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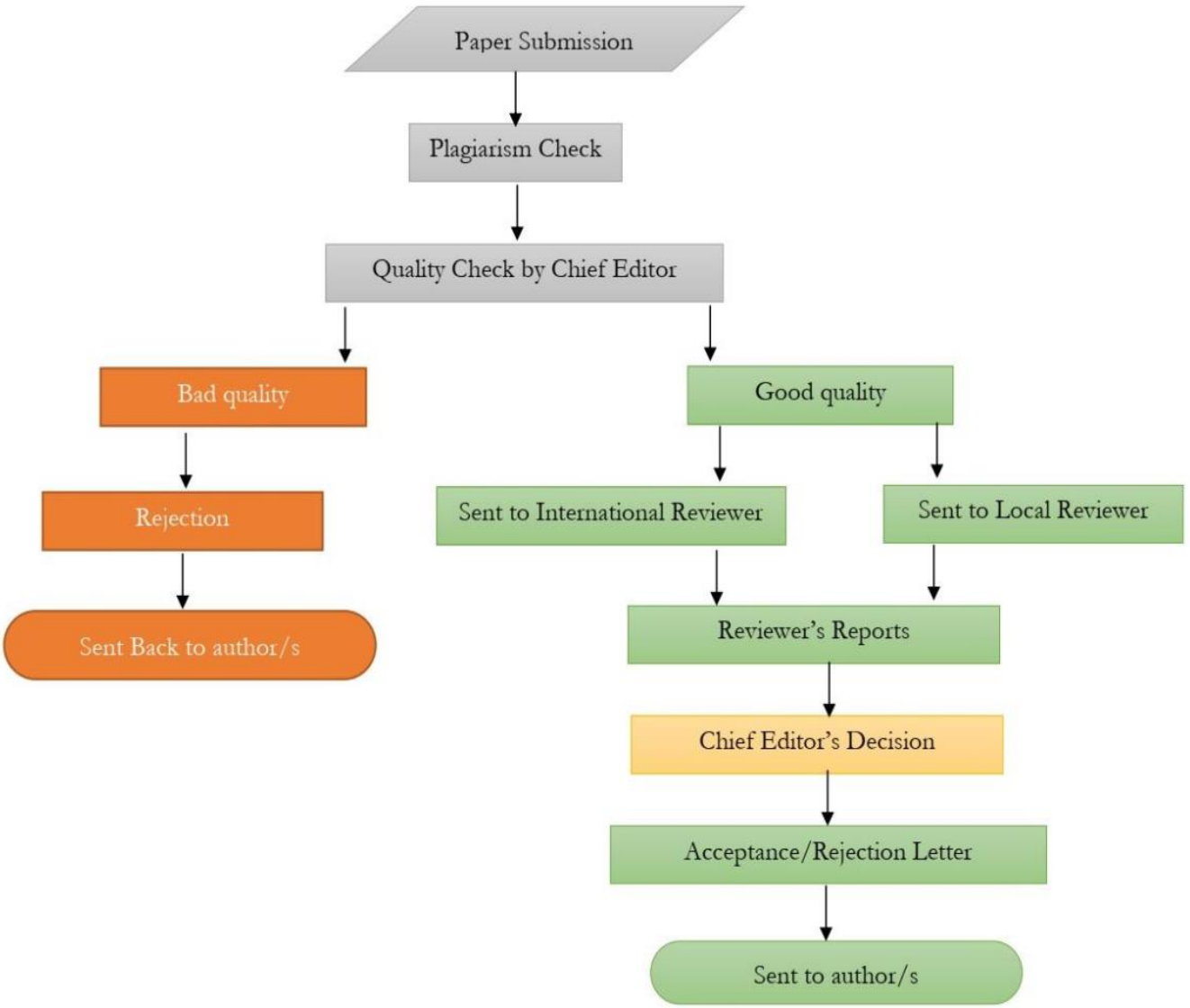

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Effects of COVID-19 Pandemic on Food Chain and Poverty in Pakistan

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COVID-19 pandemic has severely affected the food supply throughout the world. Pandemics affect the economy of nations badly but a number of countries were facing food insecurity even before COVID-19 pandemic. In this paper yearly data of food security is collected from the year 2015 to 2020 to inspect the consequences of poverty and COVID-19 pandemic through spatial regression analysis. The analysis shows that the food insecurity index has increased up to 33.5% by the year 2020 due to prevailing COVID-19 pandemic. The Asian residents which are already living in developing countries have faced higher food insecurity between the years 2015 and 2018. The spatial regression analysis babbled that the discriminations like race, religion and creed doesn't play any significant role in poverty and food insecurity. The primary factor of food insecurity is poverty. The poverty affected strongly during the years 2015 and 2018, the condition was worsened by the arrival of COVID-19 pandemic in 2020.

