Identification of the Spatial Distribution of Environmental Development Needs using GIS

- A Study of Polonnaruwa District, Sri Lanka

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In a developing country like Sri Lanka, its very important to plan and manage its development programmes in a rational manner ensuring optimum use of resources. Therefore, a decision maker has to carry out spatial prioritization to manage the scarcity of resources, while identifying the desires of the rural community. In this context GIS provides a tool for the managers to identify the spatial distribution of requirements and then to make a comparison of presently deployed resources to make rational decisions through Environmental Development Needs Assessment Programmes. The present work is on the development of a GIS for the Polonnaruwa District to identify the spatial distribution of Environmental Development Needs. A household survey was conducted including approximately 31,000 households out of a total of 91,000. The survey assessed the desirable environmental development needs for self development and also for the village development. A vector based GIS model was developed to compute the spatially aggregated priority GN and the DS divisions. Survey responses for development needs were analysed considering the number of responses and the associated stakeholder priorities. GIS data layers were prepared to reflect the priority needs for the district. Ratio Estimation Procedure was used to compute the weights for the aggregation of development need options for the identified spatial extents. For individual family development, the top priority was the need of a housing unit whereas in case of needs to develop one's own village the topmost request was to obtain electricity supply. The study indicates the potential of GIS to identify the spatial distribution of EDN based on each GND thereby facilitating a resource manager to carry out rational management of development assistance.

Key Words: Sri Lanka, Polonnaruwa, GIS, Model, Environmental, Development, Overlay, Stakeholder Assessment, Planning, Management

1.0 Introduction

In a developing country like Sri Lanka, its very important to plan and execute its development programmes in order to suitably manage valuable resources to ensure the fulfilment of public aspirations. Sri Lanka being a developing country has significant room for enhancement of living standards of its nationals and this is more so in the case of rural areas. There are critiques who indicate that insufficient attention had been given to the needs of rural area community when launching and executing rural development projects. In this backdrop, a decision maker has to carry out prioritization to suitably utilize the scarce resources, while identifying the desires of the rural community. Prioritisation of resources allocation requires spatial assessments. Therefore, to identify the spatial resource mobilization needs, it is necessary to carry out a stakeholder needs assessment at a suitable spatial resolution.

Though the spatial unit of assessment can be as fine as household level, the location identification with household coordinates would require an enormous amount of time and financial resources. The next level would be to identify the needs at village level. As such the administrative unit of Grama Niladhari Division (GND) would be the next best representative spatial unit.

Geographic Information System (GIS) provides a tool for managers to identify spatial

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distribution of resources requirements and then to make a comparison of presently deployed resources. Therefore, Development Needs Assessment Programmes could effectively utilize GIS to make rational development planning decisions (Barros, Maseda, and Rivera 2008, Weerakoon 2002).

The present work is on the development of a GIS to identify the spatial distribution of results identified through an Environmental Development Needs Assessment (EDNA) programme carried out for the Polonnaruwa District (Map 1). The paper describes the environmental development needs assessment, and the development of a GIS model using Arc GIS. The main objective of the work was to identify the stakeholder perspective of environmental development needs in a geographically distributed manner and identify priority spatial extents in order to provide information for appropriate decision making.

The specific objectives were to:

1. assess the needs of the stakeholders for self development,
2. assess the needs of the stakeholders for the development of their village,
3. develop a geographic information system enabling the assessment of above needs in a spatially distributed manner and

4. prioritise and assess the needs in relation to administrative boundaries enabling suitable decision making.

2.0 Study area

The study area was taken as the Polonnaruwa District which is in the North Central Province and located between longitudes $81^{\circ} 0'$ East, and Latitudes $7^{\circ} 56'$ North. The city of Polonnaruwa is approximately 260 kilometers away from Colombo. Sri Lanka's average population percentage below the poverty line (Head Count Index) is 23%. The Polonnaruwa District Head Count Index is 24% with an approximate number of 89,000 persons falling in to this category (Census 2002). The district consists of the seven different Divisional Secretariat Divisions (DSD) and 295 Grama Niladhari Divisions (GND) with an area of 3472 Sq. Km. The total population of Polonnaruwa District counted to 358,984 (Census 2001) having a density of approximately 117 persons per square kilometre (Map 2). The male population of 187,789 indicated a marginal difference when compared with the females. The total number of households were 91,000. Land cover maps prepared with the use of 1:50,000 topographic maps showed that the predominant type is forest while paddy is the next major type. This reflects that the agriculture, either irrigated or rainfed is influencing the living patterns of the population in the district (Map 3).

