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Supplementary Material

File S1: Questionnaire used for participatory interviews.

Participatory assessment of the impact of climate and land-use changes on food production in the Village Tank Cascade Systems in Anuradhapura District of Sri Lanka

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Section A (i): Social-economic and farming characteristics

1. Survey sheet number	
2.Date and time	
3.Name of the VTCS	
4. GN division	
5. Respondent's name	
6.Mobile Number	
7.Occupation/profession/livelihood	
8.Gender/Sex	
9.Age	
10.Marital status	
11.How many members are in the household	
12.How many family members are employed	
13.Member of any farmer organization	
14.Education level	
15.Number of generations the respondent has been living in this area	

Section A (ii): Farming information

16. Engagement of farming a) professional full-time b) occasional part-time c) no farming

17. If farming full-time, where is your farm located in VTCS a) upstream b) midstream c) downstream

18-19. What types of farming do you practise in the VTCS and what type of water source used for farming? (Please tick/write)

Farming practice	**Pl. tick**	**Farming seasons** *Y=(Yala) M=(Maha)*	**Water sources** (T), (RF), (AW), (DW)
a) Minor irrigated paddy (Lowland)			
b) Rainfed paddy (upland)			
c) Rainfed shifting cultivation (Chena)			
d) Seasonal crops farming based on climatic seasons			
e) Home garden horticulture,			
f) bee-keeping			
g) Livestock farming			
h) Fishery			
i) Plantation crops			
j) Medicinal crops			
k) Other			

(T, Village Tank; RF, Rainfed (soil moisture); AW, Agro-well; DW, domestic well)

20. What type of food groups do you cultivate on your farm? (Tick the right columns)											
Cultivated food groups	**Farming types (please refer above A (ii))**										
	a	b	c	d	e	f	g	h	i	j	k
a. Cereals (paddy)											
b. Cereals (maize)											
c. Underutilised cereals (e.g. Maha meneri)											
d. Legumes/Pulses											
e. Common vegetables											
f. Leafy vegetables											
g. Underutilised vegetables (e.g Welthibbatu)											
h. Condiments and spices											
i. Common fruit crops											
j. Nuts and seeds											
k. Oil seeds											
l. Tubers and roots											
m. Underutilised fruits (e.g. Damba)											
n. Plantation crops											
o. Medicinal and herbal crops											
p. Livestock											
q. Fish											
r. Other (Pl specify)											

21. What is the size of farm plots?.....ha

22. How long has the respondent been farming in the area?.....years

23. Do you collect food items from the non-farming areas of the VTCS?
a) Yes: b) No:

24. If yes, what type of non-farming areas?
a) Catchment Forest b) Kattakaduwa c) Gasgommana d) Tank bund e) Scrub land Streams f) Tanks g) Other (Pl. specify)

25. How have the expenses (cost) for farming changed over the past 10 years?	a) Increased b) Constant c) Decreased
26. How has the income/profit for farming changed from the past 10 years?	d) Increased e) Constant f) Decreased
27. To What extent is your household dependent on food generated from within the VTCS resources?	0%, <25% <50% <75% >75%

Section B: Farming challenges

Discussion point: Different challenges experienced by the farmers due to various biophysical and socio-economic changes in the MVTCS.

28-29. What major challenges affect farming in your area? In your perception, please rank and rate the impact of those constraints. (Tick the right column)

Challenges/Constraints	**Rank**	**Impact on food production**				
		Not at all (1)	Low (2)	Medium (3)	High (4)	Very high (5)
a) Inadequate water for farming (crop/livestock/fisheries)						
b) Unpredictable weather						
c) Poor soil fertility						
d) Wildlife disturbances and damage						
e) Lack of access to markets for farm products selling						
f) Lack of local government institutional support						
g) Lack of seed supply						

h)	Lack of agriculture extension services						
i)	Land use change related issues (soil erosion, land degradation, sedimentation, loss of biodiversity)						
j)	Aquatic invasive weeds						
k)	Changes in salinity in soil and irrigation water						
l)	Shortage of labour and migration						
m)	Increasing population						
n)	Lack of local government support						
o)	Pest and disease outbreaks						
p)	Human health issues						
q)	Poor function of farmer organizations						
r)	Shortage of groundwater						
s)	Others (Please specify)						

Section C: Perceptions on land-use change influential factors and pressures affecting farming

(This section evaluates farmers' perceptions of the behaviour of influential factors of land use change and their impacts on food production).

