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### **A Geographic Study on The Role of Physiography In The Incidence of Illnesses Related To Endosulfan In Kasaragod District, Kerala, India**

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#### **ABSTRACT**

The excessive use of pesticides in agriculture has an adverse impact on human health and the environment. Environmental health problems vary from region to region, reflecting the geography, climate and the level of economic development. Many health problems are associated with poverty and lack of fundamental resources. The aerial spraying of pesticides leads to suspension of toxic compounds in the environment. The residue of pesticides accumulates over years which lead to gradual occurrence of diseases. Kasaragod, the northern most district of Kerala, is a lush region with large cashew plantations. The use of pesticides in the cashew plantations has resulted in long term negative impacts on the health of the people living in the vicinity of plantations as well as in remote regions. The affect of pesticides on the health of settlements in remote area has to be understood along with the physiography of the region. The role of physiography in the spread of diseases has been systematically studied and analyzed using GIS technique. The result shows that a large number of victims have been identified in the settlements near to the river banks.

**KEYWORDS:** Endosulfan; Environment; Physiography; GIS ; Health

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## **INTRODUCTION**

The last few decades have witnessed enormous infrastructural and environmental changes associated with population growth, human migration, and economic development. This has resulted in the spread, emergence and re-emergence of many infectious diseases worldwide<sup>1</sup>. Medical geography is an important field which provides an understanding of health problems that the people are facing world-wide in the context of the various geographic factors influencing them.

Medical geography is one of the fastest growing fields in geography. It applies geographic concepts and techniques to the health-related problems<sup>2</sup>. In addition, Medical Geography studies the impact of climate and location on an individual's health as well as the distribution of health services. Studies in Medical Geography have focused on disease ecology and man has viewed diseases in the light of its geographic settings. The foundational idea of disease ecology is that human life is a process, a continual interaction between the internal and external environments<sup>3</sup>. Modern science and technology has played a major role in the economic development of man, meanwhile, it has also triggered environmental issues leading to severe health hazards. Pesticides, chemicals, radiation, air pollution, and water pollution, are some of the man-made hazards that are believed to contribute to human illness<sup>4</sup>. About four decades ago, the crop yields in agricultural systems depended on internal resources, recycling of organic matter, built-in biological control mechanisms and rainfall patterns. Pesticides started a revolution in agriculture and quality improvement methods.

In the 20<sup>th</sup> century Rachel Carson, a scientist and writer, revolutionized America's interest on environmental issues. Her book, *Silent Spring*, published in 1962, highlighted the impacts of pesticides and awakened society to its responsibility towards other forms of life. Use of pesticides has come at a cost. Pesticides frequently enter the surface and groundwater through either point source (direct locations where excess pesticides spill), or non-point sources, where the pesticides enter the streams through wind, precipitation, run-off, and leaching. The accumulation of pesticides in the soil and in organisms, due to bio magnification, has resulted in the emergence of numerous health issues. The environmental impact of pesticides is conspicuous on the non-target species. Pesticides are biocides that kill living organisms either immediately or over a period of time.

Pesticides known as Persistent Organic Polluters (POP's) are toxic substances that are reasonably recent in origin. Today, food supplies in most regions of the world are contaminated by POPs. POPs are able to stay in the system for decades causing problems such as cancer, birth defects, learning disabilities, immunological, behavioral, neurological and reproductive disorders in humans and animals. Several POPs are hormone disruptors which can destroy the normal function of reproductive systems in humans and wildlife. Cardiovascular disease, cancer, obesity, and diabetes

have been linked with POPs. Exposure effects can range from mild skin irritation to birth defects, tumors, genetic changes, blood and nerve disorders, endocrine disruption, coma or death<sup>5</sup>. Endosulfan has been proved to be bio accumulate in exposed organisms. As such, it should be included on the list of Persistent Organic Pollutants targeted for global elimination by the Stockholm Convention<sup>6</sup>.

Endosulfan, a pesticide belonging to the organochlorine group of pesticides, is one such pesticide which is classified under Persistent Organic Pollutant under the Stockholm convention on Persistent organic pollutants of 2011. The world is using Endosulfan since its introduction in the 1950's and has been widely used in agriculture. The Endosulfan poisoning caused many deaths during the 1999-2000 cotton seasons in Benin's Borgou province<sup>7</sup>. More cases of hydrocephalus are seen in the Muthalamada and Kollengode panchayats in Palakkad district, Kerala. In Karnataka State, Kokkada, Patrame and Nidle villages in Belthangady taluk of Dakshina Kannada District, Endosulfan was sprayed till 2001, in the Cashew plantations owned by the Karnataka Cashew Development Corporation<sup>8</sup>.

In Kasaragod District, the aerial spraying of Endosulfan has started since 1970's. Due to this, several major abnormal health issues have been identified. The spraying can be maximum spread up to 2 km area from plantation estates. But the affect of Endosulfan can be seen in whole Kasaragod district. Even though the spraying of Endosulfan is stopped in 2000 the younger generations has also been affected. The role of physiography in the diffusion of toxins has to be understood to envisage the impact of Endosulfan. The major physiographical features have been identified such as water bodies, land use (cashew plantations and settlements), and are mapped using GIS (Geographic Information System) technique to understand the root cause of this issue.

### ***Aim and Objectives***

The aim of the work presented here is to identify the role of physiography in the incidence of illness due to the usage of Endosulfan in Kasaragod District, by using GIS (Geographic Information System) technique.

The objectives of the study are:

- a. To demarcate the area affected by Endosulfan in Kasaragod District and to understand the incidence of illness related to Endosulfan.
- b. To identify the relationship between the proximity of the streams flowing out from the cashew estates and the areas affected by Endosulfan.

## Methodology

In this study both primary and secondary resources have been used to understand the spatial impact of the use of Endosulfan on human health. The primary survey was mainly a GPS survey of different areas of Kasaragod estates (Periya, Swarga and Rajapuram) that are not shown on the topographical sheets. A questionnaire survey has been done at Primary Health Centers (PHC's). This area has been incorporated in to the maps.