Map. 1: Polonnaruwa District Water Bodies, Rivers and Canals

Map 2: Polonnaruwa District - Population Density

Map 3: Polonnaruwa District - Land Cover

3.0 Methodology

The assessment of environmental development needs according to the stakeholder perspectives was based on a questionnaire survey. Investigation of stakeholder interests, characteristics and circumstances were taken into consideration while designing the questionnaire to arrive at an understanding of issues within a systems context (Grimble 1998). Initial preliminary discussions were held with the divisional authorities, local politicians, administrators and general public, to identify important aspects for data collection. Having recognized the importance of identifying the existence of a significant variation in stakeholder opinions (Baggett, Jefferson and Jeffery 2008) special attention was given to this aspect. During discussions, it was noted that stakeholder groups did not possess divergent views on key areas that were to be developed. Therefore, the options in questionnaire sections covering self and village development needs were designed to provide a listing where each stakeholder ranked according to preference. Questionnaire listings were made quite comprehensive within each cluster, as the stakeholder interests had to be indicated in a specific manner to effectively capture

stakeholder preference. After preliminary information collections a survey questionnaire was developed and tested. The questionnaire developed in Sinhala language considering the capabilities of the stakeholder community consisted of seven major aspects of data collection. The data capturing efforts to identify needs and propose solutions included, 1) family details, 2), details of the chief of household 3), family employment details, 4), Debt details, 5), Debt Settlement Plans, 7) Priority development needs pertaining to the village in common, and 6) Priority needs for self household development. Other than the above details, geographic information pertaining to Grama Niladhari Division, names and signatures of Grama Niladhari and Chief Occupant of the household were collected. The questionnaire which was designed to be filled by the Chief Occupant carried two pages of instructions out of a total of 5 pages.

Data collected were first entered into a database created using MS Access and Visual Basic which consisted of a data row for each questionnaire. Data entry formats were prepared to easily incorporate each data in the GIS with detailed data of each household as attributes. Each questionnaire was given a unique identity number to facilitate easy data checking. After computing summary statistics of survey data using a statistical software, database was then migrated to the off-the-shelf Geographic Information System software ArcGIS. GIS utilised the spatial data aggregated in each Grama Niladhari Division to identify the spatial variations through appropriate classification, reclassification and overlay operations.

Survey responses for development needs were analysed considering the number of responses and the stakeholder priorities indicated for each of the selected development needs. The priority needs for the district were identified and then the requests corresponding to the population in each GN were computed and classified to form GIS data layers showing the spatial variation and a priority indication based on the number of requests in each spatial unit. The classification filter used to assess stakeholder responses assumed a five class stepped function having ranges as Super Primary, Primary, Secondary, Tertiary and Normal to assess all stakeholder responses. District level

Figure 1 :Sequence of Operations in the GISModel Computations

aggregation of responses received for each environmental development need were used to assign normalised weights for the Ratio Estimation Procedure (Malczewski 1999). An overlay GIS model (Figure 1) was developed to compute the aggregated priority GN divisions and the DS divisions in the entire district. R_j which is the aggregated priority rating of a GN_j , and $\bar{R}$ which is the spatial aggregation over a DS division were computed using the model for both Development Need responses.

$$R_j = \sum_{i=1}^n \varphi(SR)_{ij} w_i$$

$$\bar{R} = \frac{\sum_{j=1}^k A_j R_j}{\sum_{j=1}^k A_j}$$

R_j and $\bar{R}$ representations given above, the suffixes i, j denote the development need, and the GN division respectively. The Number of Development needs is taken as n and k is the number of GN divisions in the particular DS. SR is the Number of stakeholder responses and A_j is the area of the respective GN division. φ is the classification function that rank the strength of the stakeholder responses. w is the normalised weight assigned to each development need.

4.0 Data and Data Collection

Survey team included Grama Niladhari(GN) Officials, Divisional Secretariats of the area to achieve the collection of data pertaining to 31,591 households (Map 2). Except for two GND all other GND participated with significant contributions. An approximate average of 4500 households from each DSD contributed to the survey. The minimum participation was 2750 from Elahera DSD. Questionnaires prepared were tested with sample communities and also with the

Divisional Secretaries to ensure the clarity and completeness of the options incorporated for assigning priority levels. The survey data collection was completed in less than one month.