Discussion point: Past and present land-use changes in the area and how these land-use changes affect agriculture productivity, food security and livelihoods.

30. The village tank cascade system (VTCS) that I am living in has undergone rapid environmental changes (e.g. in land use, water use, natural vegetation, biodiversity, etc.) in the last 10 years. Do you agree with this statement?

a) Strongly disagree b) Disagree c) Neutral d) Agree e) Strongly agree, f) No idea

31. Have you observed any land-use changes in the village landscape areas during the last 10 years

a) Yes b) No c) No idea

32. If yes, do you think these changes have any impact on overall productivity and food security in VTCS?

a) No idea b) Not affected c) Little d) Somewhat e) Highly affected

33-34. If yes, Which of the following Land Use Change Influential Factors (LUCIFs) have you experienced and how has it adversely affected (severity score) food production? (Tick the right column).

Land-use change stresses	**Impact**	**The scale of Impact (Pl tick)**				
	Yes/No/ No idea	Not at all (1) (0%)	Low (2) (< 25%)	Medium (3) (<50%)	High (4) (<75%)	Very high (5) (>75%)
a) Increased land fragmentation						
b) Land use pattern changes – Arrangement of different land uses in the VTCS landscape						
c) Land use structural changes – Size, shape, composition etc. in a particular land use type						
d) Increased deforestation in catchment forest						
e) Increased encroachment in semi-natural scrub lands						
f) Others (Please specify)						

35-36. What are the negative impacts of the above LUCIFs on your food production?

Challenges/Constraints	**Rank**	**Impact on food production**				
		Not at all (1)	Low (2)	Medium (3)	High (4)	Very high (5)
a) Land and soil degradation/decreased soil fertility						
b) Decreased diversity – biodiversity, agrobiodiversity, habitat diversity and ecosystem services						
c) Increased wildlife damage						

d)	Increased soil erosion leading to sedimentation/eutrophication						
e)	Reduction of soil moisture and groundwater						
f)	Decreased water quality						
g)	Increased following of lands						
h)	Decreased livelihood diversity and options						
i)	Effects of household dietary requirements and food pattern (Impacts on household food and nutrition security)						
j)	Impact on farmers' health and capacity						
k)	Others (Please specify)						

37. Over the next 10 years, I expect that the rate of land-use changes will increase significantly. Do you agree with this statement?

a) Strongly disagree b) Disagree c) Neutral d) Agree e) Strongly agree f) No idea

38. Over the next 10 years, I expect that the rate of land-use changes will decline. Do you agree with this statement?

a) Strongly disagree b) Disagree c) Neutral d) Agree e) Strongly agree f) No idea

39. Ecological conditions of natural land uses in the village landscape are very unstable or unpredictable (i.e. there are strong fluctuations in ecosystem services and biodiversity)

a) Strongly disagree b) Disagree c) Neutral d) Agree e) Strongly agree f) No idea

Section D: Perceptions on climate change influential factors and impacts on farming

(This section evaluates farmers' perceptions of the behaviour of influential factors of climate change and their impacts on food production risk).

Discussion point: Past and present climate change and variability trends in the area and how these changes impacted agriculture productivity, food security and livelihoods.

40. During the last 10 years, have you noticed any changes in the (i) long-term trend of climatic conditions such as rainfall and temperature (ii) Short-term changes of climate variability and weather patterns such as increased frequencies and intensities of weather events (iii) Occurrence of extreme climatic or/and weather events (e.g. droughts and floods)in the VTCS areas?

*(i) Long-term **trend** of **rainfall changes** (e.g. gradually decreasing or increasing RF from last 10 years)*

a) Yes b) No c) No idea

*(ii) Short-term changes of **rainfall variability** such as increased frequencies and intensities of rainfall events, uncertain and erratic rainfall patterns)*

a) Yes b) No c) No idea

*(iii) Occurrence of **extreme** rainfall **events** (e.g. droughts and floods)*

a) Yes b) No c) No idea

*(iii) Increasing **trend** of **average temperature.***

b) Yes b) No c) No idea

41. If yes what is the most prominent and most impactful climate change factor? Pl rank

*(i) Long-term **trend** of rainfall changes (e.g. gradually decreasing or increasing RF from last 10 years) (……..)*
*(ii) Short-term changes of **rainfall variability** (increased frequencies and intensities, uncertain/erratic rainfall pattern) (…….)*
*(iii) Occurrence of **extreme rainfall events** (e.g. droughts and floods) (……)*
(iv) Increasing trend of average temperature (……)

42-43. During the last 10 years, which of the following Climate Change Influential Factors (CCIFs) events have you experienced? And how has it impacted (severity score) food production? (Tick the right column).

