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Recent floods in Kerala and its impact on rice yield in *Kuttanad* – A retrospective analysis

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सार – 2018 और 2019 की अभूतपूर्व भीषण बाढ़ ने केरल को काफी प्रभावित किया, कुट्टनाड को लगभग पूरी तरह से जलमग्न कर दिया और इन भीषण बाढ़ के प्रभावों के बाद चावल की फसल का अध्ययन किया गया। इन भीषण बाढ़ों में, मुख्य रूप से मिट्टी की उर्वरता में वृद्धि हुई और कीटों तथा बीमारियों की कमी के कारण चावल की फसल छिद्रण में उल्लेखनीय वृद्धि हुई। कुट्टनाड क्षेत्र में चावल के कुल उत्पादन को देखते हुए, भीषण बाढ़ का चावल के उत्पादन पर भी सकारात्मक प्रभाव दिखा और इससे रबी की फसल की सिंचाई के लिए भूजल स्तर में वृद्धि हुई। न्यूनतम तापमान और सापेक्षिक आर्द्रता में उल्लेखनीय अंतर देखा गया। इन सभी कारकों ने चावल की उपज की वृद्धि में महत्वपूर्ण योगदान दिया। बाढ़ हमेशा विनाशकारी नहीं होती है। कभी-कभी फायदेमंद भी हो सकती है जैसा कि कुट्टनाड में बाढ़ के कारण चावल की पैदावार से संकेत मिलता है।

ABSTRACT. Unprecedented severe floods, which affected Kerala during 2018 and 2019 submerged Kuttanad almost completely and the effects of these severe floods to following rice crop were studied. In these severe floods, the following rice crop *puncha* reflected a marked increase in yield mainly due to increase in soil fertility and less incidence of pests and diseases. In view of total rice production in the *kuttanad* region, severe floods have even a positive effect on rice production as the ground water table rose to facilitate water to the *puncha* crop. It was observed that there has been a notable variation in minimum temperature and relative humidity. All these factors contributed significantly to increase in rice yield. Floods are not always disastrous and can sometimes be advantageous as indicated by the post flood rice yields in *kuttanad*.

Key words – *Kuttanad, Padashekharams, Puncha*.

1. Introduction

The rice cultivation area of *Kuttanad* in Alapuzha district shares about 25% of the Kerala State's total rice producing area and contributes nearly 37% of the rice production of the state. This contributes to 19.2% of total wetland paddy area in the state [Ag. statistics (2017-18)]. Owing to its primacy in rice area and production, *Kuttanad* had been long time referred as "The Rice Bowl of Kerala". *Kuttanad* represents a low-lying deltaic region characterized by wetlands and is highly complex, dynamic and unique rice growing agro-climatic tract of Kerala lying 0.5 to 2.5 m below MSL. It extends between 9° 8´ N and 9° 52´ N latitudes and 76° 19´ E and 76° 44´ E longitudes, spread over Alappuzha, Kottayam and Pathanamthitta districts.

Kuttanad meaning 'low lying lands' is a deltaic region spread over the district of Alappuzha, Kottayam & Pathanamthitta which is crisscrossed by rivers, canals & waterways. Four major rivers namely *Achenkoil*, *Pampa*, *Manimala* & *Meenachil* originating from the high ranges discharge their water into the Arabian Sea through the *Kuttanad* region (Fig. 1).