Since the main objective of stakeholder survey was to identify the environmental development needs of the district, the spatial distribution of self and village development needs of each household were incorporated into the GIS in a very detailed manner. GIS data were primarily from the 1:50,000 topomaps. Polonnaruwa District GN boundaries pertaining to 295 units were obtained from the Agriculture Development Ministry, Population and Household data were taken from the Department of Census and Statistics Web site. The spatial boundary data posed many problems with the names, alignment and boundary matching. GIS data were checked for accuracy and then processed to prepare GIS maps. Collection of available data, collecting supplementary data, data cleaning, data modelling, overlay and layout generation (Kaijuka 2007) were suitably carried out to create GIS maps for decision making. (Yeung 2005, Longley et al., 2001. Divisional Secretary and Grama Niladhari boundaries, Main towns and villages, main roads, forest cover, paddy lands, water bodies, population density are some of the layers which were taken as base datasets.

5.0 Analysis and Results

5.1. General

Survey results indicated that the average distribution of nationality in the Polonnaruwa district consisted of 91.7% Sinhalese, 1.6% Tamil, 6.6% Muslim and 0.1% others. Lankapura DSD had a Muslim percentage of 23 while the Tamil population in Welikanda DSD was 10%. The average distribution according to the religion was 90.9% of Buddhists, 6.6% of Islam, and 1.5% of Hindu. Each 23% Islam in Lankapura DSD, 9% Hindu in Welikanda DSD and 2% Christian in Hingurakgoda DSD were notable variations.

Families with female household heads were 14.2% and the marital status data revealed that 13% of the household heads were either a widow or a widower. With regards to the

Table 1: Stakeholder Responses for Own Household Development Needs and Identification of Community Priority

		Development Needs (Community)																	
		Q6F1	Q6F2	Q6F3	Q6F4	Q6F5	Q6F6	Q6F7	Q6F8	Q6F9	Q6F10	Q6F11	Q6F12	Q6F13	Q6F14	Q6F15	Q6F16	Q6F17	Q6F18
Individual Priority	1	20506	3117	2190	741	248	113	62	31	13	14	5	3	3	3	2	2	8	13
	2	370	1954	774	775	588	369	248	143	102	61	37	45	26	14	9	14	18	41
	3	453	1087	594	192	151	98	61	57	37	29	30	26	25	15	20	26	41	32
	4	680	4610	2431	1671	913	484	304	151	84	63	28	28	13	16	7	17	14	5
	5	213	870	1739	979	799	451	289	192	113	77	63	34	25	24	24	24	8	9
	6	1406	3978	2347	1398	738	479	198	88	69	59	45	33	31	23	25	19	9	11
	7	339	324	963	719	519	343	251	124	90	80	54	47	41	43	43	20	16	12
	8	297	677	905	622	474	263	176	113	53	56	53	51	42	30	22	49	13	6
	9	170	591	1093	710	623	439	354	167	97	65	49	55	53	47	55	20	18	17
	10	23	78	192	139	136	116	96	97	71	68	56	48	59	80	40	33	26	24
	11	173	554	746	600	573	419	260	220	152	77	63	46	37	43	32	14	21	5
	12	99	303	548	504	414	326	216	188	161	90	52	69	47	32	39	37	29	7
	13	20	96	204	199	226	198	189	115	112	140	66	67	73	51	56	38	39	30
	14	214	1365	1659	1428	1164	698	421	258	148	105	67	33	31	47	40	45	43	15
	15	558	799	916	691	480	279	195	134	39	84	88	34	31	39	37	50	52	44
	16	924	1408	1952	1383	1050	561	344	224	145	82	66	59	34	24	25	39	31	34
	17	3271	4531	3515	1691	1180	624	417	237	137	79	38	58	37	14	18	13	36	25
	18	398	1796	3116	1433	1140	734	420	306	210	109	52	35	51	30	16	16	18	48
Maximum		20506	4610	3515	1691	1180	734	421	306	210	140	88	69	73	80	56	50	52	48
Total		20506	10768	22768	14442	10276	6994	3125	2845	1833	879	756	485	475	295	374	408	360	378
Community Priority		2	4	1	3	5	6	7	8	9	10	11	12	13	18	16	14	17	15

education status, it was revealed that a majority of 37% household heads were of the group having an education to a stage between Grade 6 and 9. 64.1% of the household heads had received primary level education.