Climate change and variability stresses (CCIFs)	**Impact**	**The scale of Impact (Pl tick)**				
	Yes/No/ No idea	Not at all (1)	Minor (2)	Moderate (3)	High (4)	Very high (5)
a) Average rainfall amount changed - Increased or decreased rainy length of season or rainy days,)						
b) Average rainfall amount change – Decreased rainy days /length of rainy season						
c) Extreme events – High-intensity rainfall within a short period leading to high runoff and floods						
d) Erratic and uncertain rainfall pattern (Changes in monsoonal rainfall pattern. Untimely rain/delayed rainy season: early/delayed onset)						
e) Increased dry spells (No rainfall after a short rainy season)						
f) Extreme event (Prolonged drought /long dry spell/insufficient rainfall for cultivation)						
g) Average temperature variations/Increased hot days/heat stress						
h) Other (Please specify)						

44-45. Based on your knowledge, What has been the impact (score) of the above CCIFs on your food production? (Tick the right column)

Impacts	**Scale of Impact**				
	Not at all (1)	Low (2)	Medium (3)	High (4)	Very high (5)
a) Decreased food production (crops, livestock, fishery) due to shortage of water, increased temperature, decreased soil moisture and groundwater etc.					
b) Decreased food production (crops) due to stormwater and flood damage					
c) Decreased land suitability for farming or increased fallow lands					
d) Increased land degradation/soil erosion due to stormwater					
e) Increased wildlife damage to crops					
f) Increased pest and disease outbreaks and invasive aquatic plants					
g) Increased sedimentation/eutrophication due to stormwater					
h) Increased cost of food production					
i) Decreased biodiversity and capacity of ecosystem services provisions					
j) Decreased livelihood diversity and options					
k) Effects of household dietary requirements and food pattern (Impacts on household food and nutrition security)					
l) Impact on farmers' health and well-being					
m) Other (Please specify)					

Section E: Farmers' perception of adaptation to climate change

46. Are you aware of adaptation practices or measures to cope with climatic and non-climatic stresses?

a) Not aware b) Slightly aware c) Moderately aware d) Aware e) Fully aware

47. Have you received any awareness-raising programme/training on the climate change and their impact mitigation

a) Yes b) No

48. What training/awareness have you received on farming and adaptation to climate change?	a)	Resistant crop varieties
	b)	Soil conservation and SLM practices

(Tick the right raw)	c) Resistant animal breeds
	d) Soil conservation by sustainable land use management
	e) Soil moisture conservation
	f) Improvement of soil organic matter content
	g) Adjusting farming practices
	h) Agro-forestry and agroecology practices
	i) Drought early warning
	j) On-farm rainwater harvesting
	k) Household food and nutrition management
	l) Pest and disease management
	m) Other (specify)

49-50. What adaptation/coping strategy/s or practice/s have you adopted on your farm to mitigate the climate change stresses? How has it improved your agriculture production?

Adaptation measures	**Effect on food production (Pl tick)**				
	Not practised (0)	Low (1)	Moderate (2)	High (3)	Very high (4)
a) Adjust the planting time (Early planting/delayed planting time)					
b) Use of drought-resistant varieties					
c) Use of traditional varieties/breeds					
d) Use of organic fertilizer					
e) 'Bethma' practice during the drought period					
f) 'Pangu' method - Regular maintenance of tanks to avoid disasters					
g) 'Goda wee hena' due to inadequate tank storage					
h) Practicing crop diversification					
i) Crop rotation					
j) Soil moisture conservation through mulching and other measures					
k) Soil conservation measures					
l) Maintenance of village commons micro-land uses (Kattakatuwa, Gasgommana, Iswati, Kiul ela etc)					
m) Household rainwater harvesting					
n) Agro-forestry farming					
o) Use of traditional knowledge for forecasting and early warnings					
p) Access government subsidies					
q) Irrigation using agro wells					
r) Use of rituals and astrological practices					
s) Elephant fencing					
t) Access to agricultural extension and information services					
u) Other (Specify)					

51. Based on your experience in the last 10 years, how do you rate land use change and climate change impacts on food production in the area?

