country consists of 20 administrative atolls comprising of 194 inhabited islands. For political purpose these 20 administrative atolls are grouped as 7 regions. The capital Male' has separate administrative status. The frame for Male' consists of 6 wards and 324 enumeration blocks. HIES uses the area frame as a basis, to make the sample representative for the administrative and geographic structure of the country. All the inhabited islands have clearly marked census enumeration blocks, which were used in the sampling. Major characteristics of the HIES sampling frame are given below. A total of 880 blocks and 45,993 households were in the 194 inhabited islands of the country.

Table 1.1: Number of Households and Enumeration Blocks by Region (Census 2006 Administrative islands)

Regions	Number of administrative atolls	Number of inhabited islands	Number of households	Number of enumeration blocks
Region 1 (HA, HDh, Sh)	3	45	7,502	128
Region 2 (N, R, B, Lh)	4	45	7,330	126
Region 3 (K, AA, ADh, V)	4	32	3,491	66
Region 4 (M, F, Dh)	3	20	2,120	39
Region 5 (Th, L)	2	25	3,415	61
Region 6 (GA, GDh)	2	19	3,602	54
Region 7 (Gn, S)	2	7	4,426	82
Atolls	20	193	31,886	556
Male'	-	1	14,107	324
Republic	20	194	45,993	880

1.2 Stratification

Stratification allows proper allocation of sample in different groups and makes it more representative. The purpose of the stratification is to divide the population into relatively

homogeneous groups and thereby reduce the total variation by the margin of inter-group variation.

It was essential to treat Male' separately in the whole sampling procedure. As the income opportunities and expenditure pattern in Male' is very much different from the rest of the country. It is also necessary to produce separate estimates for Male' like in all other national surveys in Maldives. So, there are two domains of the survey namely: **Male' and Atolls.**

In order to avoid the listing of all the households, the stratification in Male' was done by wards to make the sample spread over different urban areas. Male' has 6 wards including Vilingilli and Hulhumale'. For each of the 6 strata blocks were allocated according to the proportion of population. A total of 40 sample blocks and 15 randomly selected households from each block were included in the sample.

Atolls are too big to take as sampling unit and the size of islands in terms of the number of households varies from merely 20 to 1,500. Initially, it was thought to split some big islands and combine smaller islands to get evenly distributed area units. Alternatively, census enumeration blocks were chosen as primary sampling units for practical considerations. The size of enumeration blocks varies from 20 to 64 households. A minimum sample of 20 households was allocated for each selected island less than 1500 population. For larger islands, sampling rate was increased by 20 households for every 1500 population. Stratification in the Atolls were done by population and then by region. Hence, all those islands with a population of above 2000 persons were selected as seen from table 1.2.

Table 1.2: Stratification in Atolls by population size

Population Stratification	Region 1 (Ha,Hdh, Sh)	Region 2 (N,R,B,Lh)	Region 3 (K,Aa,Adh, V)	Region 4 (M,F,Dh)	Region 5 (Th, L)	Region 6 (Ga, Gdh)	Region 7 (Gn, S)	Total islands in sample	Total Islands
less than 500	1	1	1	2	1	1	-	7	72
500 - 1000	1	1	2	2	1	1	-	8	59
1001 - 2000	1	1	2	1	2	1	1	9	47
2001 - 3000	3	2	1	-	1	-	2	9	9
3000+	1	2	-	-	-	1	2	6	6
Total	**7**	**7**	**6**	**5**	**5**	**4**	**5**	**39**	**193**