According to the survey data approximately 49% of the population in Polonnaruwa District are farmers; 16.4% are daily paid labourers; another 5.7% are self employed; and 10.6% are government employees. Unemployed component is 7%. Welikanda DSD with 66.7%, Dimbulagala DSD with 66.8% have shown highest percentages of farmers. The highest unemployment of 10.3% is at Tamankaduwa DSD.

The household heads had indicated that most of their loans had been taken for agricultural purposes. The number of households amount to 47.6% of those who had resorted to loans. Loan amounts of 55.6% of the households had not exceeded 20,000.00 rupees. 44.5% of the loans are from the recognized banks and the Samurdhi Bank loans had amounted to 20.4%.

5.2. District and DSD Development Needs

Stakeholder priority responses received for each of the development needs pertaining to own households, were tabulated for the entire district (Table 1). In this table, each column represented

a particular development need which was indicated as an option in the questionnaire. Data rows indicated the priority order as filled by each respondent and in the ascending order. Therefore, each cell in table represented cumulative responses for the entire spatial extent corresponding to a particular development need and a priority indicator. The maximum responses received by each development need was computed to arrive at the Community Priority Order for that spatial extent. The simple concept that any preferences received by a particular option would be enhanced by an equal number of preferences received by the options having higher ranks, in case those higher options were unavailable, was used. Accordingly, in the computation of community priority to a given alternative was computed as follows. Initially, the development alternative that received the maximum responses was identified along with the corresponding priority rank. The maximum indicated the rank of a particular development need that received the highest stakeholder agreement. The analysis of survey responses shows that all priority stakeholder responses that were indicated for development needs which were listed above this rank also indicates a chief occupant's liking for the maximum ranking development need, in case there is a situation where those options are not available

Table 2: Priorities of Household Development Needs for Polonnaruwa District

Priority	Responses	%	Development Need
1	22768	72.0%	Acquisition of Support for Own House Unit Q 6.F3
2	20506	64.9%	Enhancement of Family Income Q 6.F1
3	14442	45.7%	Enhancement of Funds for Self Employment Q 6.F4
4	10768	34.1%	Enhancement of Health Facilities Q 6.F2
5	10276	32.5%	Enabling Training for Self Employment Q 6.F5
6	6994	22.1%	Enabling Permanent Employment Opportunities - Children Q 6.F6
7	3125	9.9%	Provision of Land for the Second Generation Q 6.F7
8	2845	9.0%	Removal of the Difficulties in Obtaining Samurdhi Relief Q 6.F8
9	1883	6.0%	Enhancing Local Job Opportunity for a Family Member Q 6.F9
10	879	2.8%	Enhancing Foreign Jobs Opportunity - Family Member Q 6.F10
11	756	2.4%	Ensuring an Agro Well for Cultivation Q 6.F11
12	485	1.5%	Enabling Scholarships for Education Q 6.F12
13	475	1.5%	Enabling Opportunities for Continuing Education Q 6.F13
14	408	1.3%	Improving availability of Drinking Water Q 6.F16
15	378	1.2%	Enabling Harvest Enhancement Mechanisms Q 6.F18
16	374	1.2%	Facilitating Relief for Land Ownership Problems Q 6.F15
17	360	1.1%	Enabling Reasonable Sale of Paddy Harvest Q 6.F17
18	295	0.9%	Provision of a Cooperative Society for essential Food Q 6.F14

for selection. This assumption is valid for a situation where the ranks are listed in a descending priority order. Therefore, the maximum responses received for each development option was computed by adding the maximum responses to all other priority responses above the maximum priority rank. Table 2 shows the Community Priority of the entire district received for each development need pertaining to their own household. In the same manner, the priority development needs corresponding to each of the DSD were calculated. The same methodology was used to compute the community priority for the Village Development Needs (Table 3 and 4).

5.3. Spatial Distribution of Development Needs

GIS data layers were developed to identify the spatial distribution of each development need that received priority in the district. These represented the spatial variation of stakeholder requests for that particular development need. In this effort, the first ten development priorities were identified and for each need, the spatial distribution was plotted by considering the number of requests per GND. Family member details available in the survey data were used to convert the responses by each household to responses pertaining to population over 18 years in a particular GN. Thereafter, priority requests were classified by a function identified

Map 4 : District Priority 1 of Households

using the data of population in a GN division. Classification of requests for each development need as Super Primary, Primary, Secondary, Tertiary and Normal were corresponding to requests for that development need and falling into the groups, >80%, 50-80%, 10-50%, 5-10% and <5% of population respectively.