Secondary data sources used for this study is the data collected from eight PHC's of affected eleven (11) panchayats and from Endosulfan rehabilitation center at Kasaragod District. Data from other published sources are Thanal (NGO Organization) and Center for Water Resource Development and Management (CWRDM). The topographical sheets of Kasaragod district are as follows: 48L/12, L/14, L/15, 48P/2, P/3, P/4, 48P/6 and 48P/7.

The mapping has been done using GIS software (QGIS (1.8.0 Lisbon) and ARC GIS (10.1). A GPS survey has been carried out to delineate the estate areas. The reluctance to share any information both orally as well as in the form of secondary data has been a major challenge during the study. The sources of recorded information regarding the Endosulfan victims have been inaccessible due to the sensitivity of the issue.

## Study Area

Kasaragod is the northern most district of Kerala. The latitudinal and longitudinal extensions are 12°12' N to 12°30' N and 74° 26' E to 74° 52' E, respectively. The district lies between the Western Ghats and the Lakshadweep Sea. The eastern part is hilly with small forest tracts.

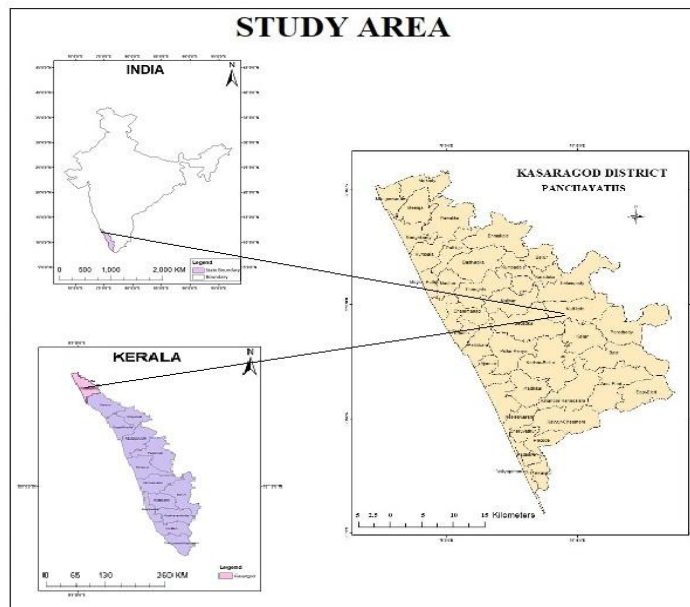


Figure 1 Kasaragod Location

It is bordered on the east by Kodagu and Dakshin Kannada districts of Karnataka state and in the north by Mangalore taluk (Kannada district) of Karnataka state. On the west it is bordered by the Lakshadweep Sea, and in south by Kannur district (Kerala state). It has an average elevation of 19 meters. Kasaragod district comprises of a single revenue division. It has two taluks- Kasaragod and Hosdurg. There are four community development blocks, 38 Gramapanchayats, and 127 villages in Kasaragod district. Figure 1 depicts the location details of the study area (Kasaragod district).

The Physiographic division of Kasaragod district consists of three sub micro regions. They are Cannanore Coast, Kasaragod table land and Peringom- Mattanur undulating upland. Cannanore Coast is a narrow coastal strip on the western side of the district. The coastline is fringed with low cliffs alternating with stretches of sand. The Kasaragod table land is a continuation of the Karnataka plateau (Deccan plateau). The Deccan plateau ends abruptly with low hills on the north eastern part of Kasaragod taluk. There is no prominent mountain peak in the district. The average height of this region is between 250m and 300m. The maximum height (1,046m), the land slopes towards west and forms the catchment area of Uppala, Shiriya and Chandragiri rivers. Peringom- Mattanur undulating upland has an undulating terrain with a number of isolated hills. The terrain slopes towards west and this region forms the catchment area of Nileshwar and Kariangote rivers.

There are 12 rivers in the district and all of them flow westwards. 12 rivers flow through Kasaragod district. The rivers of Kasaragod provide sufficient irrigation facilities. People in Kasaragod district cannot depend directly on surface water, because of the terrain. There is high discharge in rivers in the monsoon season and low discharge in the dry months. People here used to depend on groundwater and use Surangas or Surangams, which are the specially devised local water harvesting structures. A Suranga can be compared to a horizontal well or a cave like structure that is mostly excavated in hard laterite soil formations. The water is further carried through a downward slope on the floor of the cave. During the rainy season, water flow is higher. On the whole, Kasaragod district may have at least 6000-7000 Surangas.

## **RESULTS AND DISCUSSIONS**

Kasaragod is an area where agriculture is done on a large scale. The major crops cultivated in this region are paddy, coconut, arecanut, cashew, vegetables and tapioca. Cashew is largely grown in low fertile areas of the laterite hilly slopes. Cashew is cultivated on a large scale and many plantations are promoted by the Government of Kerala. The Cashew tree is a tropical evergreen tree that produces the cashew apple and cashew nut.

### ***Impact of Endosulfan on the Health of the People***

In Kasaragod district large tracts of forests were cleared to make way for the cashew plantations. Subsequent to this there was a large infestation of tea mosquitoes which affected the cashew plantations. Tea mosquitoes affect the buds of the cashew trees and adversely affect the yield of the trees. The persistent organo polluter Endosulfan was extensively and repeatedly used in the Cashew plantations of Kasaragod District to control tea mosquitoes. The Plantation Corporation of Kerala has been aerially spraying the pesticide Endosulfan on the cashew plantation covering several villages in Kasaragod District over the past two and a half decades.

