Farm level damage and loss assessment of natural disasters: How realistic are the assessments?

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Received 05 November 2021; received in revised form 01 May 2022; accepted 05 May 2022

Abstract

The mounting evidence on global climate change and its effects leading to increased occurrence of natural disasters that directly impact the lives and livelihoods of people is a matter of serious concern. The climatic extremes are often found to adversely affect farm production and productivity as agriculture is highly vulnerable to climate variability and change. The study was undertaken in the background of the unprecedented deluge that engulfed the entire state of Kerala in the year 2018 triggering 341 landslides, destroying topography of affected areas, claiming 433 lives and resulting in huge loss to state's economy. A large number of agriculture dependent rural households, most of which are involved in subsistence agriculture, were found to have borne the brunt of the unprecedented deluge and its aftermath. The assessment of disaster effects on farm households was carried along the flood plains of Chalakudy river in terms of damages and losses following the FAO methodology. The study revealed severe damage to crops, livestock and agricultural assets and pegged the damage and loss at about ₹ 259 crores in the flood plain. The destruction of seasonal crops in the stage of harvest imposed greater monetary loss to the farm households than any other damages. The inconsistencies with regard to the estimated flood impact to agriculture and the corresponding reported values by the government departments concerned, suggest the need for adopting internationally approved frame work for assessing the impact of disasters on agriculture; both at macro and microlevel.

Keywords: Assessment, Chalakudy river basin, Damage, Disaster, 2018 Kerala floods, Loss.

Introduction

Natural disasters are low-probability, high-consequence events that can result in significant human losses and economic shocks. Disaster induced economic damage has been increasing in the past few decades and is likely to continue growing because of urban development, population growth and ecosystem alteration (IPCC, 2012). As per the annual report of Weather, Climate and Catastrophe Insight, natural disasters alone have caused economic losses in tune of USD 225 billion across the world in 2018, and its far-reaching effects are now clearly visible on agricultural sector, on which relies the food production and economy of the world (Arora, 2019). At the same time, the United Nation Sendai Framework for Disaster Risk Reduction 2015-30, which advocates for substantial reduction of disaster risk and losses in lives and livelihoods of people, communities and countries has observed under-reporting of disaster induced damages in the case of low-income countries (UN, 2015).

Floods are the most common natural hazards in India. While Asia accounted for 45 percent of the total flood events recorded worldwide during the period 1980-2017, India accounted for five percent of these flood events and lost about 58.7 billion USD (Patankar, 2019). According to GOI (2011) statistics, approximately 40 million hectares of land in the country is flood prone. During the period

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1980-2011, the annual loss of Gross Domestic Product (GDP) was around 0.46 per cent on account of flood, and the reduction to GDP contribution in terms of crop loss, damage to private and public properties were reported as 0.18, 0.25 and 0.21 per cent, respectively (Parida, 2017).

Kerala state, with its location along the sea coast with a steep gradient along the slopes of the Western Ghats is highly vulnerable to natural disasters, and floods are the most common natural hazards in the state. Kerala stands fourth in the state-wise vulnerability to flood, measured in terms of average annual flood damage as percentage of the Gross State Domestic Product (GSDP) (Parida, 2017). The State is also at fourth position with regard to average annual area affected by floods as percentage of State geographical area (Parida, 2017). Kerala encountered the worst floods in its history since 1924, between June 1st and August 19th of 2018. The combined precipitation that the state received during this period was 42 per cent in excess of the normal and in the fortnight from 1st to 19th of August, the state received 164 percent higher rainfall (IMD, 2018). The extreme downpour and the subsequent deluge affected all aspects of human lives including socio-economic conditions, transportation, infrastructure, agriculture and livelihood. The PDNA (Post Disaster Need Assessment) by the state government has pegged the total disaster effects at around ₹ 26,720 crores, comprising of total damages (₹ 10,557 crores) and total losses (₹ 16,163 crores). Considering the agriculture sector comprising of crops, livestock and aquaculture/fisheries sub sectors, the total disaster effect was estimated as ₹ 7,154 crores. Crops were most heavily affected, accounting to 88 per cent of the total loss and damage to the sector (GOK, 2018).

