People's Hazard Risk Perception of Recent Environmental Change in the Dry Zone of Sri Lanka

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වර්තමානයේ සිදුවෙමින් පවතින වේගවත් පරිසර විපර්යාසය හමුවේ ශුෂ්ක කලාපීය ග්‍රාමීය ජනතාව තුළ ඇතිවන ආකල්පමය වෙනස්කම් හැදෑරීම අවශ්‍යතාවකි.එසේම තිරසාර බව හා අස්ථාවර බාවය පිළිබඳ අධ්‍යයනයේදී මානව හා පාරිසරික සංසිද්ධීන් ඒකීය පද්ධතියක් සැලකීම අවශ්‍යතාවකි.මෙම අධ්‍යයනයේ අරමුණ වන්නේ 1950 සිට 2010 තෙක් කාලය තුළ ශ්‍රී ලංකාවේ වියළි කලාපීය පරිසරයේ සිදුවූ පාරිසරික විපර්යාසවල ගතික ස්වභාවය හා එම විපර්යාස පිළිබඳව ප්‍රදේශයේ ජනකාවගේ ආපදා අවදානම් සංජානනයේ ඇති වූ වෙනස්කම් ප්‍රමාණාත්මකව හඳුනාගැනීමයි. ලිකර්ට්(Likert) පරිමාණයේ ප්‍රාන්තර පහක් සහිත ප්‍රශ්නාවලියකට සියදෙනෙකුගෙන් ලබාගන්නා ලද තොරතුරු ආශ්‍රයෙන් ස්පියර්මන් (Spearman) සහසම්බන්ධතා සංගුණකය හා සාධක විශ්ලේෂන(Factor Analysis) යන ක්‍රම යොදාගනිමින් ස්වභාවික හා මානව පරිසරයේ අංශ අටක් සැලකිල්ලට ගෙන කාලපරාස තුනක් සඳහා ආපදා අවදානම් සංජානනය හා වඩාත් ප්‍රබල සාධක හඳුනාගන්නා ලදී.නියඟ,සුළුවාට අසමානතාව ප්‍රථම කාල පරාසය වන 1950-1970 අතරදී ප්‍රධාන වශයෙන් ආපදා අවදානම් තත්ත්වයට දායකවී ඇත. දෙවන කාල පරාසය වන 1970-1990 කාලය තුළ වඩාත්ම දායක වී ඇත්තතේ කෘමිහානි මානව වනජීවී ගැටුම් වන අතර තෙවන කාල පරාසයේදී (1990-2010) ජල ගැලීම් හා සමාජ අසමානතාව සාධක වී ඇත.මුළු කාලය සලකාබලන විට සමාජ හර පද්ධතිය බිඳ වැටීම කෘමි හානි සුළුකාව හා පරිපාලන ගැටළු ක්‍රමයෙන් උස්සන්න වී ඇත.මේ අතර ජල ගැලීම් හා සමාජ අසමානතාව ක්‍රමිකව අඩු වී ඇත.මානව වනජීවී ගැටුම හා නියඟ පළමු කාලපරාසයට වඩා දෙවන කාල පරාසයේදී වැඩිවී දෙවන හා තෙවන කාලපරාසය අතර මෙම ප්‍රවණතාව හා සම්බන්ධ හේතු සාධක සාකච්ජා කොට ඇත.

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Introduction

Study of the dynamics of rural perception of the recent change in the tropical dry lands is an important aspect in the face of recent rapid environmental change (Mertz, 2009). In this field, consideration of the coupled human-environment as whole systems is a requirement in assessing sustainability and vulnerability (Lambian, 2003). In the light of recent rapid global environmental change, studying dynamics of perception on the various aspects of natural and social changes is becoming inevitable component in the evaluation of various effects and impacts of changes. This is important not only to explain the nature of human behavior but also to evaluate changes made by development activities how they are impacted on mentality of people. Perception of the rapid changes taken place during last 60 years after 1950s is recorded in the minds of elderly generation and access to this information through recalling might be valuable for adjustments to present human activities in order to reduce adverse effects.

All the changes, whether social or natural, are interrelated: change of one aspect affects all other aspects in the complexity of the human ecosystem. Therefore, social, economic and environmental aspects of sustainable development need to be given balanced treatment (Munasinghe, 2008). These changes make positive or negative impact on the mentality of people. In accessing the effects it is more important to learn negative impact in order to reduce possible social unrest and in order to make necessary changes to the direction of development activities. These negative impressions on changes reflect on wellbeing of people. This study suggests studying those negative impressions on changes as hazard risk perceptions.