The aerial spraying of Endosulfan over the cashew plantations in Kasaragod was started in 1976 after some trials in the Plantation Corporation of Kerala cashew estates. The intensive spraying of the pesticide began in 1976 and continued until 2000. From 1981 the plantations were regularly sprayed three times a year. Because of the large size of the cashew trees, the pesticide Endosulfan was sprayed aerially by helicopters. The aerial spraying was also done to save labour cost as it is estimated that one day aerial spraying can save about 500-man days. In Kasaragod district there are three main cashew estates- Kasaragod estate, Cheemeni estate and Rajapuram estate. Figure 2 shows the location of cashew plantations with endosulfan affected panchayaths in Kasaragod district. They are mostly located in the eastern part of the district. Kasaragod estate lies in the north east with a small portion in the west. Rajapuram estate lies in the east and Cheemeni estate lies in the extreme south. These three estates are spread over 20 villages.

All the three estates include forests within them. Kasaragod plantation covers an area of 2190.00 hectares. It is divided in to four major divisions - Muliya division (367.86 hectares), Perla Division (783.14 hectares), Adhur division (749.00 hectares), and Periya division (290.00 hectares). Rajapuram estate covers two Panchayat's- Kallar and Panathady. The plantation covers an area of 1526 hectares and is divided in to 7 divisions - Payinikkara division, Panathur division, Kallapally division, Chetthukai division, Kattimala division, Kammadi division, Pokkimala division. Cheemeni estate is located in Kayyur- Cheemeni Panchayat. The topography of this panchayat is undulating. Cashew estates are found mainly in Timiri, Kayyur and Cheemeni village.

Between 1976 to 2000, more than 50,000 villagers have been exposed due to Endosulfan sprayed on the cashew plantations owned by the Plantation Corporation of Kerala. More than 3000 people living near downstream and downwind of the estate were affected by congenital birth defects, reproductive health problems, cancers, and loss of immunity, neurological and mental diseases. Following the public outcry, a number of health based scientific studies confirmed that the health problems were directly linked to the exposure to Endosulfan. The studies done by the National

Human Rights Commission (NHRC) and the National Institute of Occupational Health (NIOH) in 2001 has observed that “aerial exposure” to Endosulfan was responsible for delay in sexual maturity among the adolescents. Residues of Endosulfan were found from human blood samples, soil and water.

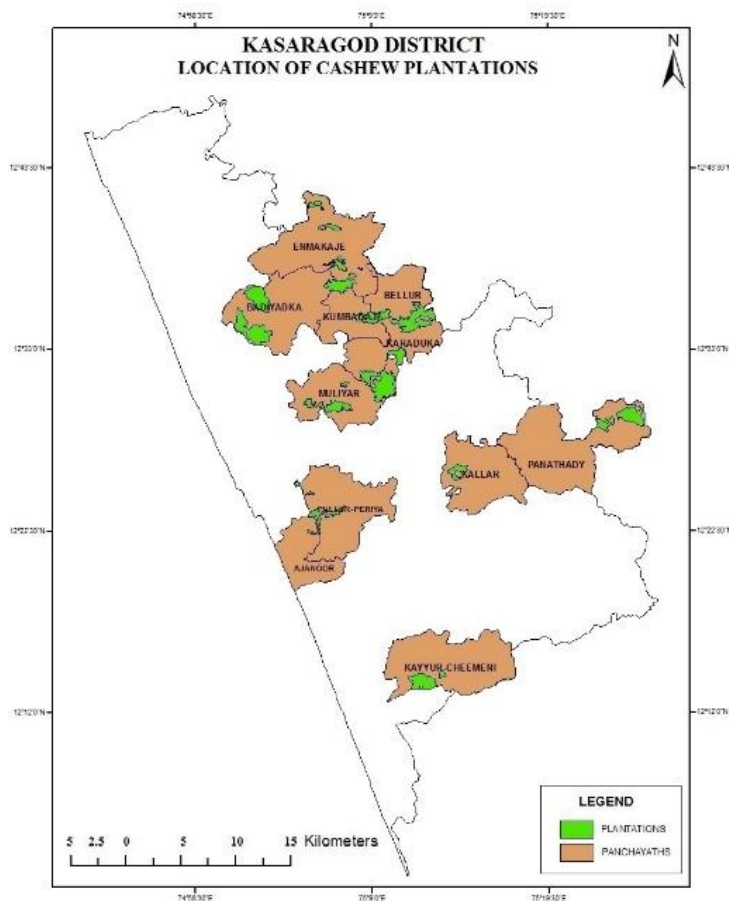


Figure 2 Location of Cashew plantations in Kasaragod District, Kerala and affected panchayaths

The aerial spraying of Endosulfan occurred over 11 Gramapanchayats in Kasaragod district- Ajanur, Badiyadka, Bellur, Enmakaje, Kallar, Karaduka, Kayyur-Cheemeni, Kumbadaje, Muliya, Panathady, and Pullur-Periya Panchayats. Figure 8 shows the location of cashew plantations along with the affected panchayats.

The residues of the pesticide that was sprayed found its way into the water and soil. Studies carried out by the Centre for Water Resource Development and Management, Kerala found that toxic residues of Endosulfan in the sediment and soil samples taken from the affected areas of Kasaragod were found to persist in the soil for a period of 1.5 to 2 years.