Studies focusing on impacts of flood disasters are increasingly gaining significance in the recent decades as frequency of occurrence of the flood events are on the rise. This is further complicated by the increasing population and socioeconomic activities in the river basins (Shrestha et al., 2014). According to the Global Facility for Disaster Reduction and Recovery (2010), conducting post-disaster damage and loss assessment would help to measure quantitative requirements for financial recuperation and restoration after disasters, to determine limit of government to lead post calamity programs on its own and to give quantitative basis for the *ex-ante* disaster risk management schemes. In most cases, disaster loss assessment confines itself to just an assessment of damages, and the loss of livelihood, which has a greater long-term impact, is mostly neglected.

This paper discusses one universally accepted methodology for damage and loss assessment in agriculture and estimates the value of the loss and damage suffered by the farm households along the flood plains of Chalakudy river in the Kerala floods, 2018. An attempt had been made to provide a systematic estimate of the agricultural loss due to the flood, as well as its impact on the farm households in the study area.

Materials and Methods

Study area and sampling

The study was undertaken in the flood plains of Chalakudy river spread over Thrissur and Ernakulam districts of Kerala. Chalakudy river is the seventh longest river in the state, originating from the Anamalai and Nelliampathy ranges of the Western Ghats, the 130 km long river flows through the districts of Palakkad, Thrissur and Ernakulam of which major portion lies in the Thrissur district. The river joins the right arm of the Periyar river, before it discharges into the Arabian Sea through the Kodungallur–Azhikode estuary (Latha et al., 2012). The basin is characterised by an average annual rainfall of 3250 mm, with Southwest monsoon during June-September contributing more than 70 per cent of annual rainfall. The basin is spread across 19 Panchayats in six blocks (Kodakara, Chalakudy, Mala, Angamaly, Parakkadavu and Nemmara) and one Municipality (Chalakudy) in Kerala. According to the 2017-18

Table 1. Major crops in the Chalakudy river basin and the blocks which occupy the highest area under each crop

Crop	Block	Area (Ha)
Coconut	Kodakara	5154.41 (21.88)
Paddy	Nemmara	9909.66 (78.59)
Nutmeg	Chalakudy	1887.46 (26.20)
Banana	Angamaly	936.8 (31.56)
Plantain	Angamaly	870.06 (30.18)

Note: Figures in parentheses indicate per cent to total area under respective crop in the basin
Source: Agricultural Statistics 2017-18, Department of Economics and Statistics, Government, of Kerala.

Agricultural Statistics, coconut occupies the largest area under cultivation in the basin followed by paddy, nutmeg and banana. Maximum area under coconut is in Kodakara block, whilst for paddy it is Nemmara block. Chalakudy and Angamaly blocks account for maximum area under nutmeg and banana, respectively. Area under major crops in the river basin is given in Table 1.

A multistage purposive sampling procedure was adopted in the study. At the first stage, out of three districts that make up the Chalakudy river basin, Thrissur and Ernakulam districts were purposively selected based on the extent of flood havoc. In the second stage, all the panchayats in the selected districts coming in the river basin were identified and listed using the physical map of the basin obtained from the Regional office of the Kerala State Land Use Board at Thrissur. Accordingly, 19 panchayats were identified and from them, 10 severely affected panchayats were selected in consultation with the Assistant Directors of Agriculture of the respective blocks. The list of farmers who had applied for the natural calamity claims in the selected panchayats were obtained from the respective Krishi Bhavans, making the population size as 5706. Farmers were then randomly selected for the survey from the list obtained from each panchayat so as to make a total sample of 120 farmers.

Data and variables

The study made use of both primary as well as secondary data for the analysis. The secondary data on agricultural loss in the selected panchayats was obtained from the records maintained at respective Krishi bhavans. The weekly wholesale price data of major crops for the year 2018 corresponding to the month of August 2018 in the main markets near the selected panchayats were collected from the website of AGMARKNET. The primary data on crops that were lost due to flood, damage to assets including crops and loss experienced by the households in their income flow was collected through personal interview method using pre-tested structured interview schedule.