Dry Zone of Sri Lanka is a particular human ecosystem in the tropical region where rapid environmental change had occurred during the last 60 years. It is attributed to both rapid environment change led by climate change and societal change. The societal change is partly a result of expansion of settlements and introduction of open market economy. Changes are reflected in the ecosystems and in the social systems in the region transforming savanna in to paddy fields, feudal village societies in to cities. This study would also be an attempt to work out a scientific methodology for retrospective perception analysis.

Objectives

The aim of this study is to quantify environmental change of the Dry Zone of Sri Lanka occurred during the period from 1950 to 2010 in terms of hazard risk perception of people. The objectives are to: 1) quantify role of different aspects in hazard risk perception in three phases arbitrarily defined as phase I from 1950 to 1970, phase II from 1971 to 1990 and phase III from 1991 to 2010 and 2) quantify trends of change during the period in terms of hazard risk aspects.

Methodology

This study adapts retrospective quantitative approach in studying evolution of the hazard risk perception with consideration of complexity of the environmental phenomena. Hundred respondents of age above 60 years (n = 100) were selected from randomly selected 10 clusters of villages located in the Dry Zone of Sri Lanka. The locations, representing the three agro-ecosystems, particularly small reservoir, major reservoir and Mahaweli, are Medirigiriya, Horoupothana, Kekirawa, Tambuttegama, Galnewa, Rajangane, Padaviya, Madatugama, Kebitigollewa and Kahatagasdigiliya. Structured questionnaire with 24 subject questions of Likert five scale response options for five levels of hazard, being five for highest and 1 for lowest, and seven questions to gather background information was administered. The 24 questions are being designed to get scores for eight aspects of the environmental change and for three phases (8X3 = 24). The phases are: I- period from 1950 to 1970, II- 1971 to 1990 and III – 1991 to 2010. The eight aspects of environmental change are: drought, flood, human wildlife conflict, pest hazard, health hazard, inequality, administration, and values. Data were processed and analyzed using SPSS 16 version. The risk levels definitions were adapted from Natural Hazards Local, National, Global (White, 1974) and in place of percentages of perception, five type Likert scale was used adapted from Poortinga et al 2004. (Poortinga,2004). Further Factor analysis was also conducted following the method adapted by Pootinga et al.

The nature of the three phases was identified by analyzing descriptive, particularly, central tendency and dispersion measures. Eight aspects in each phase were further analyzed using nonparametric (Spearman) correlation to find relationships among aspects. Factor analysis

was conducted for each phase for eight aspects using principle components analysis method and rotated with variance maximization in order to find the important aspects in each phase. The level of change of the aspects from one phase to other was computed by conducting nonparametric test for several related samples repeated measures (Friedman test) and established test ranks.

Result

The data analysis has made possible to identify specific features of three phases emphasizing the disaster situation of the period under study and to establish potential trends of disaster situation in relation to the eight aspects of the environmental change. Mean values of eight aspect scores and the ranks of each aspects of three phases show particular differentiation in the disaster situation. Patterns of Spearman's correlation of scores of eight aspects within a given phases demonstrate relationship characters specific to each phase. Further, factor analysis has produced a number of major axis around which the aspects rotate in three phases demonstrating the complex relationship of the disaster situation in relation to the aspects in each phase. Retrospective trends of disaster situation in each aspect were possible to identify by computing nonparametric Freidman test values of aspects in the first - second and second - third phases.

3.1. The first phase of disaster perception

Highest mean score was achieved in flood disaster situation during the first phase followed by drought indicating comparative high level of disaster related to the two aspects of floods and droughts (3.22 and 2.86 respectively out of highest possible score five) in the dry zone of Sri Lanka (Table 1). Human-Wildlife conflict was the third aspect of disaster during the first phase followed by inequality, diseases (health hazard) and pest problems. The lowest disaster situation has been shown in the social values and administrative system (1.13 and 1.62) indicating that the social values and the administrative system less distracted them in the survival and progress during the first phase (Table1).

Table 1 Descriptive Statistics of the First Phase

		drought1	flood1	hwc1	pest1	inequil 1	admin1	health1	value1
N	Valid	100	100	100	100	100	100	100	100
	Missing	0	0	0	0	0	0	0	0
Mean		2.86	3.22	2.81	1.70	2.28	1.62	2.22	1.13
Std. Deviation		1.155	1.001	1.203	.882	1.016	.801	1.011	.338
Skewness		-.323	-.704	-.299	.992	.000	.921	.740	2.234
Std. Error of Skewness		.241	.241	.241	.241	.241	.241	.241	.241

Some of the aspects of hazard perception are related with others: nonparametric (Spearman) correlations between aspects have shown the patterns of these relationships. For example, flood and drought correlates with each other positively creating the coefficient of 0.392" significant at the 0.01 level indicating that, according to people's perception during the first phase drought and flood are related phenomena. Drought had also positive relationship with human-wildlife conflict (0.383") and inequality (0.277"). A little higher relationship had existed (0.373") between health and pest hazards. Human-Wildlife Conflict had also positive relationship with flood (0.278"). Social values of this period had negative relationship with drought (-0.292") and with health a positive (0.273") relationship. Administration had low positive relationship with health (0.260"). Other relationships are not significant and possess lower values (Table 2).