**Table: 1 Total number of Endosulfan victims in Kasaragod district**

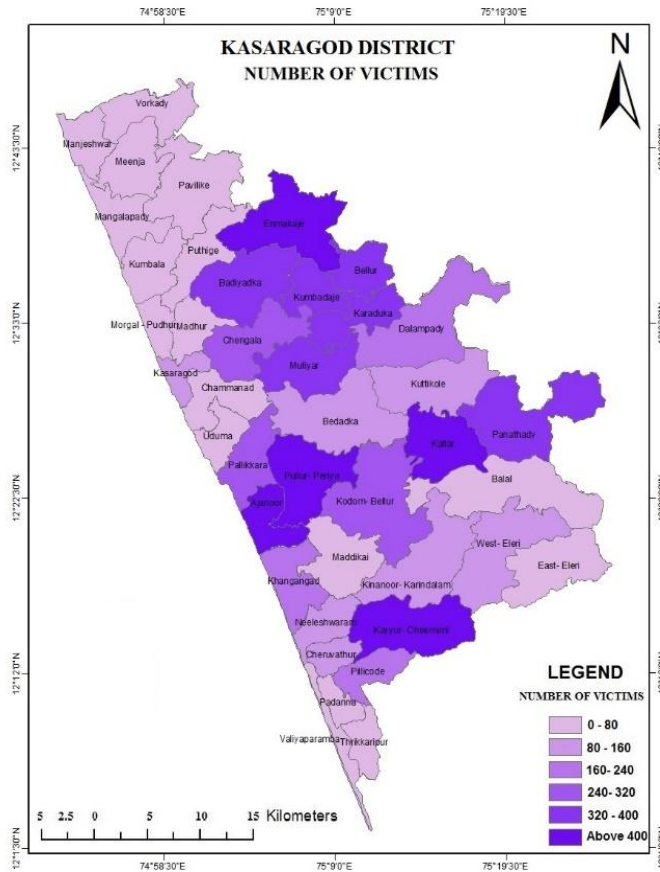
Source: Endosulfan rehabilitation center, Kasaragod, Kerala, 2012

SL NO	NAME OF PANCHAYAT	NUMBER OF VICTIMS	SL NO	NAME OF PANCHAYAT	NUMBER OF VICTIMS
1	AJANUR	391	20	KUMBADAJE	307
2	BADIADUKA	332	21	Kumbala	1
3	Balal	2	22	Kuttikole	9
4	Bedadka	13	23	Madhur	5
5	BELLUR	300	24	Madikai	4
6	Chemnad	5	25	Mangalpady	3
7	Chengala	86	26	MULIYAR	326
8	Cheruvathur	11	27	Nileswaram	7
9	Delampady	20	28	Padne	1
10	ENMAKAJE	377	29	Pallikara	91
11	KALLAR	383	30	PANATHADY	259
12	Kanhangad	19	31	Peringom	1
13	Kankol- Alapadamba	4	32	Pilicode	28
14	KARADUKA	272	33	PULLUR PERIYA	407
15	Karivellur	1	34	Puthige	6
16	Kasaragod	8	35	Uduma	4
17	KAYYUR CHEEMENI	381	36	Valiyaparamba	2
18	Kinannur- Karinthalam	12	37	West- Eleri	14
19	Kodombellur	90		TOTAL	4182

As early as 1979 there was a realization that the pesticide was causing problems. People noticed the death of fishes, honeybees, frogs, birds, chicken and even cows. Domestic animals were affected and farmers complained of calves being born with deformed limbs. The rising incidence of cases of mental illness and congenital anomalies in Kasaragod were first revealed by Dr. Y.S. Mohan Kumar, a doctor practicing in Padre Village in Enmakaje Panchayat. The local people attributed this to the anger of the local deity Theyyam, but Dr. Mohan Kumar strongly believed that the health disorders were probably related to pesticide contaminated water. In late 1980s he found that in Padre Village there were 171 patients with severe disabilities and all the households of the village had cancers of one kind or the other (2001).

Studies by THANAL (2001), a Trivandrum based NGO, reported that the consumption of the water in areas where Endosulfan has been sprayed has resulted in diseases ranging from physical deformities, cancers, birth disorders and damages to brain and nervous system. Other abnormalities like cancer and infertility are also seen. The Table 1 shows the number of Endosulfan victims in the various panchayats of Kasaragod district. It can be seen that the number of victims of Endosulfan is unusually high in eleven panchayats.





**Figure 3 Total Number of Endosulfan victims in Kasaragod District**

Figure 3 shows the total number of victims in Kasaragod district. Although it can be seen that there are incidents of victims in all the districts but their numbers are negligible in most of the districts. It is seen from the map that eleven districts have a very high number of victims. All these panchayats have cashew plantations in which Endosulfan was aerielly sprayed. People in these panchayats live in villages near the plantations or within the plantations and are affected with different kinds of illnesses.

The Primary health centers reported that the types of diseases seen were similar in the six panchayats located at Kasaragod estates. Mental retardation, neurological problems, and cancers predominate.

It is seen that the people living near the areas where Endosulfan was sprayed have been affected much more than the others. The cases of mental retardation seem to be especially high since Endosulfan is a neurotoxin. Villagers reported that mental retardation and other neurological problems were common in several children born during the last two decades. It has been reported

that several children who were normal until about age five or so, has developed neurological problems or became mentally retarded.

According to the villagers, these health problems were not present before the cashew nut plantations started their operations. Many studies were later done in the area by collecting soil and water samples. It was found that although residues of Endosulfan was found in soil samples in both areas the (sprayed and non-sprayed areas, the levels were higher in the eleven panchayats.

### ***The role of Physiography in the incidence of illnesses related to Endosulfan***

The physiography of the eleven panchayats appears to have played a crucial role in the link between Endosulfan sprayed areas and issues of health. Except Periya I and II of Periya division of the Kasaragod estates that lies in the plains all the other estates occupy the hill tops and slopes.

The estates are located mostly in the Kasaragod table land and a portion of Peringom-Mattannur undulating upland. The average height of this region is between 250m and 300m. The land slopes towards the west and forms the catchment area for rivers like Uppala, Shiriya and Chandragiri rivers. Several streams originate from these slopes. The residues of the pesticide that was sprayed in the cashew estates probably found its way into the soil and water. The cashew plantations are all located on the thin laterite slopes of the hills. The pesticide probably would have washed down the slopes during rains and entered into the streams and drinking water sources. Translocation of Endosulfan in water could have occurred from the soil on the hilltops and subsequently people were exposed to the pesticide residues in the affected areas.