Table 1.3: Number of households to be sampled by islands

Name of the island	Number of sample housholds per island
S. Hithadhoo	140
Gn. Fuvammulah	120
Hdh. Kulhudhuffushi	100
Lh. Hinnavaru, Lh. Naifaru, Gdh. Thinadhoo	60
Ha.Hoarafushi, Ha.Ihavandhoo, Ha.Dhidhdhoo, R.Ugoofaaru, B.Thulhaadhoo, B.Eydhafushi, K.Maafushi, Adh.Mahibadhoo, Dh.Kudahuvadhoo, L.Gamu, S.Maradhoo, S.Feydhoo	40
Hdh.Kunburudhoo, Sh.Feevah, Sh.Komandoo, N.Lhohi, R.Kinolhas, K.Thulusdhoo, Aa.Ukulhas, Adh.Fenfushi, V.Felidhoo, M.Muli, F.Feeali, Th.Vandhoo, Th.Thimarafushi, Ga.Dhevvadhoo, Ga.Nilandhoo, Gdh.Gadhdhoo,	20

1.3 Sample size and sample allocation

Allocation of sample in domains was based in proportion to the number of households identified in the population and housing Census 2006. The sample selected from Male' included 40 enumeration blocks and 600 households as given in table 1.4. This is a 12% sample of total blocks and 4.3% of total households in Male'.

Table 1.4 Sample allocations in Male'

Ward	Total Population	Total Number of Blocks	Total Number of Households	Sample	
				Number of blocks	Number of households
Henveiru	23,597	77	3,316	10	150
Galolhu	19,414	60	2,719	6	90
Machchangoalhi	19,580	57	2,573	8	120
Maafannu	29,964	108	4,132	12	180
Villingili	6,956	16	1,005	3	45
Hulhumale'	2,866	6	344	1	15
Hulhule	334	1	18	0	0
Total	**102,711**	**325**	**14,107**	**40**	**600**

The sample selected from Atolls included 73 enumeration blocks and 1460 households as given in table 1.5. This is a 13% sample of total blocks and 5 % of total households in Atolls.

Table 1.5: Sample allocation in atolls

	Province / Atoll / Island	Total Population	Total Number of Blocks	Total Number of Households	Sample	
					Number of Blocks	Number of households
Region 1		**41,358**		**7,502**		
	Total (Selected Islands)	**16,325**	**56**	**2,664**	**14**	**280**
1	Ha. Hoarafushi	2,204	7	375	2	40
2	Ha. Ihavandhoo	2,447	7	305	2	40
3	Ha. Dhidhdhoo	2,512	9	454	2	40
4	Hdh. Kunburudhoo	85	1	26	1	20
5	Hdh. Kulhudhuffushi	6,998	26	1,123	5	100
6	Sh. Feevah	746	2	133	1	20
7	Sh. Komandoo	1,333	4	248	1	20
Region 2		**41,897**		**7,330**		
	Total (Selected Islands)	**14,757**	**46**	**2,388**	**14**	**280**
1	N. Lhohi	552	2	87	1	20
2	R. Kinolhas	345	1	66	1	20
3	R. Ugoofaaru	2,988	8	472	2	40
4	B. Thulhaadhoo	1,759	6	313	2	40
5	B. Eydhafushi	2,409	8	363	2	40
6	Lh. Hinnavaru	3,017	9	482	3	60
7	Lh. Naifaru	3,687	12	605	3	60
Region 3		**23,427**		**3,491**		
	Total (Selected Islands)	**6,551**	**16**	**843**	**8**	**160**
1	K. Thulusdhoo	1,148	2	187	1	20
2	K. Maafushi	2,000	3	180	2	40
3	Aa. Ukulhas	615	2	96	1	20
4	Adh. Fenfushi	560	2	101	1	20
5	Adh. Mahibadhoo	1,780	6	205	2	40
6	V. Felidhoo	448	1	74	1	20
Region 4		**13,036**		**2,120**		
	Total (Selected Islands)	**3,726**	**10**	**625**	**6**	**120**
1	M. Muli	746	2	115	1	20
2	M. Naalaafushi	321	1	70	1	20
3	F. Feeali	741	2	128	1	20
4	F. Dharanboodhoo	279	1	40	1	20
5	Dh. Kudahuvadhoo	1,639	4	272	2	40