Land use change impacts: a) Minimum b) Low c) Moderate d) Severe

Climate change impacts: a) Minimum b) Low c) Moderate d) Severe

52. Over the next 10 years I expect that people in this area will become much more vulnerable to food production due to climate and land use change impacts. Do you agree with this statement?

a) Strongly disagree b) Disagree c) Neutral d) Agree e) Strongly agree f) No idea

Closing: Do you have any other comments on the land use and climate change impacts on the village and its community?

Thank You!

Figure S1: Farmers' perceptions of climate change impacts on food production. (a) severity of climate change influential factors (CCIFs); and (b) impacts on food production.

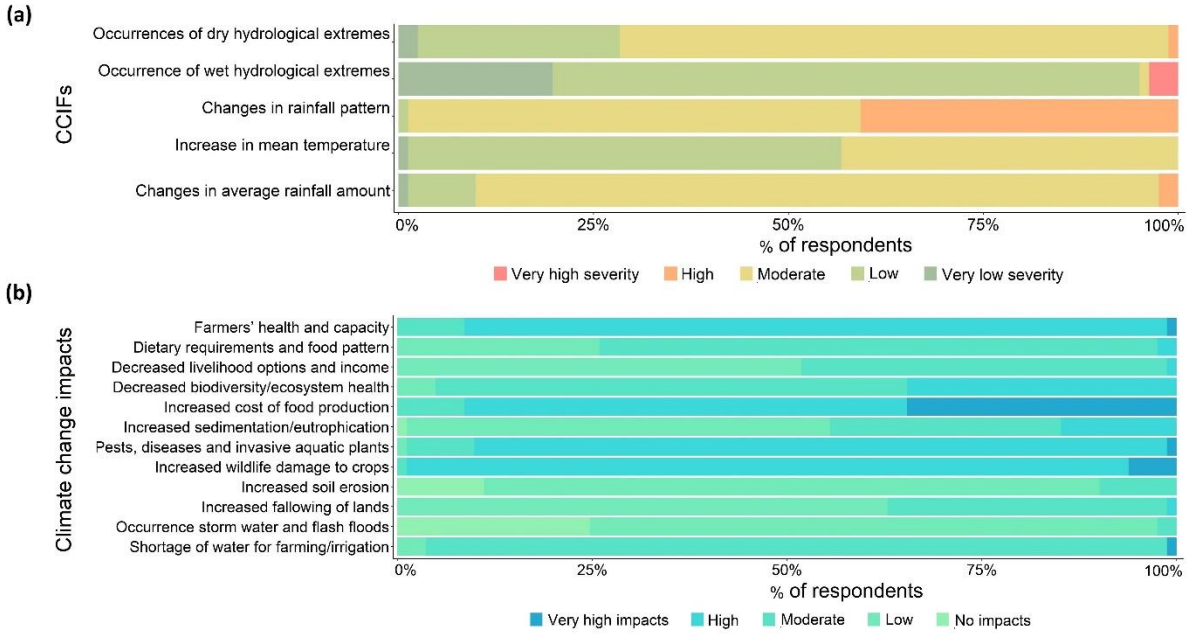


Figure S2: Farmers' perceptions of land use change impacts on food production. (a) the severity of land use change influential factors (LUCIFs), and (b) impacts on food production.

