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Studies on toxicity of dishwashing gel to fingerlings of *Catlacatla* and changes in the behaviour of fingerlings

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Abstract

The toxicity of liquid detergent (dishwashing gel) to Catlacatla was studied with static bioassays during 2019. The 96 h LC50 of dishwashing gel was found out by the graphical method of Krouwer and Monti (1995). The value of 96 h LC50 for dishing gel was found to be 0.040ml/litre. During investigation the exposed fingerlings before death exhibits number of changes in behavior like nervousness, fast swimming, and imbalance, secretion of mucus, frantic movements and bleeding from operculum. This represents the adverse and highly toxic effects of detergents on the fingerlings.

Keywords:

Introduction

The environment is a driving force behind the survival of organisms on the planet. However, environment being a very crucial element of the nature, humans has exploited it over the years. Factors like over population, industrialisation, pollution, mining, agriculture, deforestation, etc. have destroyed the environment and now the world is facing issues like global warming and climate change. These changes have now created unhealthy environmental conditions for the human race as well as the flora and fauna. These conditions are bound to worsen with time which will lead to degradation of life on earth.

The inland fishery industry is among the largest industries around the world. Freshwater and marine fishes are exported and imported on large scales for consumption and other uses. In recent times, along with degrading ecosystem conditions, aquatic ecosystem is also at a high risk. Problems like increase in turbidity, chemical runoff, release of sewage, lower pH ranges, temperature fluctuations, ill-use of water, etc. can be observed which create negative living conditions for aquatic flora and fauna.

Freshwater fishes from rivers, lakes and ponds are largely consumed by the people as proteins. The nutritional value of fishes is adversely affected due to their habitats having chemicals and sewage which enter their system and thus end up in the humans and animals who consume them. These lethal components are thereafter recycled into the environment and may again enter the food chain. Fish diversity of freshwater species is declining due to the harmful effects of these pollutants on the fishes and thus, overall food chain also disturbed due to pollution. Many fishes which disappeared from heavily contaminated areas of Mula Mutha river of Pune[1].

Nowadays, the main aquatic bodies of world were severely contaminated with discharges from households and industries, both discharges contains huge amount of detergents. Because of its ionic property, in hard water the detergents work better than soaps and also are foaming agents to some extent. The enormous amount of surfactants is used in production of laundry products like detergent powders and cakes, as well as in various hair cleansers, dishwashers and lavatory soap, saving cream etc. Because of surface-active property of surfactants, it becomes most powerful cleaning agents. These surfactants create froth in the aquatic bodies, it stop the interaction between air and water, causing reduction in the dissolved oxygen concentration available to the aquatic animals underneath water surface, thus it affects growth and survival of fingerlings, plants and microbes in water.

These are non-degradable contaminant accrued in aquatic ecosystem. Then, they enter the food chain through the food. Detergents and surfactants are released into the water through sewage and activities of humans like defecation, washing clothes, animals and utensils on the banks of these freshwater bodies. Detergents show a detrimental effect on the chemical and biological factors of the aquatic habitat[2].

The liquid dishwashers contain Sodium LAS which is an anionic surfactant. Dishwashing detergents pose a threat to the plankton diversity in aquatic habitats which constitute the food material of these freshwater fishes. This can prohibit the growth of fishes and reduce their lifespan[3]. Surfactants are absorbed in the body of fishes through the gills and the body surface which is later circulated throughout the whole body through the blood circulation process. This surfactant adversely affects the organs of the fishes and can also prove to be fatal. These fishes when consumed by humans and animals contribute to the entry of surfactants in the humans resulting in toxic effects on them.

Surfactants can damage liver and cause other harmful reactions to the skin along with decreasing the body's immunity as well. Moreover, accumulation of surfactants in sewage also inhibits the microorganism action of removing pollutants and other harmful substances from the water[4].

The surfactant is chief component of detergents, the commercial surfactants like Alkyl Sulphates (AS), Cetyltrimehtyl Ammonium Bromide (CTAB), Alkyl Phenol Ethoxylates (APE), Linear benzene sulphonate (LAS), Alkyl Ethoxylates (AE) and Alkyl Ethoxysulphates (AES) are artificial ingredients, which are utilized in huge quantities in detergents, soap, shaving creams, textile softeners, flavours for food, paint, leather and fabric items, pesticides, defoliants, antiseptics, disinfectants[5].