		Population	No. islands	Households	Sampling islands	Sample households
	Region 5	**20,194**		**3,415**		
	Total (Selected Islands)	**6,494**	**19**	**1,089**	**7**	**140**
1	Th. Vandhoo	268	1	44	1	20
2	Th. Veymandoo	928	2	157	1	20
3	Th. Thimarafushi	1,237	4	222	1	20
4	L. Isdhoo	1,559	4	267	2	40
5	L. Gamu	2,502	8	399	2	40
	Region 6	**18,998**		**3,602**		
	Total (Selected Islands)	**6,895**	**19**	**1,255**	**6**	**120**
1	Ga. Dhevvadhoo	480	1	105	1	20
2	Ga. Nilandhoo	534	1	94	1	20
3	Gdh. Gadhdhoo	1,439	5	328	1	20
4	Gdh. Thinadhoo	4,442	12	728	3	60
	Region 7	**25,498**		**4,426**		
	Total (Selected Islands)	**22,893**	**73**	**3,866**	**18**	**360**
1	Gn. Fuvammulah	7,636	27	1,332	6	120
2	S. Maradhoofeydhoo	1,025	3	183	1	20
3	S. Maradhoo	2,043	6	347	2	40
4	S. Feydhoo	2,724	9	511	2	40
5	S. Hithadhoo	9,465	28	1,493	7	140
	Selected islands- Total	**77,641**	**239**	**12,730**	**73**	**1,460**
	Atoll admin islands total	**184,408**	**556**	**31,886**		

Table 1.6: Sample allocation by strata in Atolls

Population Stratification	Number of islands	Population	Number of households	Sampling islands per strata	Number of sample households per strata
less than 500	72	21,882	4,373	7	140
500 - 1000	59	41,279	7,345	8	160
1001 - 2000	47	64,173	10,999	9	260
2001 - 3000	9	21,829	3,406	9	360
more than 3000	6	35,245	5,763	6	540
Total	**193**	**184,408**	**31,886**	**39**	**1,460**

1.4 Weight Estimation

The weighting procedure for HIES required two steps.

In Male' first step was calculation for wards and the calculation for households as the second step. Male' was stratified in to 6 wards. The total sample was allocated to each ward using proportional allocation. SRS sample of blocks selected within each stratum. The design weight was computed as;

$$w_{bi} = \frac{N}{n} = \frac{1}{f}$$

The proportional sampling design weight does not vary much across the strata. At the estimation stage, design weight may undergo some changes to adjust the difference of the number of households in the frame and in the actual list as well as the non-response.

In the Atolls the first step was calculation of region weights and the second step was calculation of enumeration blocks weight. And then adjustments were made for non-response.

Table 1.7: Design weight calculation for Male '

Male'	Number of households in totals	Number of blocks in sample	Number of households in sample per block	Number of households in sample	Design weights
Henveyru	3,316	10	15	150	22.11
Galolhu	2,719	6	15	90	30.21
Machchangolhi	2,573	8	15	120	21.44
Maafannu	4,132	12	15	180	22.96
Viligili	1,005	3	15	45	22.33
Hulhumale'	344	1	15	15	22.93
Total	14,089	40		600	

Table 1.8: Design weight calculation for Atoll Strata

Strata	Atoll	Island	Number of households	Number of blocks	Number of sample households	Estimation weight to blocks	Estimation weight to Strata	Design weights
Region 1								
	Hdh	Kuburudhoo	26	1	20	1.30	51.77	67.30
	Sh	Feevah	133	2	20	3.33	23.13	76.90
	Sh	Komandoo	248	4	20	3.10	38.08	118.05
	Ha	Hoarafushi	375	7	40	1.34	7.06	9.45