The National Institute of Occupational Health (NIOH) carried out a study in Padre Village of Enmakaje panchayat in 2002. The study found that Endosulfan appeared in water samples throughout the year, even in the season in which there was no spraying of the pesticide. This could be because of the persistence of the pesticide in the soil. The NIOH studies have found that Endosulfan strongly adsorbed to the soil and the half-life of the pesticide was between 60 – 800 days.

Kasaragod estate is located in Enmakaje, Badiyadka, Muliya, Kumbadaje, Bellur and Karaduka panchayat. In Kasargod estate all the plantations are located on the hill slopes at an average elevation of 300 mts. The soil cover is primarily thin laterite and many streams originate from these plantations. It is seen from the figure 4 that many of the settlements are located along these streams.

It can be clearly seen from figure 5 that the people in the villages which lie closer to the plantations and which have a large number of streams flowing through them are more affected by the pesticide. Ubrangala village which lies further away from the plantation and has almost no stream flowing through it, has very few victims. On the other hand, Badiyadka village which has very few

plantations but has a large number of streams which originate from the estate has a large number of victims.

Enmakaje Panchayat is having a large number of Endosulfan victims in all its four villages and the villagers reported that the majority of the victims were in the villages of Padre and Enmakaje which lies within one kilometer (1 km) of the estates. Shenii and Kattukukya villages which are further away from the plantations also have victims but the numbers are smaller. Both these villages do not have many streams instead they are served by Surangas. Padre village which has large number of plantations, streams and Surangas has an abnormally high number of victims. A large number of settlements are seen within the plantations in Padre. Shenii and Kattukukya villages have only a few victims because they are further away from the plantations. Both these villages do not have many streams but they are served by Surangas.

In Kumbadaje village the population is low but the number of victims is very high because there are many cashew plantations and streams here. Except Shenii and most parts of Kattukukya of Enmakaje Panchayat and Ubrangala village of Kumbadaje panchayat, all the other villages lie within a radius of two kilometers from the cashew plantations.

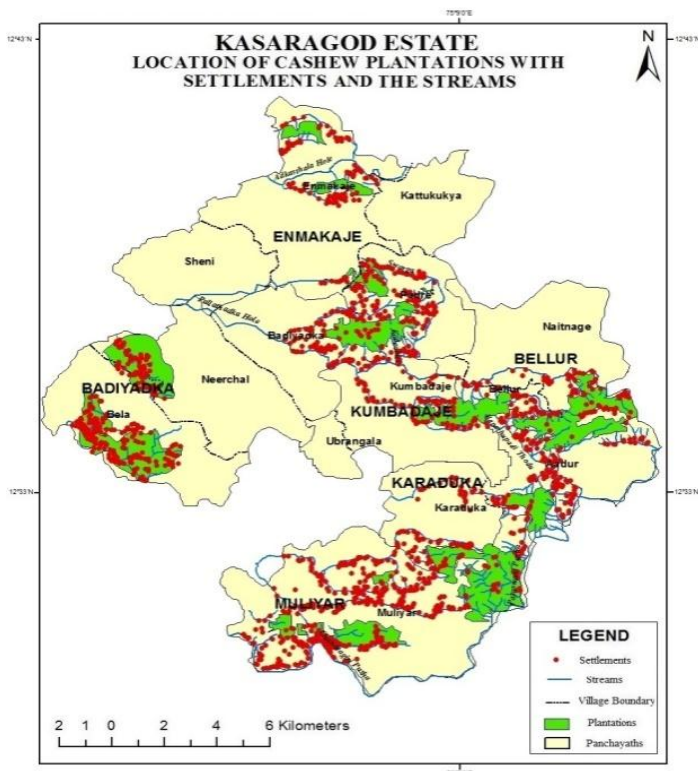


Figure 4 Location of Cashew plantations with settlements and Streams of Kasaragod estate

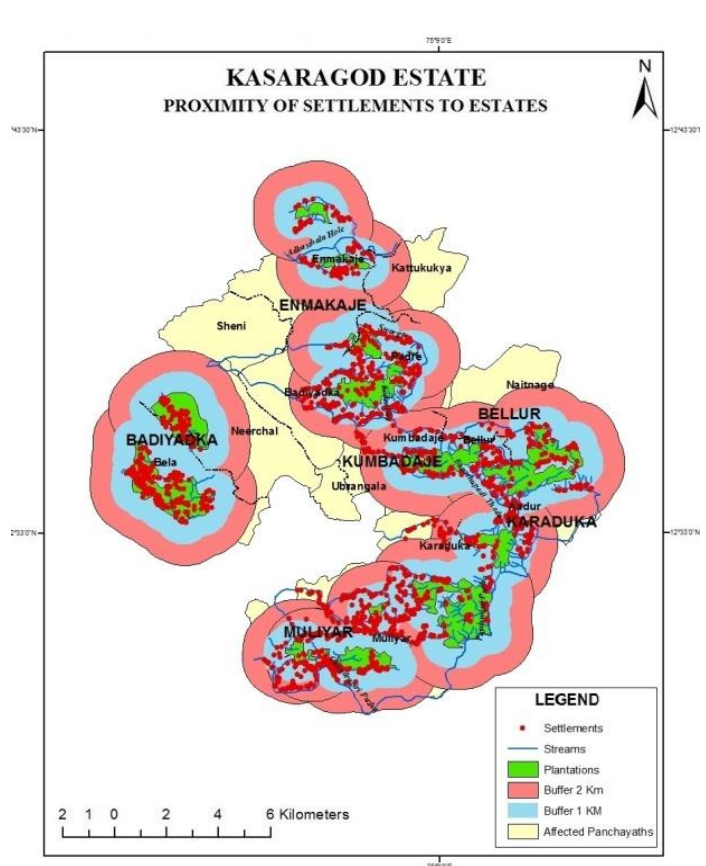


Figure 5 Proximity of settlements to plantations- Kasaragod Estate

Badiyadka, Bela and Neerchal villages in Badiyadka Panchayat all lie within one kilometer of the estates and have a large number of Endosulfan victims. Badiyadka has few plantations but it lies next to Padre Village and the numerous small streams from Padre Plantations join Palathadaka hole in Badiyadka. The PHC at Badiyadka reports that cancers, mental retardation and neurological diseases are more common in the Endosulfan affected villages.