Keywords
Food Insecurity, Demographic, Spatial, COVID-19, Poverty

Introduction

Pakistan's social and living standards state that food insecurity is a lack of access to adequate food required to maintain a healthy lifestyle [1]. Food security levels are distributed into four levels, high, marginal, low and very low. High level of food security indicates adequate delivery of food in a society. In marginal food security, the society faces problems in accessing food, though the quantity, quality or variety of food is not reduced substantially.

Quality and variety of food is reduced in low level of food security while the consuming patterns of members of a family are disrupted in very low level of food security due to lack of food resources and money [2].

In Pakistan, food insecurity affected 16.4 out of 100 houses with marginal to low food insecurity in the years 2018 and 2019 [3]. This number was higher than the previous years. Nearly 11.8 % of Pakistani population faced food insecurity by the year 2017, this population lacked adequate food required for a healthy life [4]. The food insecurity was low in the year 2016 that was nearly 12.3 % [5,6,7]. The food security was above 4.9 % but it reduced to 4.5 % by the year 2016 [8]. High inflation rate, increasing unemployment, poverty and lack of adequate quantity of food has complicated the issue of eradication of food insecurity in Pakistan [9]. Food insecurity is source of multiple issues including birth deficiencies, anxiety, depression, anemia and malnutrition. According to latest research, food insecure families are at higher risk of having anemia, asthma and other malfunctions including poor growth [10]. These families are at 2 to 3 times higher risk of having malnutrition children [11].

Pakistan being underdeveloped and the sixth highly populated country, has moderately high levels of undernourishment and food insecurity. Nearly 15 % population including women and children consume barely acceptable quantities of food per day [12]. Although, Pakistan is self-dependent for the production of wheat but the level of hunger and malnutrition is extremely high in the country. One of the major reasons of food insecurity is poverty. Nearly 18.4 % population of Pakistan is of elders who lies among non-productive members of society [13]. Children share 35 % of the population of country. [14, 15].

Nearly 54 % families of Pakistan lie below poverty line and struggle to get adequate food on daily basis [16]. Rate of food insecurity is 11.2 % higher in south as compared to the northern west region i.e., Punjab where the food insecurity is 9.6 % [17,18]. Further policies were made by the government of Pakistan to address the issue of food insecurity. Government introduced a food security policy in 2018 for the first time in Pakistan. This program was introduced to attenuate hunger and poverty and to encourage the sustainable food production [19].

Several other efforts are being made including the Food for Peace (FFP) program through which US has provided an aid of nearly 2 million dollars to fight acute malnutrition prevailing in Pakistan [20]. UNICEF is an organization working in Pakistan since 1948 for the welfare of children providing the basic amenities including nutrition, sanitation and general hygiene [21]. UNICEF is supporting government of Pakistan to ensure health and nourishment of children in Pakistan. In 2018, the FFP program donated 21 million dollars to UNICEF to eradicate food insecurity, malnutrition and health issues of the country [22].

The natural disasters are also considered the root cause of food insecurity. Livelihood of millions of people was affected in 2019 due to drought as a consequence of floods and heavy

rain falls. Over one million people in seven districts of Pakistan were severely affected by drought which resulted in high food insecurity. Nearly 40 % population has encountered multidimensional poverty while 25 % lies below this line. About 38% children in Pakistan are suffering from malnutrition and stunt growth [23].

COVID-19 pandemic has severely affected the economy and food accessibility to nearly 210 countries with approximately 1.5 million deaths globally [24, 25]. The pandemic brought a global crisis of food, infrastructure and economy. The unemployment rate was also increased in this pandemic due to lockdowns and social distancing. In Pakistan this pandemic has affected livelihoods of nearly 7.15 million people [26].