Methods and tools of data analysis

Economic evaluation of flood damage to agriculture is necessary to get a real picture of the loss to the sector as a result of the hazard. A comprehensive review of past studies showed the existence of several flood damage modelling methodologies, and Win et al. (2018) has reported the existence of two different methods for damage and loss estimation. The first method is to conduct a thorough questionnaire survey of the affected population and properties to estimate the incurred loss and the second method is to use stage-damage functions, which define the relation between flood parameters and possible damage. The present study followed the Damage and Loss Assessment (DaLA) methodology developed by the Food and Agriculture Organization (FAO) in 2012 for the damage and loss assessment due to disaster, with appropriate modifications. This was selected purposefully as the method proved to be the simplest and less time consuming one available for estimating both damage and loss to agriculture.

Post disaster damage and loss assessment in agriculture in Chalakudy river basin

The types of disaster effects on a society and economy considered for valuation are destruction (total or partial) of physical assets and subsequent changes or modifications to economic flows in the affected area. While the former is addressed as damage, the latter is reckoned by the term loss.

Damages are the costs of repair of partially damaged assets and/or replacement of totally destroyed assets. On the other hand, losses are the values of foregone income, investment losses or higher production costs and other unexpected expenditures. The aggregate of these damages and losses constitutes the total disaster effects (FAO, 2012).

The FAO procedure follows four specific steps as outlined below.

1) Creating pre-disaster baseline information – As the 2018 flood was totally unexpected in the state, pre-disaster baseline as envisaged by FAO could not be fully materialised. However, the base line information was created using the secondary data available with the revenue / agricultural departments and also through field survey and focus group discussions.

2) Assessing damages: The damages are categorized as Damages to farm assets (D_A) (such as animal sheds, farm equipment and machineries, irrigation systems, fertilizers, seed stock, *etc.*), Damages to crops (D_C) and Damages to livestock (D_{LS}).

Total Damages (D) = $D_A + D_C + D_{LS}$

where,

D_A = (Number/Quantity of partially damaged assets x Average repair cost) +(Number/Quantity of totally destroyed assets x Average replacement cost)

D_C=Damages to seasonal crops (D_{SC}) + Damages to perennial crops (D_{PC})

D_{SC}= Production loss x Market wholesale price
(Production loss = Expected pre-disaster yield – Realized post - disaster yield)

D_{PC}= Total damages - Salvage value
(Total damages = Number of trees totally destroyed x Average replanting cost per tree)

D_L= Number of dead animals x respective values

3) Estimating losses:

Total loss (L) = Losses from seasonal crops (L_{SC}) + Losses from perennial crops (L_{PC})

L_{SC}were taken as equivalent to investment loss as almost all farmers reported a complete destruction of their seasonal crops.

Losses from perennial crops (L_{PC}) = Losses from totally destroyed perennial crops (L_{PC1}) + Losses from partially destroyed perennial crops (L_{PC2}).

L_{PC1} = Production loss + Investment loss

L_{PC2} = Production loss x Market wholesale price
(Production loss = Expected pre-disaster yield – Realized post-disaster yield)

The investment loss was taken as the cost incurred in bringing the totally destroyed crop to the stage of destruction (including establishment cost and maintenance cost). Production loss in the case of totally destroyed perennial crops was computed by the method of discounting costs and returns over the next seven years, keeping in view that the replanted crop will start to yield after seven years.

4) Summarizing the damages and losses for the year that the disaster occurred

Since the aggregate of damages and losses constitutes the disaster effect, damages and losses were added up and the average value was worked out to obtain the disaster effect to an individual household which was then extrapolated to obtain the total disaster effect among the farm households who have applied for relief assistance in the flood plain.

Total disaster effect = $D_A + D_C + D_L + L_{SC} + L_{PC}$

Limitations of the study

The logistic constraints imposed by the Covid 19 pandemic made it impossible to enumerate data from the entire farm households in the floodplain, and hence the sample selection has to be limited to the list obtained from Krishi Bhavans (Panchayath level agricultural office). However, according to the officials of Department of Agriculture Development and Farmers' Welfare, Government of Kerala, the farmers who were left out accounted for less than 5

per cent, comprised of those people who were accounted to in applying for the claim within the stipulated time. Hence the extrapolated loss estimates for the river basin would be a little less than the actual loss values expected. To account for this, the extrapolated loss has been estimated for the enrolled list of farmers for natural calamity relief with the Krishi bhavans.