In Kumbadaje village of Kumbadaje panchayat, the population is low but the numbers of victims are very high. This panchayat has many cashew plantations. Ubrangala village of this panchayat has less number of victims.

Karaduka and Adhur villages of Karaduka panchayat have a large number of victims. Similarly, Muliyar village has a large number of victims. All these villages lie within one kilometer of the estate. The Payaswani puzha flows through Adhur and Muliyar village. Palathadaka hole passes Bellur, Kumbadaje and Badiyadka. Both these streams are very long and pass through all the affected panchayat.

According to the PHC at Bovikkanam in Muliyar village of Muliyar Panchayat there are a large number of victims with mental retardation, cerebral palsy in the younger age groups (below 20) and psychiatric problems, dwarfism, muscular dystrophy and skin diseases in the older age groups

Rajapuram estate is located in Kallar and Panathady panchayats. All the plantations of Rajapuram estates are located on steep slopes on an average elevation of 500 meters. This region has rugged topography with steep slopes. The land slopes are towards the west and forms the catchment area of Uppala, Shiriya and Chandragiri rivers. There are numerous small streams that originate from the estates. It is seen that almost all the settlements are along the streams.

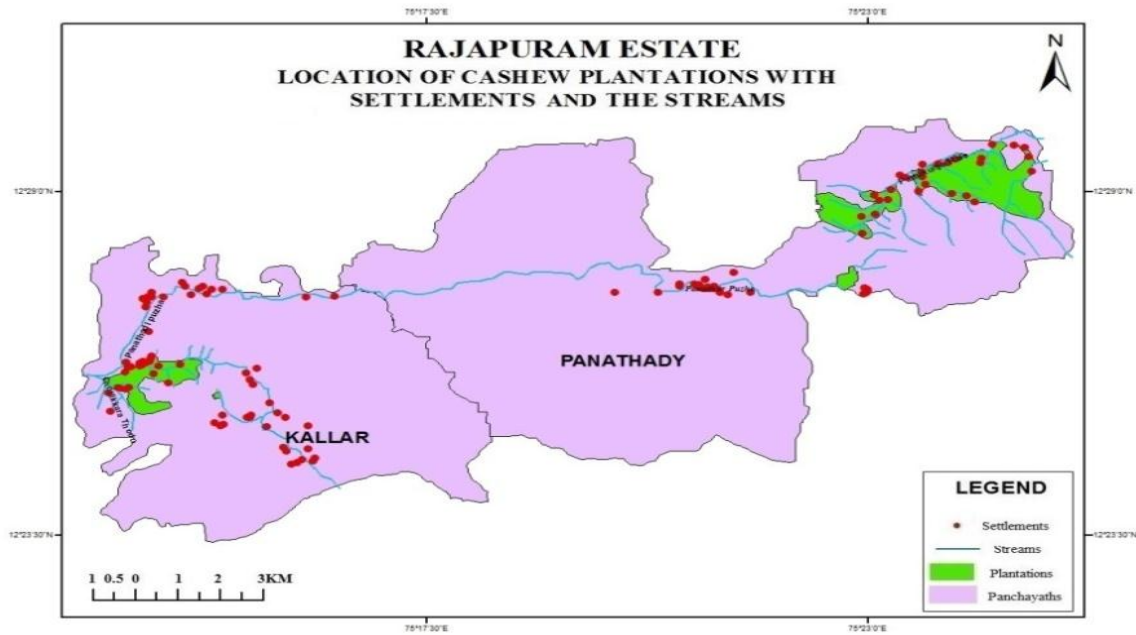
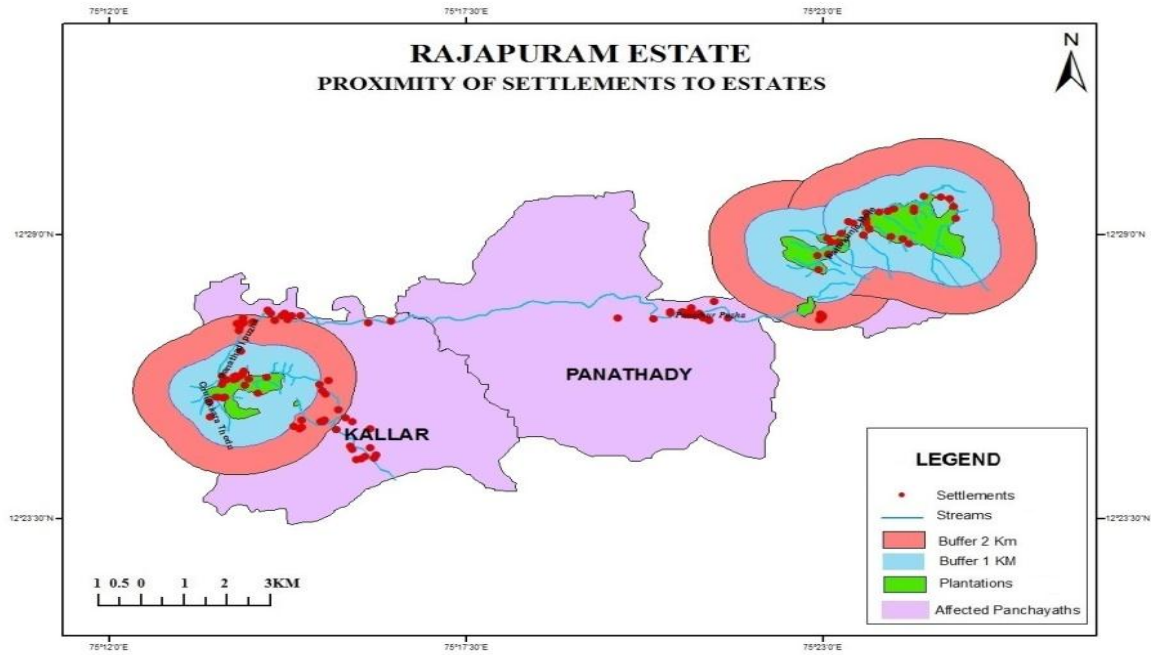