Spatial variation of priority classes for "Acquisition of Support for Own House Unit", which is the Priority number one for Polonnaruwa District, is plotted in relation to GN divisions and shown in Map 4. Similar data Layers were prepared for each of the top ten

Table 3: Stakeholder Responses for Village Development Needs and Identification of Community Priority

		Community Development Needs																											
		Q7V1	Q7V2	Q7V3	Q7V4	Q7V5	Q7V6	Q7V7	Q7V8	Q7V9	Q7V10	Q7V11	Q7V12	Q7V13	Q7V14	Q7V15	Q7V16	Q7V17	Q7V18	Q7V19	Q7V20	Q7V21	Q7V22	Q7V23	Q7V24	Q7V25	Q7V26	Q7V27	Q7V28
		Count	Count	Count	Count	Count	Count	Count	Count	Count	Count	Count	Count	Count	Count	Count	Count	Count	Count	Count	Count	Count	Count	Count	Count	Count	Count	Count	Count
Individual Priority	1	13360	1996	1347	831	638	565	266	142	92	79	61	32	16	18	12	9	7	8	5	6	2	5	6	6	6	2	1	
	2	1348	5946	1272	758	703	430	423	277	180	151	113	261	45	58	33	22	21	14	15	14	11	15	13	7	6	2		
	3	2478	2560	3132	930	646	587	570	385	333	275	208	255	167	98	49	49	22	18	15	14	11	12	9	15	11	12		
	4	1502	789	559	502	141	136	36	66	74	46	27	19	20	25	10	30	19	20	16	18	21	31	46	32	40	28	1	3
	5	902	1104	1048	779	517	317	211	208	162	180	102	95	69	82	60	35	30	16	14	23	23	39	37	37	51	8	4	1
	6	159	485	506	571	416	337	188	178	198	199	139	106	90	68	101	138	38	34	33	27	38	28	21	40	10	7	2	
	7	1008	1281	1165	659	489	340	234	158	145	104	55	76	50	37	56	28	33	32	24	21	22	20	18	11	11	7		
	8	986	1329	1072	711	575	375	400	280	213	129	117	79	255	74	39	20	20	15	17	10	11	25	10	8	4	6		1
	9	169	736	786	706	567	474	361	359	259	175	232	94	75	74	62	40	28	31	36	26	15	12	33	8	10	14	2	
	10	118	441	564	554	494	466	382	286	227	224	125	71	63	52	73	47	35	37	40	46	58	25	12	15	7	6	1	
	11	1378	1698	1510	1221	862	493	481	326	198	216	134	90	71	44	24	22	7	11	10	3	7	4	7	5	5	2		1
	12	779	596	586	349	308	295	194	139	90	77	45	119	47	24	13	105	16	9	12	17	9	8	15	12	4	2		
	13	422	775	934	912	884	703	576	505	396	261	173	132	154	63	145	45	67	26	11	20	15	17	14	34	11	4	1	
	14	1583	1501	1896	1366	1428	1037	820	787	594	489	304	214	154	126	63	71	37	38	25	18	22	24	16	15	39	11		
	15	642	1092	1095	1555	990	877	790	465	343	272	247	97	99	175	77	40	23	20	30	27	22	16	15	8	8	26	2	
	16	63	429	597	731	850	592	559	515	280	199	159	115	74	65	66	28	20	19	11	18	13	22	14	5	4		2	
	17	29	87	354	498	518	707	476	388	436	240	180	150	95	65	60	60	24	18	16	10	16	17	18	14	5	4		2
	18	520	571	675	529	442	42	357	214	286	163	113	85	74	75	48	48	35	50	41	38	37	12	14	8	9	9	1	1
	19	1116	2732	2995	2152	1814	1387	1041	329	593	536	291	174	84	83	57	86	30	29	14	12	9	4	10	3	1	4		
	20	189	1026	2546	1892	1670	1394	1248	883	792	616	380	342	169	111	94	59	86	37	27	39	19	11	7	8	2	4		
	21	623	774	930	939	910	1003	630	913	599	568	404	385	257	151	146	91	72	79	39	29	25	15	9	7	4	2	1	
	22	16	102	198	259	428	469	435	450	415	378	403	315	240	286	166	125	86	69	79	51	34	33	18	14	8	20		
	23	12	24	63	40	67	55	56	61	60	64	58	51	77	74	75	46	69	53	47	46	49	47	34	29	23	7	23	
24	97	201	105	125	106	124	105	78	79	62	61	59	69	73	64	63	46	66	67	43	46	59	43	34	21	21	1	21	
25	124	282	333	373	515	497	462	540	403	354	388	230	222	202	146	157	108	90	105	61	50	47	46	37	23	9	6		
26	45	115	153	183	420	392	414	400	444	352	329	245	254	174	139	137	150	37	81	94	76	43	45	37	30	19	4	1	
27	157	356	648	509	600	610	556	550	648	480	373	331	361	222	193	158	133	216	73	95	48	41	43	35	38	14	10	2	
28	79	222	367	499	408	530	380	416	402	373	211	203	201	132	130	112	81	81	82	53	61	46	39	42	48	34	9	7	
Max		13360	5946	3132	2152	1814	1394	1248	913	792	616	404	385	351	286	193	158	150	216	105	95	76	59	46	42	51	34	23	21
Total		13360	1996	5751	16314	13256	11939	9665	8313	5886	4631	3629	2991	3351	1857	2082	1667	1223	1149	746	823	674	502	478	529	114	286	43	30
Priority		2	14	6	1	3	4	5	6	7	9	10	12	11	15	13	15	17	18	20	19	21	23	24	22	26	25	27	28