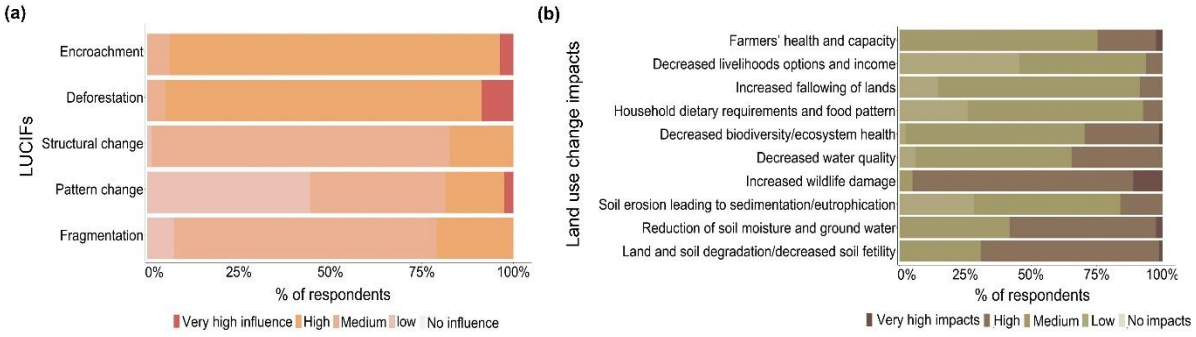
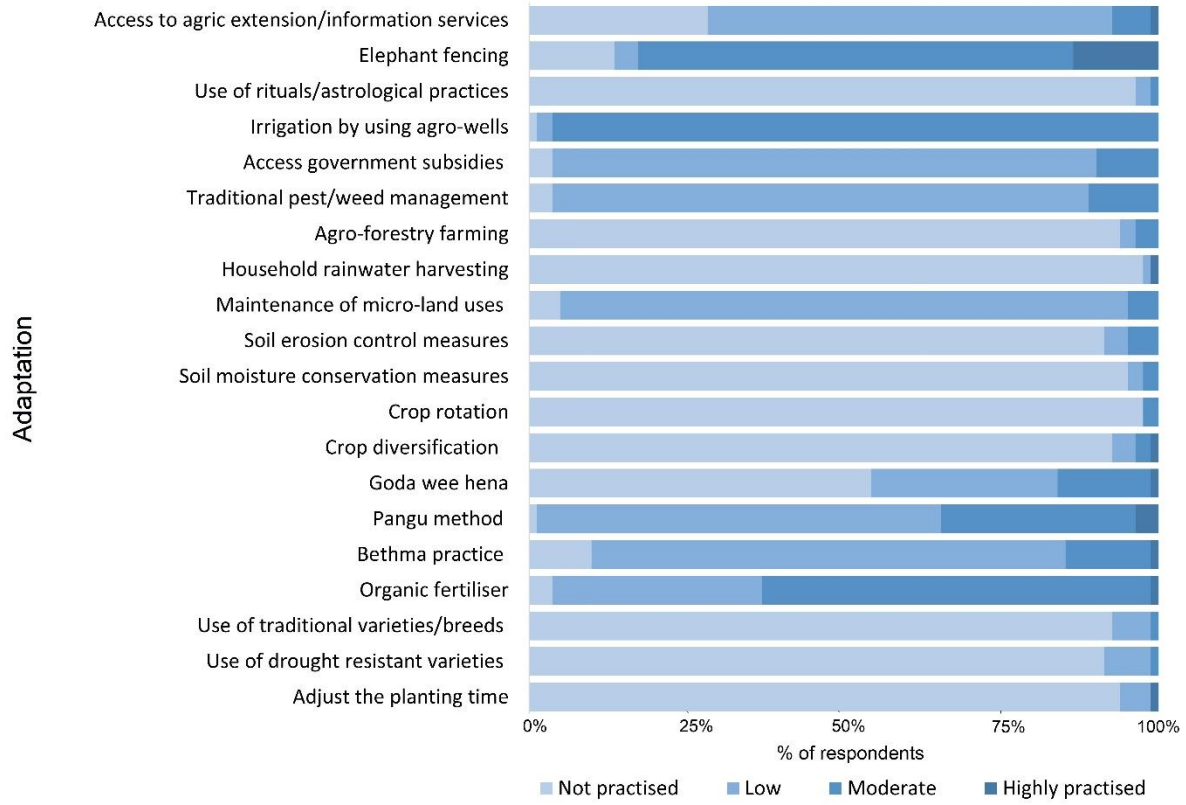


Figure S3: Farmers' perceptions of adaptation practices.



Bethma practice: The bethma cultivation practice is adopted in poor rainfall seasons when the farmers cannot cultivate the entire paddy tract by using limited water in the tank. It is a practice that temporarily redistributes plots of land among paddy landowners in part of the command area of a tank during drought periods.

Pangu method: Farmers divide the maintenance works, such as tank bund clearing, canal clearing, bund repair, sluice cleaning, etc. during dry periods as shared tasks assigned to each farmer proportionately to land ownership to prepare the irrigation system for seasonal cultivation.

Goda wee hena: When dry sowing of paddy seeds is done in tank upstream areas, it is called vee hena or goda hena.

Source: Dharmasena (1989)

References

86. Dharmasena, P. Optimum utilization of the storage in village tanks. Trop. Agric. 1989, 145, 1-11.