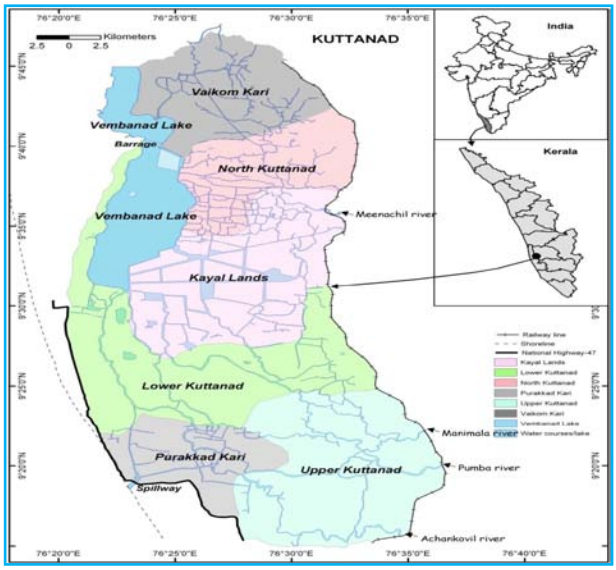


Fig. 1. Map showing the study location

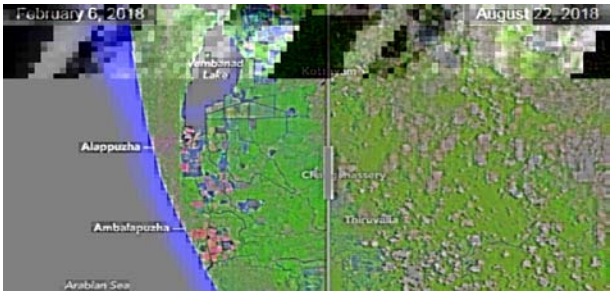
The main season is the *puncha* crop when sowing takes place in November/December immediately after the north east monsoon and harvesting is done in March/April. Paddy fields are flooded with water to reduce the soil acidity and to control weeds & pests.

1.1. *Climate*

The climatic features of *Kuttanad* are typically humid tropical and it experiences fairly uniform temperature throughout the year ranging from 21 °C to 36 °C. The average annual rainfall recorded as 2755 mm of which 83% is from the two monsoons, south west and north east monsoons. Among them, the south west monsoon (June to September) has the highest percentage of rainfall than the north-east monsoon (October-November). The summer temperature is between 30 °C-34 °C from March to May and the lowest ranging between 22 °C-24 °C in December. The driest months are February and March followed by summer reaching to severity during the months of April and May. The winds have seasonal direction of southwest during monsoon and speeds attain 45-55 km/hr. The humidity is on the higher side 70-80% due to maritime influence. During 2018 and 2019 annual rainfall received in Alapuzha district were 2916.4 and 2742.7 mm respectively.

1.2. *Soil*

The soil in *Kuttanad* is a mixture of sand and clay in varying proportions. In most of the areas, the soil is highly acidic and contains toxic salts like acid sulphates. The toxicity adversely affects plant life through capillary action when the fields are dry or when the water outside the fields rises high. The acid sulphate soils of *Kuttanad* region recorded very low pH of 3 to 5.2.



(*Source* : Earth Observatory/NASA)

Fig. 2.

1.3. *Cropping season*

Every year two crops are raised in *Kuttanad* area. First crop (*kharif*) also called as additional crop starts from June/July to September/October. Second crop called *puncha* starts from October/November to February/March. The crop is mostly broadcasted and the *kuttanad* region prefer rice variety *Uma* with medium duration for every season due to its non lodging property. Large farming areas near *Vembanad* lake were actually reclaimed from the lake. These reclamations constituted small areas of paddy fields called "*padasekharams*".

1.4. *Recent floods in Kerala*

Floods occur regularly in *Kuttanad* during the southwest monsoon and rarely during northeast monsoon. Historic data suggest that floods in *Kuttanad* have a return period of 2, 5, 10, 25 and 50 years. Floods with a return period of 10-year and above are severe, whereas the regular floods with return period of 5-yrs and less are less severe. However, it appears that during recent years, floods occur every year and they are major destructive force and a terrifying experience.

In August 2018, the state of Kerala experienced its worst flooding since 1924 (Fig. 2). During 2018 there was an increase in rainfall received during southwest monsoon period to the tune of 36% above the normal rainfall (GEER, 2018). Due to severe floods of 2018 the lowland area of *Kuttanad* was heavily inundated leading to complete crop loss. Same situation prevails in 2019 floods (Fig. 3). The rivers which are flowing from upland to lowland to drain into sea brought huge sediment deposits. These sediments were rich in nutrients and minerals

The average yield of the rice crop for *uma* variety is 5T/Ha. During 2018-19 (post flood) *puncha* the average yield obtained was 7.5 T/Ha and it was 5.5T/Ha in 2019-