This study reveals that the food security is related to employment and inflation rate of a society. The study also suggests that the disable children are more vulnerable to food insecurity as compared to healthy children. Poverty strongly impacts the circulation of food in different households in varying quantity .

Materials and method

The annual, demographic and regional effects of pandemic on poverty and food insecurity is studied through spatial regression model. In this paper theoretical and empirical data is used for measuring the effects of COVID-19 for the years 2018 and 2020.

Theoretical Model

The model is derived from the household's utility maximization and defined as:

$$u=f(x),\ subjecttoincome\ (I)\ constraint \quad (1)$$

such that $I=px\cdot X$. Where, px is the price of the bundle of food consumed; and I, the income.

$$[U(X)=f(x)=PxX \quad (2)$$

For a unit cost,

$$Px=1 \quad (3)$$

Inserting (3) into (2) gives:

$$U(X)=X(I) \quad (4)$$

$$du=dxdxdx(I) \quad (5)$$

$$x=f(I) \quad (6)$$

Since the primary goal of the study is to examine the effects of poverty on food security, we assumed poverty (z) as a proxy of income.

$$x=f(z,r,b,w) \quad (7)$$

Equation (7), is a yearly model applied to a spatial regression technique to examine the regional, demographic, and poverty effects on food security in Pakistan,

Data Construction and Source, and Estimation Procedures

The data of food insecurity for the years 2018 and 2020 was collected from various open sources e.g, statistics bureau. It provided adequate information regarding different levels of food in security in different households. It also provides information regarding

unemployment and economic variations of a country. The annual data regarding poverty, unemployment and economic changes was estimated through R software.

Results and Discussions

The study reveals that in Pakistan food insecurity affected 16.4 out of 100 houses with marginal to low food insecurity in the years 2018 and 2019. Food insecurity was reduced up to 10% in 2018. In 2015, there were nearly 44.58 million food insecure households which decreased to 39.92 million in the year 2018. The rate of food insecurity decreased due to intervention of several government programs that were introduced to reduce poverty. However, after the prevalence of COVID-19 pandemic the rate of food insecurity increased up to 53.29 million which was nearly 33%.

According to IPC Acute Food Insecurity analysis, Sindh and Baluchistan are the highest food insecure provinces of Pakistan. This survey revealed that nearly 26% population of these two provinces have suffered with high food insecurity levels in the year 2019 due high food prices, lockdowns and natural disasters including rainfall, floods and drought etc. Figure 1 is showing yearly statistics about the effects of COVID 19 pandemic on different provinces of Pakistan.

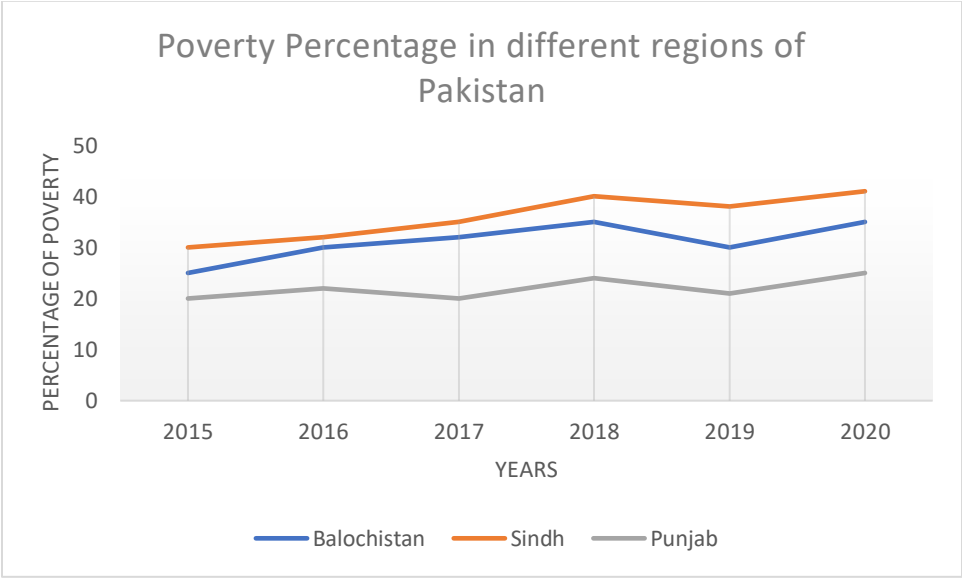

Figure 1.Food insecurity trend in Pakistan.