Results and Discussion

The results are discussed under two headings *viz.,* agricultural damages and agricultural losses.

Agricultural damages

The assessment of disaster effects on the sample farm households along the flood plains of the river with respect to damage and loss suffered to crops, assets and livestock as presented in Table 2 showed that on an average a farm household in the flood plain has suffered a damage of ₹ 0.13 lakhs to agricultural assets, while the damage suffered was ₹ 20.76 lakhs for seasonal crops and ₹ 0.09 lakhs for perennial crops. With respect to livestock and poultry, on an average, a farm household has suffered a damage of ₹ 0.12 lakhs. The total damages suffered to the farm households amounted to ₹ 1.1 lakhs per farm household, which is about ₹ 0. 23 lakhs per acre.

Table 2. Damages and losses to sample farms due to 2018 Floods in the Chalakudy river basin

Sl. No.	Particulars	Per household (₹ lakhs)	Per unit area (₹ lakhs/Acre)
1	Damages		
a	Agricultural assets	0.13	0.027
b	Seasonal crops	0.76	0.16
c	Perennial crops	0.09	0.02
d	Livestock and poultry	0.12	0.026
		1.1	0.23
2	Losses		
a	Seasonal crops	1.59	0.034
b	Totally destroyed perennial crops	1.52	0.02
c	Partially destroyed perennial crops	0.33	0.07
		3.44	0.43
3	Total	4.54	0.66

Table 3. Total agricultural damage and loss in the flood plains of Chalakudyriver (₹crores)

Sl. No.	Particulars	Disaster effect
1	Damages	
a	Assets	7.32
b	Seasonal crops	43.10
c	Perennial crops	5.36
d	Livestock	6.97
A	Total	62.75
2	Losses	
a	Seasonal crops	90.85
b	Totally destroyed perennial crops	86.72
c	Partially destroyed perennial crops	18.55
B	Total	196.12
3	Grand Total (A+B)	258.87

The disaster effects among the enlisted farmers in the flood plains of the river with respect to damage and loss suffered to crops, assets and livestock estimated extrapolating the damage and loss figures arrived at for the individual households is presented in Table 3. The enlisted farm households in the flood plain have suffered a damage of ₹ 7.32 crores to agricultural assets, while the damage from crop loss was ₹ 48.46 crores. Of this, the loss from seasonal crops accounted to ₹ 43.10 crores and the loss from perennial crops was ₹ 5.36 crores. Death of livestock and poultry in the Chalakudy flood plain amounted to about ₹ 6.97 crores.

In this context, it is worth noticing that the consolidated report of damage to crops in the selected blocks compiled from the offices of the state Department of Agricultural Development and Farmers' Welfare was ₹ 6 crores, which was much less than the corresponding figure estimated in the study (₹ 48.46 crores).