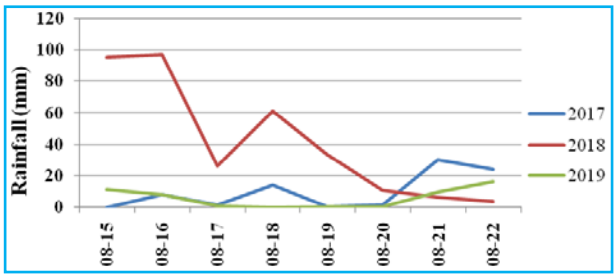


Fig. 3. Rainfall received during 15th August to 22nd August in 2017, 2018, 2019

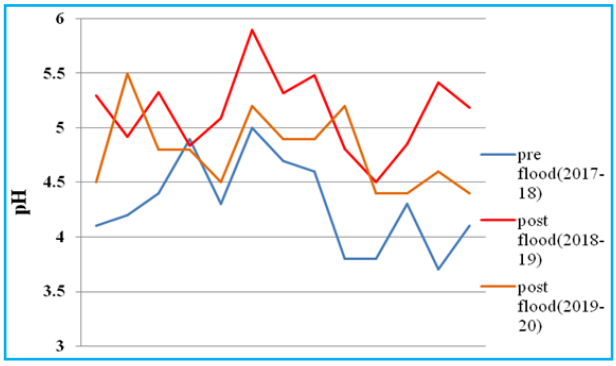


Fig. 4. Variability of soil pH during three crop seasons

20 (post flood) crop. Main aim of this study is whether the sediments after floods could bring fertility to *Kuttanad* soils which was reflected in the rice yields of *puncha* crop following 2018, 2019 floods.

2. Materials and method

In this study mainly three seasons had been compared. The crop and soil data and weekly weather data for 2017-18 period (pre flood period) followed by 2018-19 period (post flood crop) and 2019-20 (post flood crop) were analysed. Soil samples from various *padashekharams* were collected and analysed. The yield data from individual *padashekharams* were collected by Kerala Centre for Pest Management (KCPM), Moncompu, Department of Agriculture, Kerala. Likewise affected area wise pests populations and disease incidence were also collected by KCPM. Standard correlation analysis has been utilized to investigate the relationships between the various independent variables and rice yield followed by computing multiple regression. Based on this statistical analyzed data, the results of the investigation have been interpreted and conclusions drawn.

3. Results and discussion

It is important to note that floods are not necessarily disasters for farmers and they sometimes have positive implications as they bring water and fertile soil (Nakao,

TABLE 1

Pests affected area during pre flood (2017-18) and post flood (2018-19), (2019-20) period

Pests	Affected area (Ha)		
	Pre flood (2017-18)	Post flood (2018-19)	Post flood (2019-20)
Thrips	2147	208	67
Leaf folder	954	399	23
Stem borer	660	0	4
Case worm	71	37.2	13.7
Gall fly	786	0	18.7
Brown Plant Hopper	90	19.4	60
Rice Bug	66	1.2	0

1996). The analysis done for pre flood situation (2017-18) indicate that yield was mainly attributed to soil phosphorus, calcium and magnesium. Phosphorus is essential for root development, tillering, early flowering, and ripening phases. The post flood analysis done for *Kuttanad* during 2018-19 showed that the yield has increased compared to previous years. The yield was correlated to various soil factors like soil pH, organic carbon, soil phosphorus, manganese, zinc, boron, silicon, calcium and magnesium and weather parameters *viz.*, maximum, minimum temperature, morning and afternoon relative humidity. The factors which showed significant correlation were pH, available phosphorus, manganese, zinc, boron. Among the weather factors weekly values (49th to 2nd standard meteorological week) of minimum temperature, morning and afternoon relative humidity showed significant correlation. In the post flood situation timely intervention of state government in providing assistance to farmers in the form of inputs like good quality seeds, lime and fertilizers are highly remarkable. This facilitates the famers to do timely sowing for *puncha* with recommended dose of lime and basal fertilizers. This could be one factor for increase in yield during post flood year. The application of recommended dose of lime facilitated increase in pH of the soil and pH became 5.5-6 which is optimum for paddy crop (Fig. 4). The increased pH promotes the availability of organic carbon and available phosphorus in the soil (Dora Neina, 2019).

Soil sample analysis further stated the presence of most of the micronutrients like manganese, zinc and boron, silicon which were brought by the sediments. The increased deposits of sediment in *kuttanad* fields also added to the availability of nutrients like calcium and magnesium. The higher level of zinc to soil increased the total zinc content per plant at different growth stages and have beneficial effect on tiller production, increased

TABLE 2

Diseases affected area during pre flood (2017-18) and post flood (2018-19), (2019-20) period

Diseases	Affected area (Ha)		
	Pre flood (2017-18)	Post flood (2018-19)	Post flood (2019-20)
Bacterial Leaf Blight	103	0	7.8
Sheath Blight	370	8	11
Brown spot	1233	0	73.4
Blast	26	0.4	1.4
False smut	0	25	0