Table 2 Significant Nonparametric (Spearman) Correlations for the First Phase

	Flood	HWC	Pest	Inequality	Admin	Health	Value
Drought	0.392"	0.383"	-	0.277"	-	-	- 0.292"
Flood		0.278"	-	-	-	-	-
HWC			-	-	-	-	-
Pest				-	-	0.373"	-
Inequality					-	-	-
Admin						0.260"	-
Health							0.273"

" Significant at 0.001 level (Other correlations are lower and less significant)

Contributing factors to the hazard scenario of the first phase were evaluated through factor analysis using principle component analysis method with rotation of variance maximization and three components were extracted in six iterations. The first component rotates around drought (0.797), the second around health (0.752) and the third around inequality (0.742) (Table 3) indicating importance of the aspects on the hazard scenario of the first phase. This means people perceive that this phase was a period with high level of drought, health hazard and inequality.

Table 3. Component Matrix of the First Phase [a]

	Component		
	1	2	3
Drought1	.797	-.181	.229
Flood1	.684	-.114	-.005
HWC1	.651	.314	-.200
PEST1	.340	.620	-.333
INEQUILITY1	.330	.189	.742
ADMIN1	-.135	.441	.513
HEALTH1	.055	.754	-.282
VALUE1	-.383	.622	.251

Extraction Method: Principal Component Analysis.

a. 3 components extracted.

3.2. Second phase of disaster perception

The second phase characterized by high level of perception in drought as a hazard with mean value 3.14 followed by human wild life conflict being 2.77. The third aspect of hazard perception during the second phase is the pest problem (2.65). Deceases (Health) considered being in the next in the rank of hazard aspects with the mean value of 2.53. Flood, values, inequality and administration aspects have scored respectively with means of 2.28, 2.23, 2.12 and 2.12 (Table 4). While this phase with contrasting different political ideology dominated in the country for its development launching both closed economy and open market systems, rural people perceived drought, human wildlife conflict, pest problems as high hazard aspects and flood, social values inequality and administration were considered less problematic.

Table 4 Descriptive Statistics of the Second Phase

	Drought2	Flood2	Hwc2	Pest2	Inequil2	Admin2	Health2	Value 2
Valid	100	100	100	100	100	100	100	100
Missing	0	0	0	0	0	0	0	0
Mean	3.14	2.28	2.77	2.65	2.12	2.12	2.53	2.23
Std. Deviation	.804	.866	.839	.609	.537	.498	.643	.510
Skewness	-.499	.088	.878	.085	.901	1.250	.119	1.249
Std. Error of Skewness	.241	.241	.241	.241	.241	.241	.241	.241

Considerable positive significant correlations were found between Pest – social values (' 0.327") Pest- Health (0.298") pest – HWC (0.276"), and inequality – health (0.311) during the second phase (Table5).

Table 5 Significant Nonparametric (Spearman) Correlations for the Second Phase

	Flood	HWC	Pest	Inequality	Admin	Health	Value
Drought	-	-	-	-	-	-	-
Flood		-	-	-	-	-	-
HWC			0.276"	-	-	-	-
Pest				-	-	0.298"	0.327"
Inequality					-	0.311"	-
Admin						-	-
Health							-

" - Significant at 0.001 level (Other correlations are lower and less significant)

Factor analysis constructed three components of the hazard aspects for second phase with high contribution of:1) pest (0.677), 2) human-wildlife conflict (0.798) and 3) drought (0.674) indicating high contribution of those aspects to the hazard perception of the second phase (Table6).

Table 6 Component Matrix of the Second Phase [a]

	Component		
	1	2	3
Drought2	.241	.278	.674
flood2	.520	-.441	.178
HWC2	.067	.798	.233
PEST2	.677	.427	-.051
INEQUILITY2	.399	-.477	.310
ADMIN2	.373	.109	-.652
HEALTH2	.654	-.233	.042
VALU2	.632	.193	-.228

Extraction Method: Principal Component Analysis.

a. 3 components extracted.