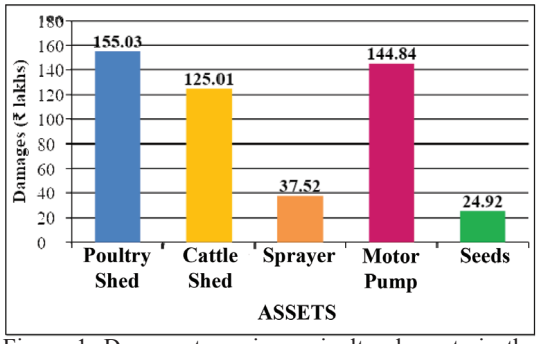

Figure 1. Damage to major agricultural assets in the Chalakudy flood plain

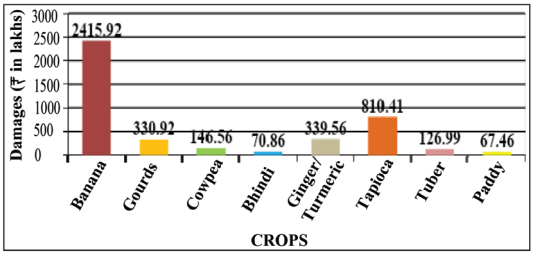

Figure 2. Damage to major seasonal crops in the Chalakudy flood plain

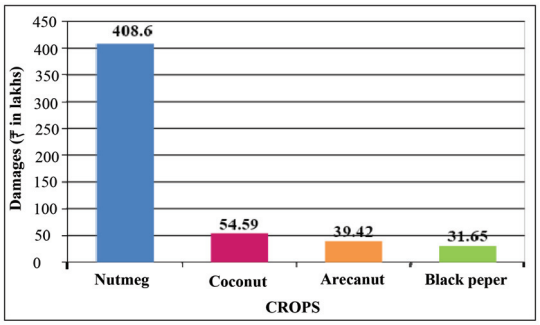

Figure 3. Damage to major perennial crops in the Chalakudy flood plain

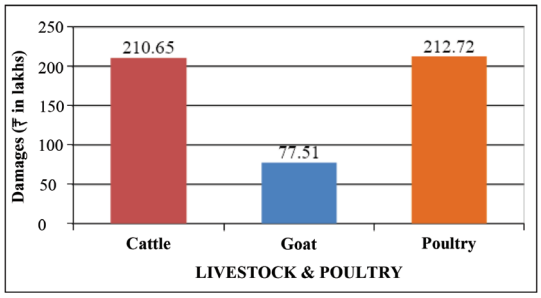

Figure 4. Damage to major livestock and poultry in the Chalakudy flood plain

Among the agricultural assets, the major assets that were reported to be damaged in the basin were poultry shed, cattle shed, sprayer, motor pump and seeds, with poultry sheds suffering the highest damage (Fig 1). The major seasonal crops that were destroyed in the basin included banana, gourds, cowpea, bhindi, ginger/turmeric, tapioca, tubers and paddy, and maximum destruction was for banana (Fig 2). Nutmeg, coconut, arecanut and black pepper were the major perennial crops that were destroyed due to the disaster in the basin with nutmeg suffering the highest destruction (Fig 3). The observations were in conformity with the cropping pattern of the basin, discussed earlier in this article. Though paddy was found to be cultivated on a larger area than banana, the extent of damage to paddy was less as the crop was yet to be sown in most parts of the basin when the disaster occurred. Goat and poultry were the major livestock damage recorded with poultry accounting the highest death calamity, around ₹ 213 lakhs (Fig 4).

A quick summary of any dataset can be visualised through a boxplot and a meaningful comparison can be made among different groups. A comparison of the total damages in different blocks (Fig.9) revealed that it was highest in Chalakudy block followed by Mala Block and Parakkadavu Block. Atleast 75 per cent of the respondents encountered a total damage not less than ₹ 1.28 lakhs in Chalakudy block and ₹ 1.21 lakhs in Mala and ₹ 0.75 lakhs in Parakkadavu Block. The outliers in each block showed that with respect to some individual respondents the total damage was extremely high in each block.

Agricultural losses

Crop loss to the individual sample farm households was also estimated and is presented in Table 2. On an average a farm household in the flood plain has suffered a loss of ₹ 1.59 lakhs from seasonal crops and ₹ 1.52 lakhs from fully destroyed perennial crops and ₹ 0.32 lakhs from partially destroyed perennial crops. The per unit area wise total losses incurred to the farmer amounted to ₹ 42746 per acre, including seasonal and perennial crops.