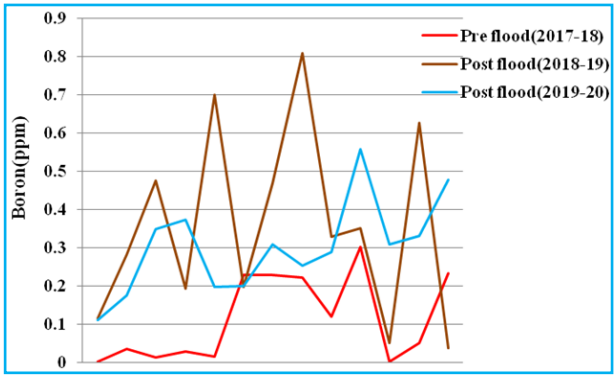


Fig. 5. Variability of available Boron in soil during three crop seasons

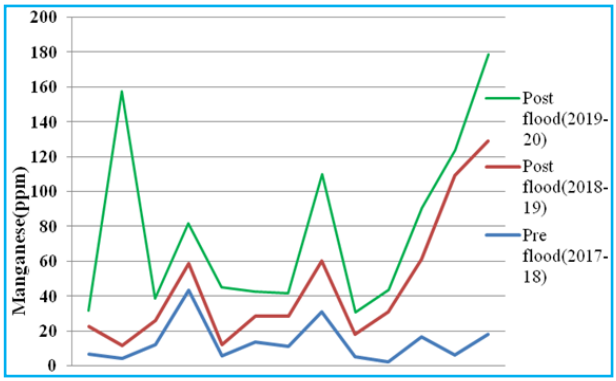


Fig. 6. Variability of available Manganese in soil during three crop seasons

pollination and grain filling and thereby more grain and straw yields (Impa *et al*., 2013; Sarwar *et al*., 2013). It is a notable feature that due to timely sowing and application of lime and basal dose of fertilizers, the crop became sturdy and healthy. This could be attributed to one reason for less occurrence of pests and diseases in post flood *puncha* season (Table 1, Table 2).

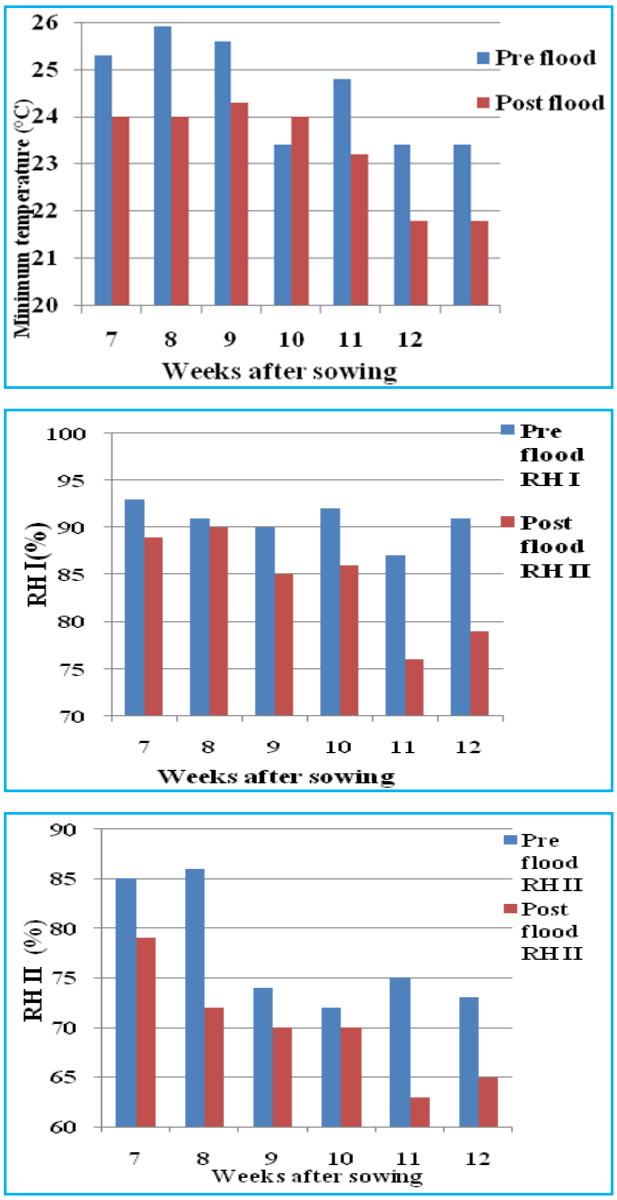


Fig. 7. Comparison of Meteorological parameters during pre flood & post flood period

Due to increased pH, iron and aluminium toxicity has reduced (Vina *et al*., 2019). This led to the increased availability of boron in the soils (Fig. 5). Boron is responsible for better pollination, seed setting and grain formation in different rice varieties (Aslam *et al*., 2002; Rehman *et al*., 2012) and is highly important during the reproductive stage compared to the vegetative stage of the crop.