In freshwater fish *Macropodus cupanus* the lethal level of detergents was 6 %, where as a sublethal concentration was 3 %. The detergent interrupts the nourishing; development, physiological and adaptation competence were reduced with raising in amount of the detergent in the fish *Macropodus cupanus*. These detergents hamper in utility of the food, development and adaptability of fishes[6]**.** The surfactants decrease the biological matters in the tissues of aquatic biota. The LC50 value of detergent to *Macrobranchium lamarrei* for 24hrs was 0.5%, also examined the drop in contents like glycogen, protein and lipid in the tissues of prawn with raise in amount of detergent and period of exposure[7].

The liquid dishwasher contain following ingredients (tests in Laboratory): i. Sodium LAS, ii. Disodium EDTA, iii. SLES, iv. Concentrated Lime Juice, v. Cl 19140, vi. Cl 42051, vii. Water.

The ingredients of the liquid dishwasher, like SLES (Sodium Lauryl Ether Sulfate) affect the kidney, liver and the central nervous system while Disodium EDTA can lead to disruption of skin cell surface and cause other chemicals to penetrate the skin easily. This experiment is therefore an attempt to study about the toxicity of liquid or gel dishwasher to the *Catlacatla* fish.

In this experiment, the value of LC_{50} is determined using graphical method of [8]. The value at which 50% of fish are observed to die is $LC_{50.}$ This value can help us understand and evaluate the amount of toxicity caused due to a particular volume or concentration of the liquid dishwasher on the *Catlacatla* fish. During the graphical calculations, concentration of the liquid dishwasher was plotted on the X axis, while the percentage of the fishes dead was plotted on the Y axis.

Materials and methods

The freshwater fingerlings of *Catlacatla* were collected from a government fish farm, Hadapsar and were used for bioassay studies. After bringing the fingerlings to the laboratory, proper aeration was provided for better acclimatisation. The fingerlings were selected having length 2.2-3.5cm and weight 2.3-5.8gm irrespective of sex. As per the guideline provided in APHA, fingerlings were assimilated in container in the laboratory for 7 days[9]. For the experiment, fingerlings were separated into groups of ten finger lings. The dead fingerling's number was recorded and removed instantly. During investigation before shifting fingerlings into the aquarium, the required volume of dishwashing gel was taken accurately and mixed in water. Concurrently a control set of experiment was arranged.

The bioassay tests were conducted in order to evaluate the acute toxicity of the dishwashing gel; dechlorinated tap water was used for accumulatisaton of fingerlings and for experiment. Fingerlings were nourished with fish diet daily subsequently changing the water. To determine LC50 values, the suitable sized fingerlings were selected for experiment and placed in different concentrations of dishwashing gel. The bioassays were conducted in glass aquarium containing twenty litres of dechlorinated water. Observations on survival were made after 96 hours. LC50 (concentration required for 50% mortality) values are calculated. Alongside, the control group of fingerlings was maintained[9].

Results and discussions

To study the changes in the fingerlings behavioral patterns, swimming patterns and operculum movements were observed. While conducting acute toxicity tests, mortality was not observed in the control group of fingerlings. The LC50 value of dishwashing gel studied for a period of 96 hours was found to be 0.040ml/L. In the present study, *Catla* exhibited several responses to dishwashing gel, for example, the operculum movement increased several times its normal rate, and the operculum either bled or turned colorless, depending on the dishwashing gel concentration in the water. The fingerlings showed violent movements like shaking or frantic swimming movements. Sometimes the fingerlings settle at the bottom of the tank and thrashed around, before slowly dying. After death, the fingerlings slowly floated to the top.