Figure 6 Location of Cashew plantations with settlements and Streams – Rajapuram estate

Figure 6 shows the location of cashew plantations in Rajapuram estate along with streams and settlements. More than fifteen streams originate from the plantations. Several streams join Patukunje hole in Panathady village. This stream joins Panathur puzha which flows through Panathady Panchayat. Panathur puzha in turn joins Pala puzha which flows through Kallar panchayat. Pala puzha finally joins Chandragiri puzha which is one of the largest rivers in Kasaragod district. All these streams are the main source of drinking water for the villages. In Kallar Panchayat there is only one village Kallar. The cashew estate is located in Kallar village.



**Figure 7 Proximity of settlements to plantations–Rajapuram Estate**

The settlements are seen mostly along the streams and only a few settlements are seen inside the plantations. In Panathady Panchayat, Panathady is the only village. The cashew plantation is located in this village. There are settlements inside the plantation and a large number of settlements are seen along the streams.

The figure 7 shows the villages that lie within a radius of one and two kilometers from the cashew plantations. The western part of Kallar panchayat (Kallar village) and the eastern part of the Panathady panchayat (Panathady village) lie within a radius of one kilometer and two kilometers respectively from the cashew plantations. This one-kilometer buffer zone also covers the Kodombellur Panchayat. This area is not notified as an affected panchayat but has several victims with different ailments.

Cheemeni estate is located in Kayyur Cheemeni panchayat. The cashew plantations are located on an average elevation of 100 meters. Kayyur, Cheemeni, Kallayikode and Timiri are the four villages of Kayyur-Cheemeni panchayat. The cashew estates are located in the villages of Timiri, Kayyur, and Cheemeni. Both these villages are close to the plantations and several streams that flow through the village begin from the slopes on which the plantations are located.

Thus, it is seen that the physiography of the region in terms of the numerous streams that flow in the region and the nature of the soil has played a great role in the translocation of the pesticides from the plantations to the settlements. This has adversely affected the health of the people. Figure 8 clearly shows the location of cashew plantation in Cheemeni Panchayat along with



streams and settlements. In Cheemeni village there are a few settlements inside the plantations. In the remaining villages settlements are found along the streams. Some streams are seen inside the plantation and it joins with the main river Ariyakadavu hole in the northern part of the panchayat. Kayyur Village and Kalayikode settlements are seen along the streams. Along the Nape chal large numbers of settlements are seen, and this stream joins with Kariangote River in the western side of the Kayyur - Cheemeni panchayat. In Timiri village large numbers of settlements are seen near the stream –Kuttamatt Thodu. Only a few settlements are seen inside the plantations.

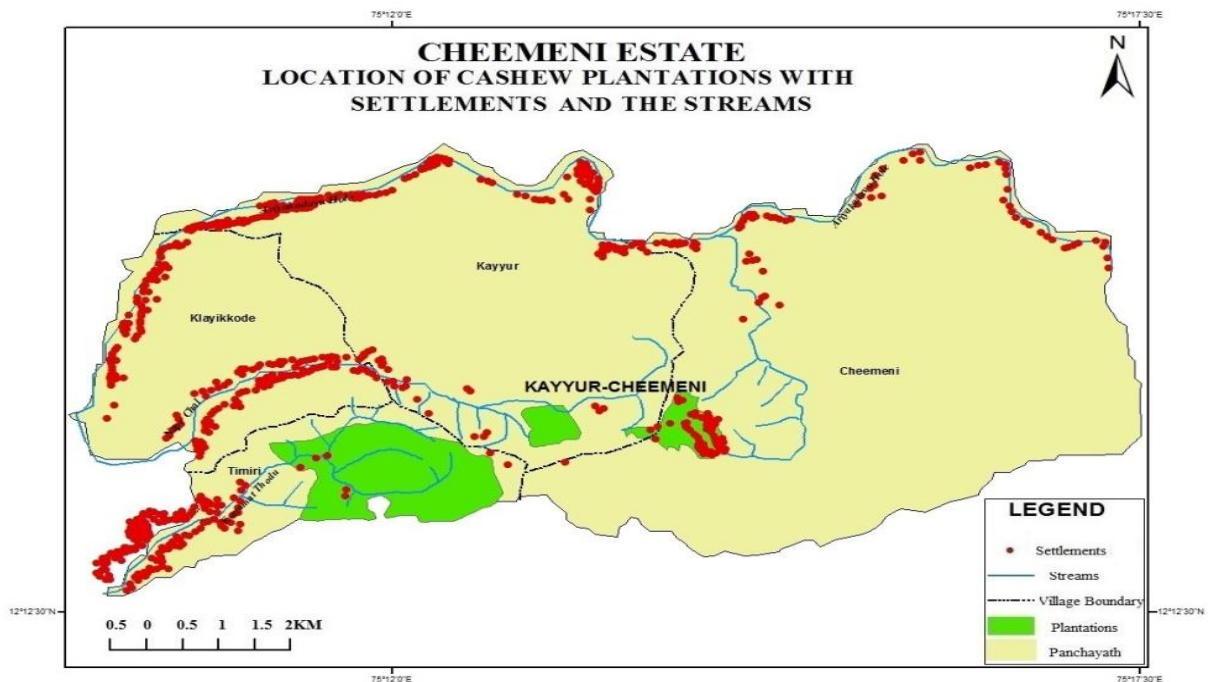


Figure 8 Location of Cashew plantations with settlements and Streams - Cheemeni estate

Figure 9 shows the villages that lie within a radius of one and two kilometers from the cashew plantations. In Kayyur –Cheemeni panchayat, large numbers of settlements are seen in and around the plantations. Timiri village, most of the Kallayikode and Kayyur village and a part of Cheemeni village in Kayyur- Cheemeni panchayat, lie within a radius of one kilometer from the cashew plantations. Except for the eastern part of Cheemeni village all the other villages lie within a radius of two kilometers from the cashew plantations. Both these villages are close to the plantations and several streams that flow through the village begin from the slopes on which the plantations are located.