One notable feature was that in the post flood *puncha* the incidence of brown spot was negligible in almost all *padashekharams*. *Helminthosporium* which is the causal agent of brown spot of paddy has the capacity

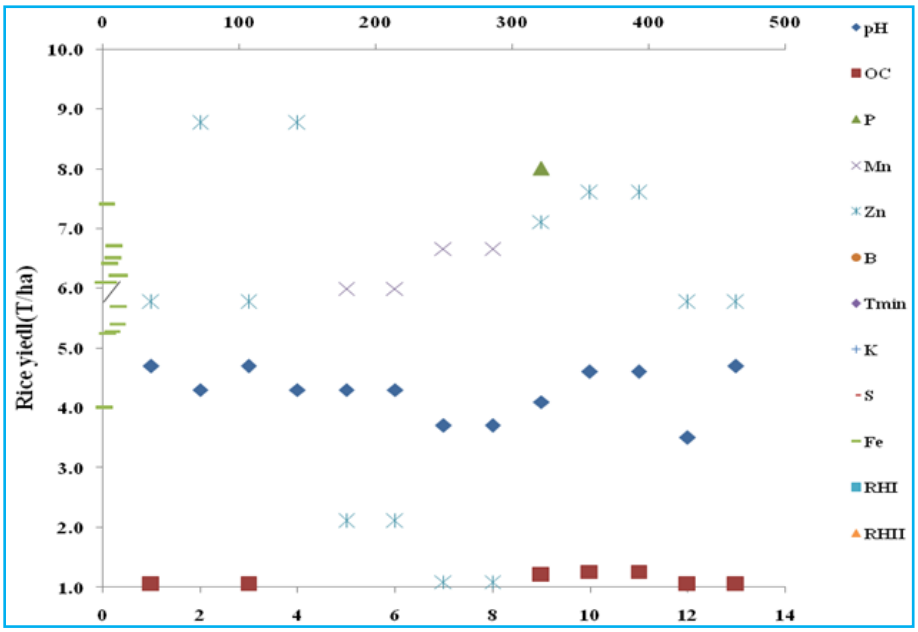


Fig. 8. Effect of soil nutrients and weather on post flood rice yield

to oxidise the available manganese in the soil. Due to decreased pathogen, the availability of manganese as Mn^{2+} has increased in the soil (Fig. 6). The analysis showed that yield increased compared to previous years which were showcased in the form of number of productive tillers, number of grains per panicle, 100 grain weight. These were mainly attributed to increased manganese content in the soil. This was in accordance with the study conducted by Paul and Maya (2014).

Another dependent variable contributing to yield is weather. Due to timely sowing the crop could escape the negative influence of high maximum temperature during the reproductive period which will result in lesser number of filled grains in summer crop. Moreover the summer crop is physiologically advantageous due to high photo-period, leading to higher productivity (Subramanyam, 2018). The results also indicated that in the post flood *puncha* there was remarkable decline in relative humidity (RH I & RH II) which contributed to less incidence of pests and diseases (Fig. 7). This was in accordance to the study reported by Ghildyal and Datta (1967), De Datta and Zarate (1970) and Sreenivasan (1985). The minimum temperature during the post flood *puncha* had reduced dramatically in the weeks coinciding with flowering stage in the tune of 1.3-1.6 °C compared to pre flood season. This was advantageous and contributed significantly to yield. Step wise Multiple regression has been computed to study the influence of various soil nutrients and weather on rice yield in post flood situation (Fig. 8). The results showed that the R^2 obtained was 0.997 which emphasized sound influence of post flood sediments on crop yield. Similarly minimum temperature during the reproductive stage had also contributed to grain yield.

4. Conclusions

Though flood situation is highly devastating, in some cases it became a boon to farmers because sediments brought by flood water is heavily loaded with mineral and nutrients and the banks of deposits became enriched with soil nutrients. Same condition was expressed by the *kuttanad* region during 2018 and 2019 floods. The studies denoted the presence of most of the micronutrients like manganese, zinc, boron and silicon in the soil which were brought by the sediments. Not only nutrients, there occurred a change in the weather of *kuttanad* during post flood season. The decrease in minimum temperature, morning and afternoon relative humidity were advantageous to the crop and pose a strong negative influence on the pest and diseases incidence. From this study it could be concluded that post flood situation were highly advantageous to the *puncha* paddy crop in terms of yield and less incidence of pests and diseases.

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Disclaimer : The contents and views expressed in this study are the views of the authors and do not necessarily reflect the views of the organizations they belong to.

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