In freshwater fish *Rasboraelonga*96 hours LC_{50}values for detergents like Surf, Besto and Key was 12.734, 77.624 and 32.292ppm respectively[10]. The lethal (LC_{50}) values of detergent Ariel is 35ppm for 48 hours to fresh water teleost *Oreochromis mossambicus*[11]. The Omo and Ariel detergents have 96 hours LC_{50} value about 34.11 and 38.66 respectively in *Heteroclarias*[12]. The toxic effects of ionic and nonionic surfactants to six freshwater fishes were studied. The 48 hours LC_{50} value of Sodium dodecyl sulphate (SDS) in *Trout* was 33.61mg/litre, in *Gambusia* was 40.15mg/litre, in *Goldfish* was 38.04mg/litre, whereas in *Cirrhina* was 30.81 mg/litre[13].

The acute effects of two detergents to *Mystusmontanus* was examined by conducting toxicity tests. The 96h LC_{50} values for Det-I20.0mg/litre and Det-II 23.5mg/litre was noted. When fishes were exposed to various concentrations of detergents displayed many behavioural changes like anxiety, loss of

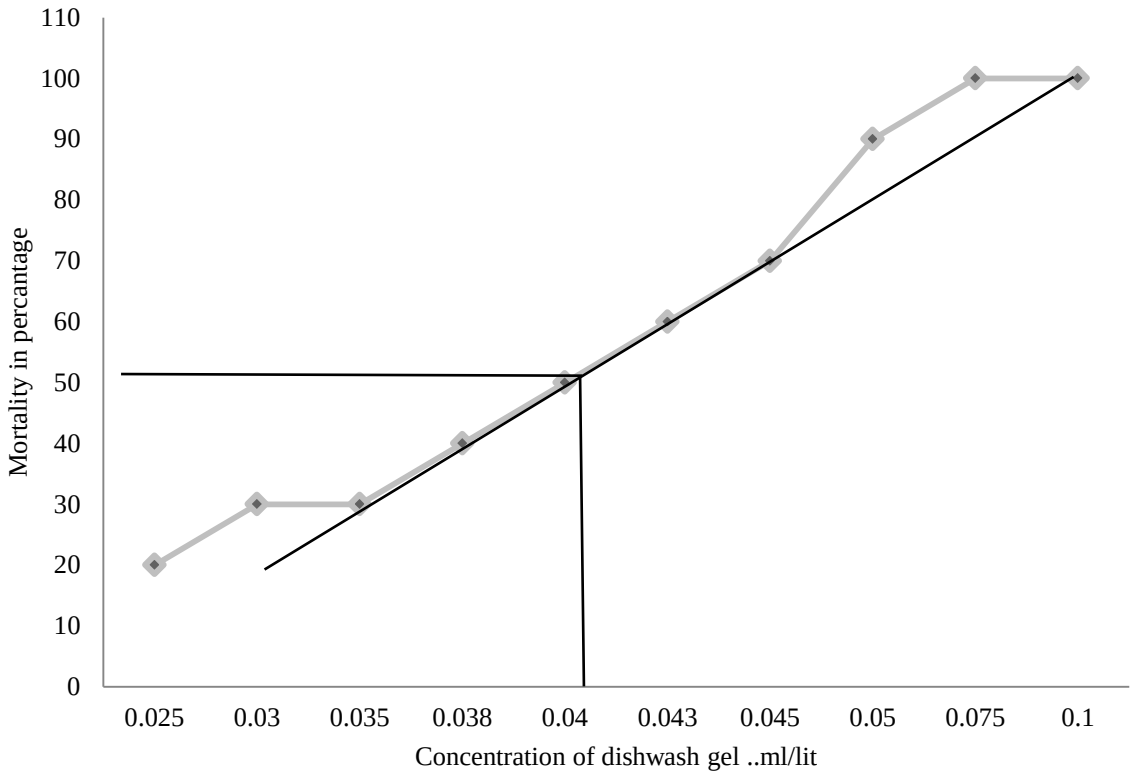
equilibrium, quick movement, breathing distress and bleeding in gill filaments were reported in fish before death. The rate of opercular ventilation aswell as visual investigation of dead fish specifies lethal effects of the detergent on the fish[14].