Table 4: Priorities of Village Development Needs for Pollonnaruwa District

Priority	Responses	%	Development Need
1	16313	51.63%	Electricity for Village (Q7V4)
2	13360	42.29%	A Village Institution for the Selling of Paddy (Q7 V 1)
3	13286	42.05%	Electricity for Part of the Village (Q 7 V 5)
4	11939	37.79%	Concessionary Telephone Service (Q 7 V 6)
5	9665	30.59%	Water for Paddy Cultivation (Q 7 V 7)
6	8318	26.33%	Water Supply for Households (Q 7.8)
7	7941	25.14%	Market for Village Agricultural Products (Q 7 V 2)
8	5886	18.63%	Transport Facilities During Day Time (Q 7 V 9)
9	5751	18.20%	Establishment of a Vocational Training Institute (Q 7 V 3)
10	4631	14.66%	Transport Facilities During Night Time (Q 7 V 10)
11	3629	11.49%	Safeguarding Crops from Elephants (Q 7 V 11)
12	3351	10.61%	Improvement/Rehabilitation of Bus Routes (Q 7 V 13)
13	2991	9.47%	Cultivation Problem due to Terrorists (Q 7 V 12)
14	2082	6.59%	Lack of Teachers in Primary Schools (Q 7 V 15)
15	1857	5.88%	Improvement/Rehabilitation of Byroads (Q 7 V 14)
16	1667	5.28%	Lack of Teachers for GCE Ord Level Classes (Q 7 V 16)
17	1223	3.87%	Lack of Teachers for GCE Adv Level Classes (Q 7 V 17)
18	1149	3.64%	Rehabilitation of Elephant Fence (Q 7 V 18)
19	828	2.62%	Low interest loans for Cultivation (Q 7V20)
20	746	2.36%	Lowering of Fertilizer and Pesticide Prices (Q 7 V 19)
21	674	2.13%	Establishment of Employment Generation Institute (Q 7 V 21)
22	529	1.67%	Solution to Solid Waste Disposal (Q 7 V 24)
23	502	1.59%	Establishment of Agricultural Advisory Center (Q 7 V 22)
24	478	1.51%	Protection of Property from Flooding (Q 7 V 23)
25	286	0.91%	Environmental Conservation (Q 7 V 26)
26	114	0.36%	Continuing Education for School Leavers (Q 7.25)
27	43	0.14%	Educational Programmes for Housewives (Q 7.27)
28	30	0.09%	Lack of Road Transport Services (Q 7 V 28)

Table 5: Allocated Weights for the GIS Overlay Model

Computed Weights for GIS Overlay Operation			
Household Development Need		Village Development Need	
Requirement	Weight	Requirement	Weight
6.1	0.114	7.1	0.138
6.2	0.153	7.2	0.082
6.3	0.217	7.3	0.059
6.4	0.241	7.4	0.168
6.5	0.109	7.5	0.137
6.6	0.074	7.6	0.123
6.7	0.033	7.7	0.100
6.8	0.030	7.8	0.086
6.9	0.020	7.9	0.061
6.10	0.009	7.10	0.048
Sum	1.000	Sum	1.000