Agricultural loss to individual households was extrapolated to draw conclusion regarding crop loss

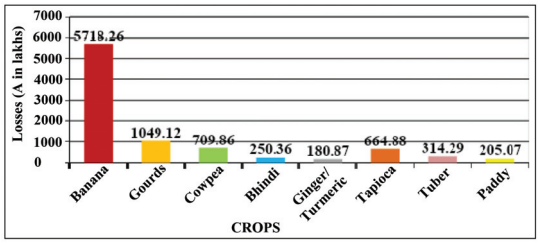

Figure 5. Loss from major seasonal crops in the Chalakudy flood plain

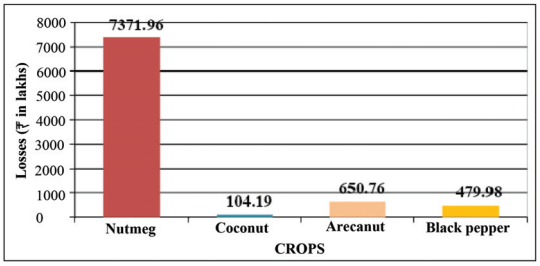

Figure 6. Loss from fully destroyed perennial crops in the Chalakudy flood plain

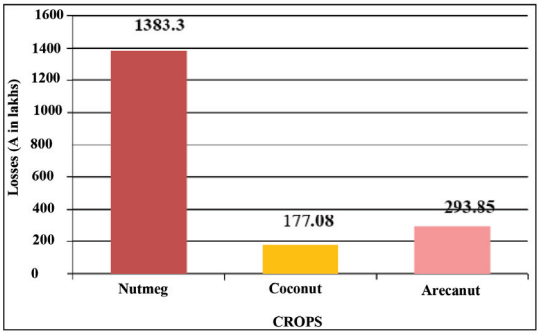

Figure 7. Loss from partially destroyed major perennial crops

among the Krishibhavan enlisted farmers in the flood plain. Almost all the households reported losses from both seasonal and perennial crops, and the results as given in Table 3 showed that the farm households have suffered a loss of ₹ 90.85 crores from seasonal crops and ₹ 86.72 crores from fully destroyed perennial crops and ₹ 18.55 crores from partially destroyed perennial crops. Thus, the total loss was estimated as ₹ 196.12 crores.

In the basin, banana, gourds, cowpea, bhindi, ginger, turmeric, tapioca, tubers and paddy are the major seasonal crops that suffered a loss with banana incurring the maximum loss (Fig 5). Among the fully destroyed perennial crops, the major ones that got destroyed were nutmeg, coconut, arecanut and black pepper with nutmeg registering severe destruction (Fig 6). Likewise, partial damage due to production loss was also reported in the case of all the perennial crops discussed above (Fig 7).

A comparison of total losses for different blocks as evidenced by Fig.10, revealed that it was highest in Mala followed by Parakkadavu and Chalakudy. But in the case of Chalakudy the number of outliers was too large which could be aroused from those individual respondents who have faced extreme losses. Atleast 75 per cent of the respondents incurred total losses not less than ₹ 3.50 lakhs in Chalakudy and ₹ 4.23 lakhs in Mala and ₹ 2.50 lakhs in Parakkadavu.

The total disaster effect due to the flood inflicted up on the sample farm households was estimated at ₹ 4.54 lakhs per farmer which amounted to a loss of ₹ 66175 per acre.

The study revealed that the destruction of seasonal crops at its stage of harvest has imposed greater monetary loss to the farm households than any other damage, and the total estimated disaster effect on seasonal crops is to the tune of 51.74 per cent of the total disaster effect estimated for the enlisted farms in the flood plain, which comprises of the disaster effect on agricultural assets, livestock and poultry, and seasonal and perennial crops (Fig 8).

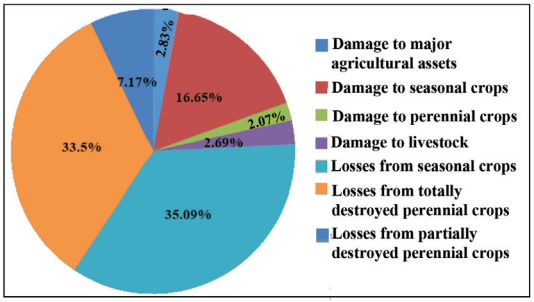

Figure 8. Total disaster effect in the flood plains of Chalakudyriver (percent to total)