Conclusion

Fingerlings show various types of behavioural changes with the various concentrations of dishwashing gel, like swimming frantically, bleeding from operculum. Even at low concentrations of dishwashing gel fingerlings died due to bleeding through gills. These fingerlings are becomes an important in the light of the fact that they forms key diet and have profitable value, and to withstand its normal population. There is a need to control pollution of aquatic bodies by washing activities and to maintain the aquatic habitat. The use of surfactant containing products like dishwashing gels in homes cannot be stopped. However, it is necessary to develop better method of disposal of surfactant the 'after-wash'. Top reserve aquatic fauna of various water bodies, there is a need to manufacture eco-friendly dishwashing gel and soaps. Continuous existence of aquatic fauna is in serious threat, if the present rate at which they are introduced into aquatic environment is not checked.

Table-1: Mortality of fingerlings of *Catla catla* to dish wash gel.

Concentration ml/litre	Mortality of fishes				
	24hrs	48hrs	72hrs	96hrs	% of mortality after 96hrs
1.0ml/litre	10	----	----	---	100%
0.5ml/litre	10	----	----	---	100%
0.25ml/litre	8	2	----	----	100%
0.125ml/litre	8	2	----	----	100%
0.10ml/litre	7	3	----	----	100%
0.075ml/litre	6	2	2	---	100%
0.050ml/litre	2	2	2	2	80%
0.045ml/litre	2	2	2	1	70%
0.043ml/litre	1	1	2	2	60%
0.040ml/litre	1	2	1	1	50%
0.038ml/litre	1	1	1	1	40%
0.035ml/litre	1	1	1	----	30%
0.030ml/litre	1	1	1	----	30%
0.025ml/litre	1	1	----	----	20%



Graph-1: Calculation of LC_{50} value by the graphical method of Krouwer and Monti (1995).