Primary health Center in the Kayyur- Cheemeni panchayat is located at Kayyur. Kayyur village and Cheemeni village has a large number of Endosulfan victims. The major types of diseases seen in this panchayat are cancers, mental retardation, kidney diseases, asthmas, congenital anomalies, skin irritation, infertility problems etc. Thanal reports that the similar cases seen in Bellur and Enmakaje panchayat are seen in Kayyur-Cheemeni panchayat. More than 350 Victims are seen in this panchayat.

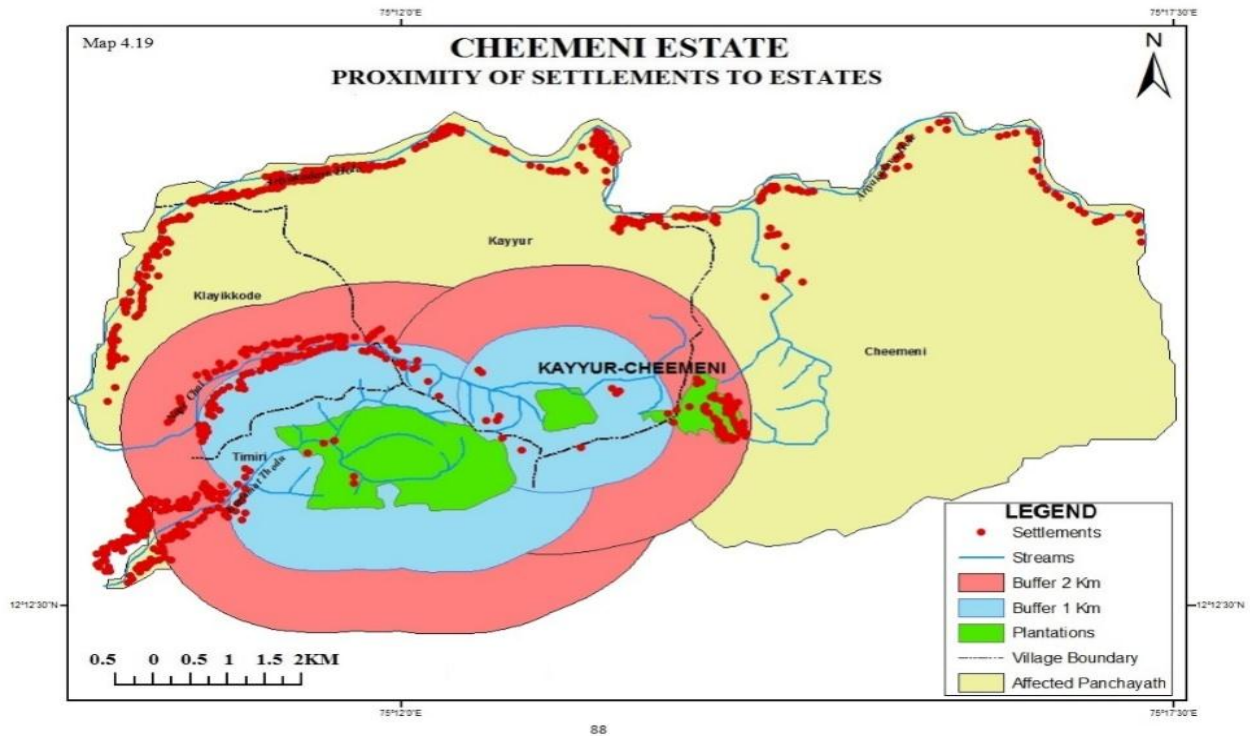


Figure 9 Proximity of settlements to plantations –Cheemeni Estate

Thus, it is seen from the physiography of the Kasaragod district that numerous streams that flow in these regions and the nature of the soil, have played a major role in the translocation of the pesticides from the plantations to settlements. This has adversely affected the health of the people.

## CONCLUSION

Green Revolution has impacted the environment by simply crowding wild plants in favor of more desirable cultivators and has had large scale impacts such as reducing biodiversity and has also affected animal and human health. The use of agricultural chemicals such as fertilizer and pesticides has magnified these impacts. Various geographical factors can determine the areas that are impacted by these pesticides. Run-off can carry pesticides into aquatic environments while wind can carry them to other fields, grazing areas, human settlements and other areas, potentially affecting other

species also. The present study has been successful in detailing the location of cashew plantations, the number of streams that are originating from these plantations and the proximity of the settlements from these plantations. The cashew plantations are all located on the thin laterite slope of the hills which allow the streams to join the major rivers of Kasaragod. These rivers are the major source of water for the entire settlements. Majority of the settlements seen on the banks of these rivers are having serious health issues. The buffer maps drawn around the estates show that all the affected villages lie within a 2 km radius of the plantation boundary and large number of them lie within a radius of 1 km. There are several settlements that are also found within the plantations. The geographical factors such as soil, terrains with slope, and rivers turn out to be the carriers of toxic pesticide and had adversely affected the human health. It is seen from this study that it is not only the use of the pesticide that has affected the health of the people but the natural environmental conditions have also played a role in the diffusion of the toxin and its persistence in the environment. The dreadful pesticides like Endosulfan will affect the health of future generations also. Hence, it is highly advised to follow the precautionary principles.

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