The assessment of agricultural loss inflicted upon by the 2018 floods to the farm households in the flood plains of Chalakudy river enlisted in the records of Department of Agriculture Development and Farmers Welfare, pegged the overall damage and loss to crops, assets and livestock to the tune of ₹ 258.87 crores. The consolidated report of damage to crops in the selected blocks compiled from the concerned offices of the state Department of Agricultural Development and Farmers' Welfare was ₹ 6 crores and the corresponding figure estimated in the study is ₹ 48.46 crores. The

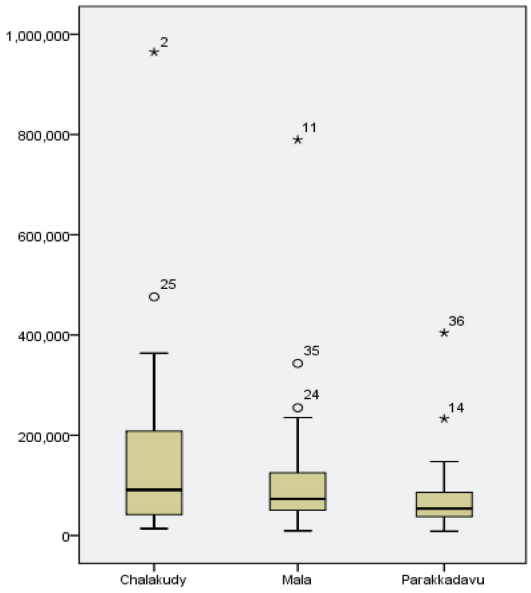

Figure 9. Box plot showing total damages to each of the respondent households – block-wise scenario

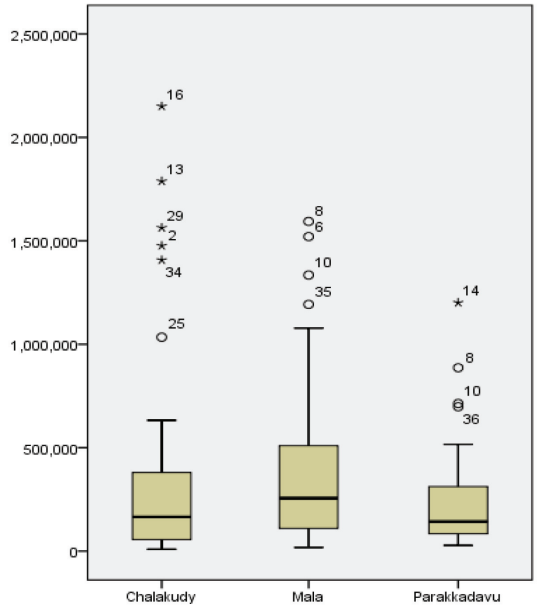

Figure 10. Box plot showing total losses to each of the respondent households – block-wise scenario

mismatch in estimates on the flood loss to crops is explained by the fact that in the study, as per the approved procedure followed by FAO, disaster effects included both damage and loss to crops, whereas disaster effect as per the secondary data obtained from the offices of the State department offices of Agriculture included the assessed value of damage alone. Also, the study has considered damage to agricultural assets and livestock, which was not included while enumerating the agricultural loss and damages by the department. Moreover, the reported value was a quick estimation, by assigning values to various damaged crops based on a pre-fixed rate as per government norms. However, the marked difference in the two estimates points out to the need for adopting a standard procedure for crop damage and loss assessment by all agencies, so that the affected farmers could be adequately compensated.

The study restates the observation by the United Nation Sendai Framework for Disaster Risk Reduction (2015) on the under- reporting of disaster induced damages in the case of low-income countries. In Asia, under- reporting is to the tune of 42 percent. The study thus points toward the need for adopting a standardized methodological approach based on internationally approved framework for assessing the impact of disasters on agriculture, and in strengthening the capacity of the authorities involved in disaster impact assessment in agriculture. Undertaking similar studies in other disaster affected areas would help in getting a realistic picture of the total disaster effect on the farm households, which could be used as the guide line for extending further Government aid and compensation to the affected farmers.

Acknowledgement

We would like to express our sincere gratitude to Kerala Agricultural University for the fellowship, the farmers and agricultural department officers for the information support and the reviewers for their valuable suggestions.

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