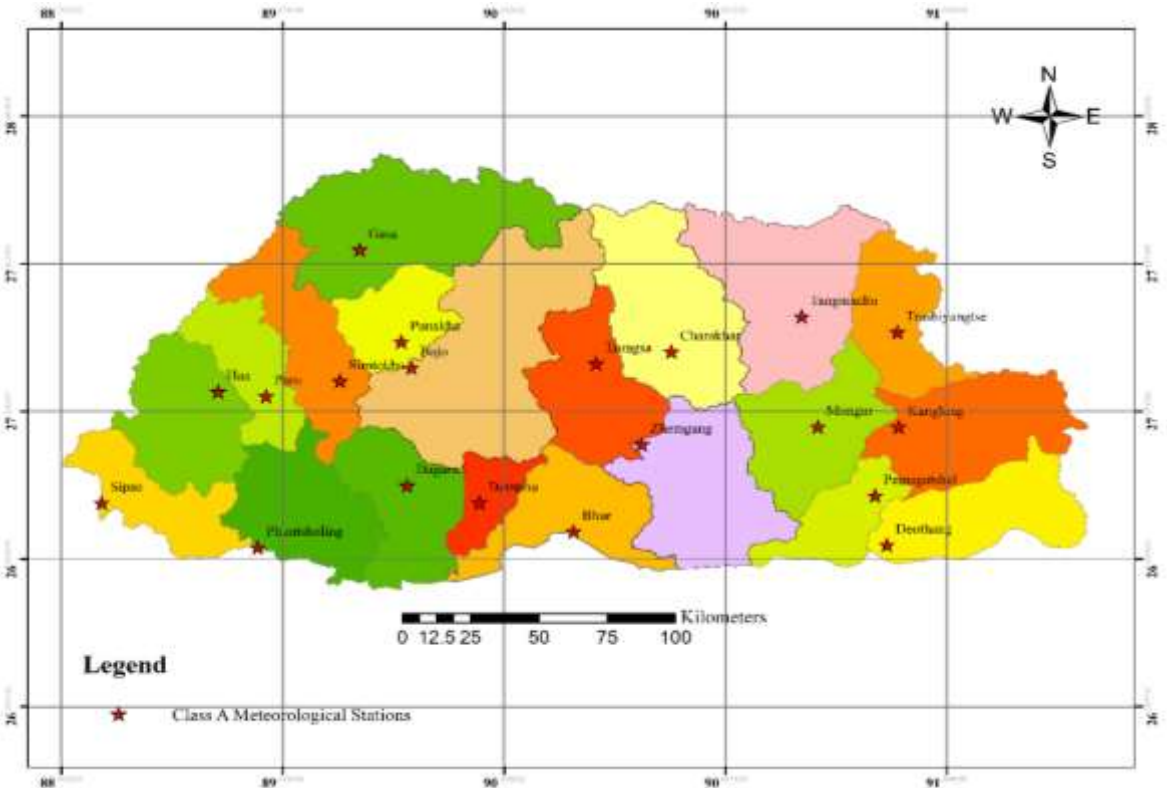


Figure-1: Location of the met stations included in the study.

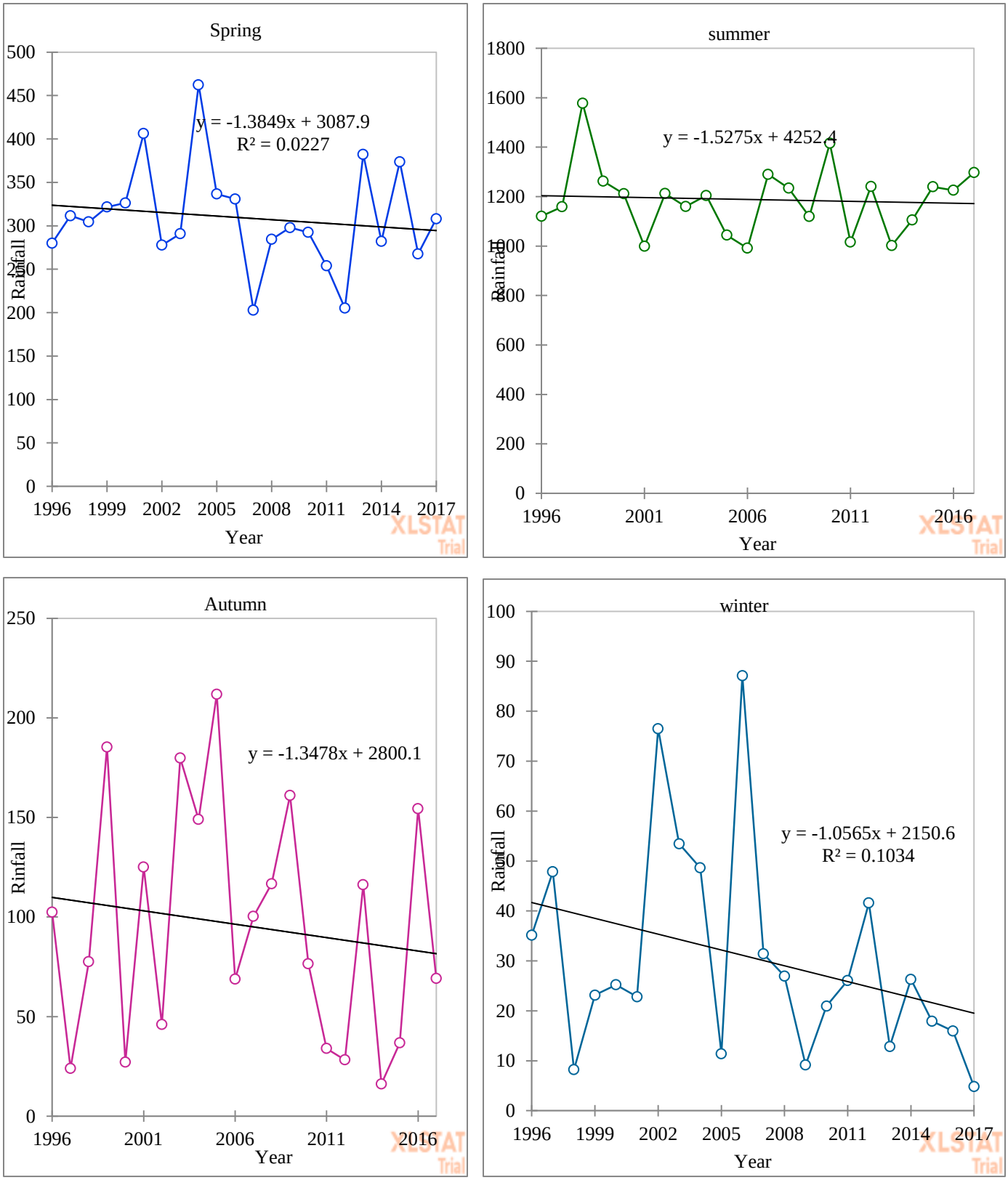


Figure-2: Line graph showing seasonal rainfall trend for Bhutan.