Map 5: Aggregated Priority GN - Household Development Needs

priorities corresponding to the own household and village development needs. As indicated earlier, and based on the stakeholder responses, weights for each option was computed and the values for each development need is shown in the Table 5. Previously described GIS model was applied to identify the spatial variation of aggregated priority rating (R_j) at GN (Map 5 and Map 7) and DS (Map 6 and Map 8) division level. Computations can also be done in the GIS to summarise the details of GND in each DSD (R) which had requested a particular development need and these capabilities are extremely useful for the management of spatially distributed resource and carrying out related monitoring activities.

Map 6 : Aggregated Priority DSD - Household Development Needs

Figure 2: Survey Data Collection Details

6.0 Discussion

Social and physical GIS data pertaining to each GN enabled the comparison of resource mobilisation needs towards meaningful development. Survey successfully collected data from 31,591 families through a structured questionnaire and with the help of the existing administration system of the government. Though there were a very limited number of inadequacies in the data collection, the effort which was completed within approximately one month could be mentioned as a great success. The survey responses were quite satisfactory and an accuracy check on the sample survey results indicated that the error level at 99% confidence was 0.6%. At a confidence level of

99% and a percentage accuracy of 5% revealed that the confidence interval was as low as 0.24 indicating the strength of the survey results (Bartlett, Kotrlik, & Higgins 2001, Lenth 2001, CRS 2007, CustomInsight 2007).

The study identified the development needs corresponding to two fundamental aspects namely the development of a "Family Household" and the "Development of the Village". GIS facilitated identifying the spatial distribution of GND with respect to either a single or a combination of development needs, while taking the strength of stakeholder requests into consideration. This is a very important information for a resource manager as it provides the pattern of stakeholder request distribution, summary of GND with different degree of stakeholder priority, and an assessment of GND numbers of different categories in each DSD.

GIS overlay operation enabled the identification of an aggregate indicator for each GND, by considering the overall stakeholder priority indicated for each development need. Incorporation of this type of weighted layer aggregation models enable the resource managers to easily identify the priority spatial extents with regards to a desired group of development needs for the region.

GIS model also enabled spatial aggregation and the results facilitate the identification of priority DSD with respect to each development need. This summary result provides the opportunity to select the sequence in which the resources should be channelled for development activities.

7.0 Conclusions

- 1.0 The survey and analysis of the data with GIS enabled the identification of priority development needs in relation to stakeholder families and their villages.
- 2.0 The study used a simple rationalisation methodology to aggregate stakeholder prioritisation responses corresponding to each development need. This method enables the computation of an aggregated development priority indicator pertaining to a given spatial extent.
- 3.0 A GIS model with the capability of spatial data aggregation through overlay operations to reflect the spatial distribution of cumulative priority status through a stakeholder based indicator (R_j) was successfully developed thus providing a tool for micro level planning, implementation and management of development activities.
- 4.0 The GIS model enabled the computation of spatially aggregated priority indicator considering the strength of stakeholder responses pertaining to a particular spatial entity, thereby enabling a decision maker to easily manage the development efforts in the macro scale. This proves the immense potential of GIS to plan or evaluate effective resource utilization in a spatially distributed manner.
- 5.0 In the Polonnaruwa district the stakeholders indicated that the five most important household development needs are listed below.
 - i. Acquisition of Support for Own House Unit
 - ii. Enhancement of Family Income
 - hi. Enhancement of Funds for Self Employment
 - iv. Enhancement of Health Facilities
 - v. Enabling Training for Self Employment
- 6.0 The most requested villages development needs were indicated as the following,
 - i. Electricity for Village or Part of the Village
 - ii. A Village Institution for the Selling of Paddy
 - iii. Concessionary Telephone Service
 - iv. Water for Paddy Cultivation
 - v. Water Supply for Households
- 7.0 The Elahera DSD was identified as the priority administrative unit for family household development while the Welikanda DSD was identified as the priority unit for the villages development.
- 8.0 The GIS model and the associated results demonstrated in this work enables decision maker to parallelly look at the development needs, the priority spatial entities and then commence the allocation of resources. This capability to carryout prioritisation facilitates a comparable assessment of local and regional development requirements and the effectiveness of already mobilised resources.

8.0 References

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