	Ha	Ihavandhoo	305	7	40	1.09	8.68	9.45
	Ha	Dhidhdhoo	454	9	40	1.26	7.49	9.45
	Hdh	Kulhudhuffushi	1123	26	100	0.43	26.00	11.23
Region 2								
	R	Kinolhas	66	1	20	3.30	16.59	54.75
	N	Lhohi	87	2	20	2.18	33.47	72.80
	B	Thulhaadhoo	313	6	40	1.30	54.77	71.43
	B	Eydhafushi	363	8	40	1.13	9.20	10.44
	R	Ugoofaaru	472	8	40	1.48	7.08	10.44
	Lh	Hinnavaru	482	9	60	0.89	10.15	9.06
	Lh	Naifaru	605	12	60	0.84	10.78	9.06
Region 3								
	V	Felidhoo	74	1	20	3.70	9.59	35.50
	Adh	Fenfushi	101	2	20	2.53	11.68	29.50
	AA	Ukulhas	96	2	20	2.40	12.29	29.50
	K	Thulusdhoo	187	2	20	4.68	7.60	35.53
	Adh	Mahibadhoo	205	6	40	0.85	20.80	17.76
	K	Maafushi	180	3	40	1.50	3.00	4.50
Region 4								
	F	Dharaboodhoo	40	1	20	2.00	4.24	8.48
	M	Naalaafushi	70	1	20	3.50	2.42	8.48
	M	Muli	115	2	20	2.88	9.99	28.73
	F	Feeali	128	2	20	3.20	8.98	28.73
	Dh	Kudahuvadhoo	272	4	40	1.70	9.29	15.80
Region 5								
	Th	Vandhoo	44	1	20	2.20	10.98	24.15
	Th	Veymandoo	157	2	20	3.93	14.85	58.30
	Th	Thimarafushi	222	4	20	2.78	12.32	34.18
	L	Isdhoo	267	4	40	1.67	10.24	17.09
	L	Gamu	399	8	40	1.25	8.00	9.98
Region 6								
	GA	Dhevvadhoo	105	1	20	5.25	3.81	20.00
	GA	Nilandhoo	94	1	20	4.70	9.11	42.80
	Gdh	Gadhdhoo	328	5	20	3.28	24.66	80.90
	Gdh	Thinadhoo	728	12	60	1.01	12.00	12.13
Region 7								
	S	Maradhoo-feydhoo	183	3	20	3.05	12.18	37.15
	S	Maradhoo	347	6	40	1.45	7.42	10.73
	S	Feydhoo	511	9	40	1.42	7.56	10.73
	Gn	Foammulah	1332	27	120	0.41	28.63	11.77
	S	Hithadhoo	1493	28	140	0.38	26.49	10.09

1.5 Non-response adjustment

Response rate was calculated as ratio between number of households which responded and number of selected households in the stratum. Non-response adjustment is defined as:

$$W_r = \frac{\#\ response}{\#\ of\ sample\ (n)}$$

The weight after the non-response adjustment for households is:

$$W_F = Wbi \times Wr$$

Where W_{bi} = Base/design weight for i-th sample area,
        Wr= Adjustment for non-response

1.6 Adjusting to Population Projection

The weight after adjustment to enumeration response is then adjusted for the projection 2010 population and housing using the adjustment factor. This factor is used to reduce bias in estimates introduces by non coverage and to make estimates consistent with known totals. This factor was applied to households, male and female to represent the data in different levels.

Table 1.9: Calculation of population adjustment factors

Stratum	Census 2006			Population projections (2010)			Adjustment factors		
	Both sex	Females	Males	Both sex	Females	Males	Both sex	Males	Females
Maldives	286,785	147,178	139,607	306,730	157,675	149,055	1.070	1.071	1.068
Male'	102,377	51,692	50,685	109,494	55,379	54,115	1.070	1.071	1.068
Atolls	184,408	95,486	88,922	197,236	102,296	94,940	1.070	1.071	1.068

Table 1.10: Calculation of household adjustment factors

	Census 2006	Population projections (2010)	Adjustment factors
Maldives	45,975	49,321	1.073
Male'	14,089	15,637	1.110
Atolls	31,886	33,684	1.056