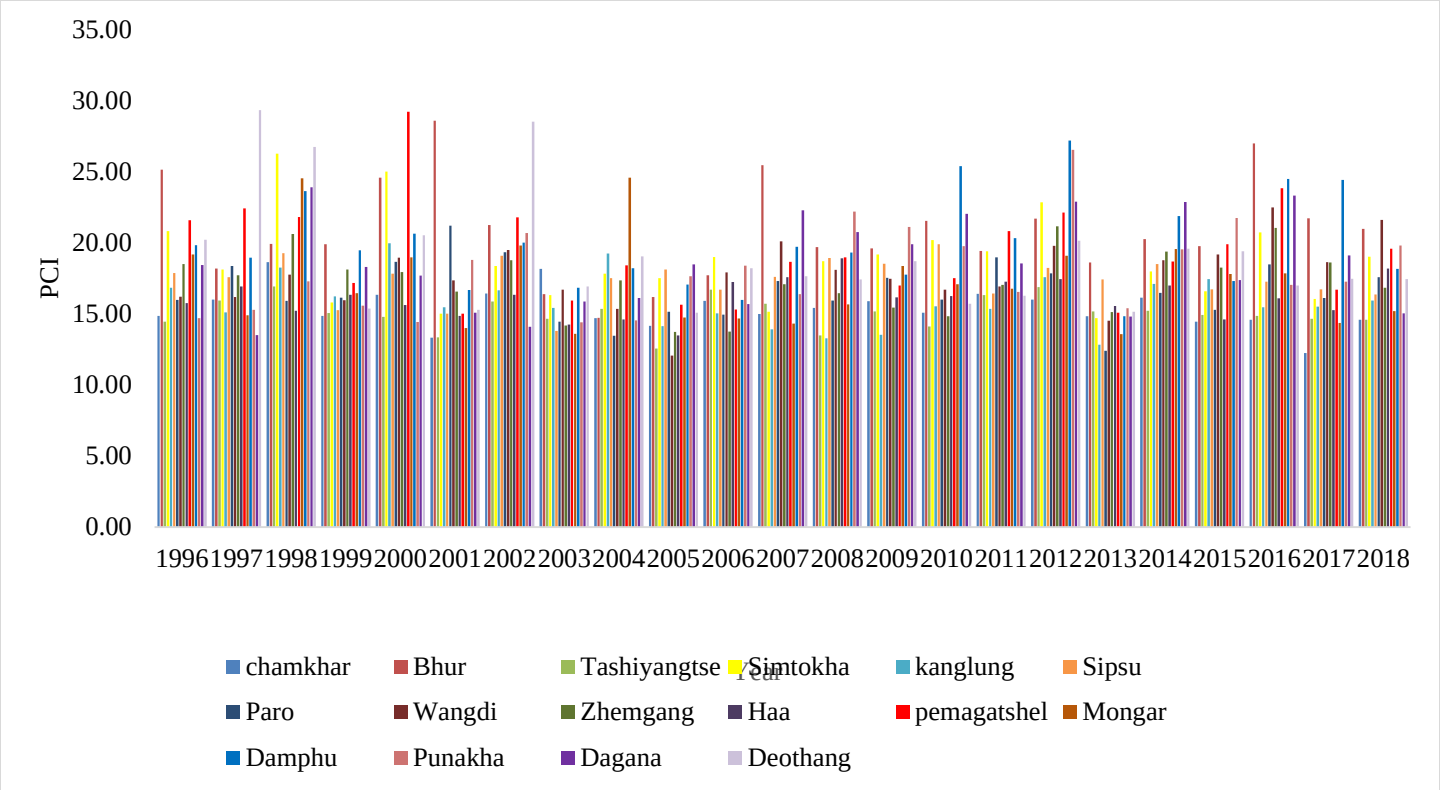


Figure-3: Annual Precipitation Concentration Index of 16 selected stations (1996-2018)