3.3. Third phase of disaster perception

Pest problem has become the highest risk perception during the third phase being in the first ranked and with 3.4 mean value out of five possible (Table 7 and 10). Values become the second followed by health risks as perceived by people. Mean value of drought hazard risk perception is in the forth in rank with mean value of 2.41. Human-wildlife conflict, administration, flood and inequality were comparatively less hazardous during the third phase.

Table 7 Descriptive Statistics of the Third Phase

		Drought3	Flood3	Hwc3	Pest3	Inequil3	Admin3	Health3	Value3
N	Valid	100	100	100	100	100	100	100	100
	Missing	0	0	0	0	0	0	0	0
Mean		2.41	1.81	2.55	3.40	1.70	2.36	3.15	3.33
Std. Deviation		1.173	.837	1.009	.667	.859	.835	1.029	.570
Skewness		.029	.584	.222	-.877	.918	.084	-.478	-.468
Std. Error of Skewness		.241	.241	.241	.241	.241	.241	.241	.241

Relationships among selected eight aspects of hazard risks during the third phase are been presented in the table 8 below and health and values appeared to be significantly correlated with more aspects. Highest correlation is found between values and flood though flood is in the seventh in the rank.

Table 8 Significant Nonparametric (Spearman) Correlations for the Third Phase

	Flood	HWC	Pest	Inequality	Admin	Health	Value
Drought	0.461"	-	-	-	-	-	-
Flood		0.412"	-	-	0.431"	0.338"	0.557"
HWC			-	-0.262"	0.314"	0.504"	0.296"
Pest				-	-	0.324"	-
Inequality					-	0.311"	-
Admin						0.336"	0.279"
Health							0.415"

" Significant at 0.001 levelOther correlations are lower and less significant

Factor analysis of the scores of the eight aspects for the third phase produced two components. The major axis of the first component rotates around flood and of the second rotating around inequality (Table 9) indicating prominent role of the two aspects in the hazard perception of the third phase. This means that in the third phase people perceives all hazards are located around flood and inequality.

Table 9 Component Matrix of the third Phase [a]

	Component	
	1	2
drought3	.452	.608
flood3	.781	.330
HWC3	.699	-.302
PEST3	.401	-.412
INEQUILITY3	-.183	.685
ADMIN3	.621	.058
HEALTH3	.710	-.317
VALUE3	.691	.228

Extraction Method: Principal Component Analysis.

a. 2 components extracted.

Table 10 Perceived hazard risk levels and ranks in three phases

Aspect	*Phase I*		*Phase II*		*Phase III*		*Trend*
	Mean	*Rank*	*Mean*	*Rank*	*Mean*	*Rank*	
Drought	2.86	**2**	3.14	**1**	2.41	**4**	Variable
Flood	3.22	**1**	2.28	**5**	1.81	**7**	Decreased
HWC	2.81	**3**	2.77	**2**	2.55	**5**	Variable
Pests	1.70	**6**	2.65	**3**	3.40	**1**	Increased
Inequality	2.28	**4**	2.12	**7**	1.70	**8**	Decreased
Administration	1.62	**7**	2.12	**7**	2.36	**6**	Variable
Health	2.22	**5**	2.53	**4**	3.15	**3**	Increased
Values	1.13	**8**	2.23	**6**	3.33	**2**	Increased

3.4. Trends in disaster perception

In order to establish the nature of temporal changes taken place during the three phase's nonparametric test for several related samples (Friedman test) was conducted treating scores of eight aspects in each phase as repeated measures. High Chi-Square value (479.96) and 0.000 asymmetry significant level indicates significant change has been established using this methodology. Accordingly, it can be deduced that in the second phase hazard risk compared to the first is higher in the aspects of values, pest, administration, drought, health and human-wildlife conflict, while flood and inequality

perception had been reduced. Highest increase from 2.76 to 8.15 was found in values which had the lowest risk in the first phase. Pest hazard perception had increased from 5.4 to 10.24 being the second in order.

Table 11 Friedman test Ranks of first and second phases

Aspect	*Mean Rank*	*Test statistic[a]*
DROUGHT1	*10.28*	*N 100*
DROUGHT2	*12.02*	*Chi-Square 479.960*
FLOOD1	*12.12*	*df 15*
FLOOD2	*8.22*	*Asym. Sig. .000*
HWC1	*10.28*	*a. Friedman Test*
HWC2	*10.36*	
PEST1	*5.40*	
PEST2	*10.24*	
INEQUILITY1	*8.37*	
INEQUILITY2	*7.43*	
ADMIN1	*5.38*	
ADMIN2	*7.58*	
HEALTH1	*7.86*	
HEALTH2	*9.56*	
VALUE1	*2.76*	
VALUE2	*8.16*	