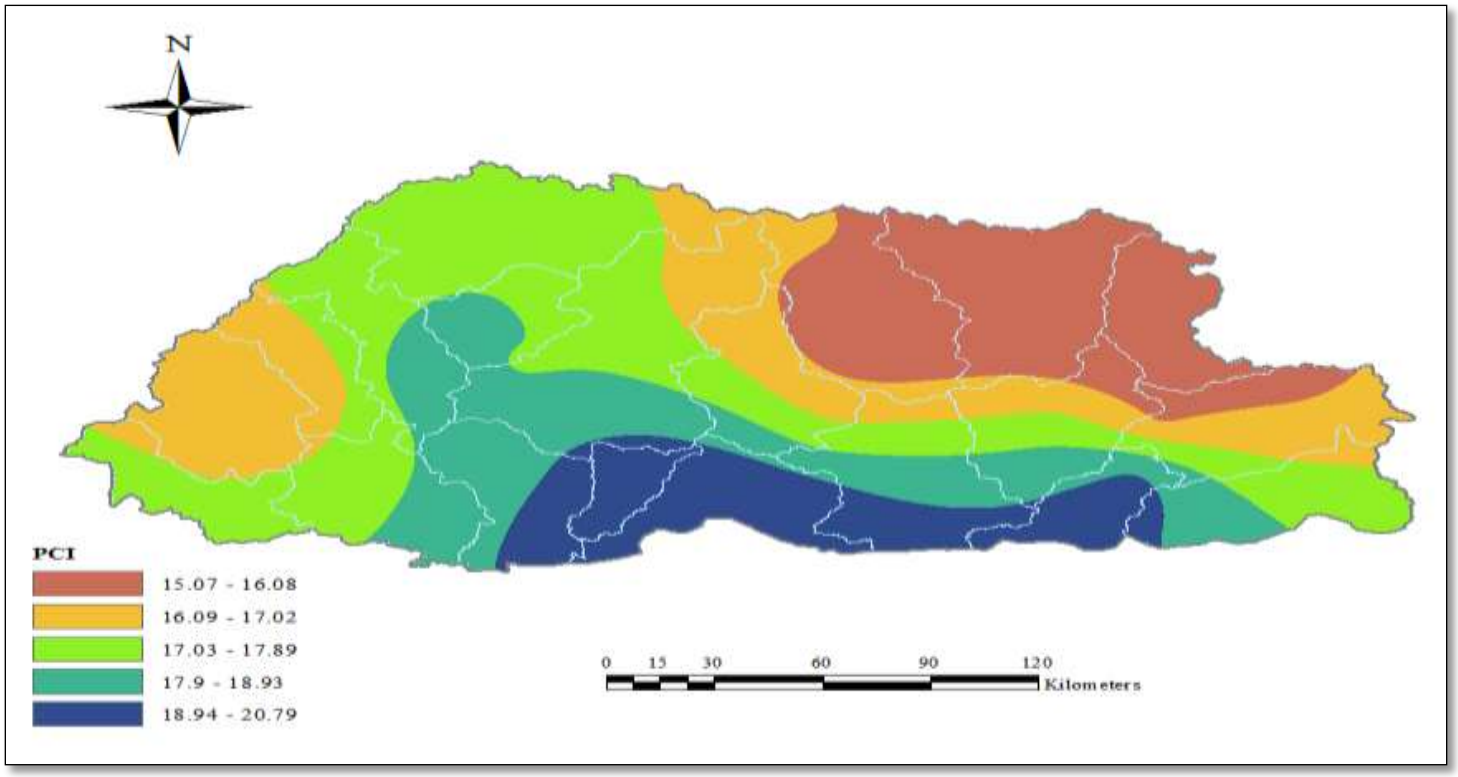


Figure-4: Spatial distribution of mean annual PCI in Bhutan.

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