Friedman test for the second and third phases reveals that drought, flood, inequality and human-wildlife conflict had been reduced and the hazard risk of values, pest, health and administration had been increased. Highest reduction is observed in droughts and the highest increase in the values

Table 12 Friedman test Ranks of Second and Third phases

Aspect	Mean Rank	Test Statistic [a]
DROUGHT2	11.29	N 100
DROUGHT3	7.91	Chi-Square
FLOOD2	7.31	df 15
FLOOD3	4.87	Asymp. Sig. .000
HWC2	9.40	
HWC3	8.62	a. Friedman test
PEST2	9.07	
PEST3	12.88	
INEQUILITY2	6.34	
INEQUILITY3	4.66	
ADMiN2	6.21	
ADMIN3	7.7	
HEALTH2	8.46	
HEALTH3	11.64	
VALUE2	6.77	
VALUE3	12.88	

Hazard risk perception of values has shown continuous increase, ranking highest in both changes. This indicates that degradation of the social values during the last 60 years had a continuous rapid change. Pest problem becomes second which also possess increasing trend in both changes. Health and administration hazard risk have shown continuous increase with lower magnitude. Human wildlife conflict and drought had increased in the first comparison and reduced in the second. Continuous decline had possessed in flood and inequality indicating reduction of hazard risk of both during the period of 1950 to 2010 period.

Conclusion

Changes of all aspects and periods could be compared with results of other studies of both natural and societal changes which are out of the scope of this study. However, some of the comparisons are essential. For example, Values, which had shown rapid change during the period is understood in the common public degradation of eastern value system, loosening of religious binding, collapse of extended family culture during the period has been discussed widely. The second aspect in the rank of rapid increase, the pest problem, has connections with climate change, rapid change in the cultivation practices with implementation of major irrigation systems, increased cost on agriculture inputs and collapse of indigenous pest management systems. Continuous increase of the health hazard

perception in spite of increased health facilities is attributed to changes in the decease scenario from infectious, vector and water borne to "new deceases" and rapid increased concern of health of the people. Though the administration system had been considerably expanded during the period and become people friendly, people's awareness on corruption and inefficiency has influenced the continuous increase of the hazard perception.

Continuous decline of the flood hazard perception during the period from 1950 to 2010 attributed to reduction of high floods killing many people such as experienced in 1957 and reduction of flood hazard due to construction of Major reservoirs in the Dry Zone and in the Mahaweli systems. Another considerable reduction in the hazard perception during the period is related with inequality, which means inequality among people has been reduced.

This is attributed to several factors such as, expanded education system providing more employment opportunities and reduced negative values of feudal society such as cast deprivation, improvement of land ownership status and expanded infrastructure and social services.

Recommendation

Findings of this study, the trends and depths of the problem are indicators to be considered by policy makers in order to reduce hazard levels of the environmental change, however, it should be noted that in some cases the situation has been improved though the perception has been degraded such as in the case of health hazard perception. There would also be some perception change mechanisms to be introduced.

The methodology tested by this study to quantify overall hazard perception of environmental change and to identify trends proven to be successful and can be applied elsewhere. The aspects and the periods may be modified. The statistical approach central tendency measures, correlation, factor analysis and Friedman test can be applied in the same way.

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Table 7 Descriptive Statistics of the Third Phase

		Drought3	Flood3	Hwc3	Pest3	Inequil3	Admin3	Health3	Value3
N	Valid	100	100	100	100	100	100	100	100
	Missing	0	0	0	0	0	0	0	0
Mean		2.41	1.81	2.55	3.40	1.70	2.36	3.15	3.33
Std. Deviation		1.173	.837	1.009	.667	.859	.835	1.029	.570
Skewness		.029	.584	.222	-.877	.918	.084	-.478	-.468
Std. Error of Skewness		.241	.241	.241	.241	.241	.241	.241	.241

Relationships among selected eight aspects of hazard risks during the third phase are been presented in the table 8 below and health and values appeared to be significantly correlated with more aspects. Highest correlation is found between values and flood though flood is in the seventh in the rank.

Table 8 Significant Nonparametric (Spearman) Correlations for the Third Phase

	Flood	HWC	Pest	Inequality	Admin	Health	Value
Drought	0.461"	-	-	-	-	-	-
Flood		0.412"	-	-	0.431"	0.338"	0.557"
HWC			-	-0.262"	0.314"	0.504"	0.296"
Pest				-	-	0.324"	-
Inequality					-	0.311"	-
Admin						0.336"	0.279"
Health							0.415"

" _ Significant at 0.001 levelOther correlations are lower and less significant