The results show that nearly 40% of Pakistani families are encountering moderate to high food insecurity levels. Inspite of being self-dependent in staple foods, the country is facing food insecurity from a couple of years. Nearly a quarter population of Pakistan lies below the poverty line and about 20 % population of Pakistan is malnourished including 45% children which are under the age of 5 according to the datasets of UN World Food Program (WFP). In the year 2019, there were nearly 1.3 million people suffering from

extremely high levels of acute food insecurity. Table 1 presents the yearly regression analyses of the regional distribution of food insecurity persons.

Table 1. Regression analyses of food insecurity by year.

	Dependent variable: Food Insecurity				
Years	2015	2016	2017	2018	2020
Sr. No	(1)	(2)	(3)	(4)	(5)
Poverty	0.212***	0.581***	0.579***	0.467***	1.204*
	(0.062)	(0.081)	(0.084)	(0.086)	(0.608)
Sindh	−0.030	0.048	0.001	0.025	−0.410
	(0.076)	(0.058)	(0.059)	(0.060)	(0.425)
Baluchistan	0.065	0.060	0.112*	0.100	−0.002
	(0.080)	(0.059)	(0.059)	(0.063)	(0.428)
Punjab	0.278***	0.194***	0.153**	0.148**	−0.762*
	(0.078)	(0.061)	(0.064)	(0.064)	(0.433)
Constant	−0.426	−0.355	−0.487	−0.365	6.071***
	(0.413)	(0.318)	(0.322)	(0.345)	(2.210)
Observations	51	51	51	51	51
R2	0.979	0.987	0.987	0.986	0.314
Adjusted R2	0.976	0.985	0.985	0.984	0.220
Residual Std. Error (df = 44)	0.171	0.131	0.133	0.135	0.957
F Statistic (df = 6; 44)	335.852***	561.839***	544.553***	528.710***	3.357***

Note: *p < 0.1; **p < 0.05; ***p < 0.01.

The prevalence of COVID- 19 has created high food insecurity and hit the economy of Pakistan hardly. According to Pakistan Bureau of Statistics (PBS), 20% rural and 9.2% of urban population of Pakistan was facing severe food insecurity in the year 2019. According to world food program, half million population in Sindh and Baluchistan was in an emergency situation in 2019. The country faced nearly 5.1 billion dollar economic loss in the years 2018 and 2019. The inflation rate of country was about 8.2% in the year 2018 which increased up to 5% additional in next few months. This study suggest that natural disasters effects the food supply badly and these include drought, heavy rain falls and floods and pandemics like COVID-19. During Pandemic the lockdowns increased unemployment as a consequence of which the poverty and food insecurity enhanced in the country was increased from moderate to high level

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

1. Zhou, Deyi, et al. "Factors affecting household food security in rural northern hinterland of Pakistan." *Journal of the Saudi Society of Agricultural Sciences* 18.2 (2019): 201-210.
2. https://www.dawn.com/news/1626141/food-insecurity
3. Babatunde, Raphael O., and MatinQaim. "Impact of off-farm income on food security and nutrition in Nigeria." *Food policy* 35.4 (2010): 303-311.
4. Food and Agriculture Organization (2013).*The State of Food Insecurity in the World 2013: The multiple dimensions of food security*. Accessible:http://www.fao.org/docrep/018/i3434e/i3434e06.pdf
5. Government of Pakistan (2017). *Pakistan Economic Survey 2016-2017*. Accessible: http://www.finance.gov.pk/survey/chapters_17/overview_2016-17.pdf
6. Government of Pakistan Ministry of National Food Security and Research Islamabad (2017). *National Food Security Policy*. Accessible: http://www.mnfsr.gov.pk/mnfsr/userfiles1/file/12%20Revised%20Food%20Security%20Policy%2002%20June%202017.pdf
7. Kugelman, M. et al. (2011). "Hunger Pains: Pakistan's Food Insecurity", *The Woodrow Wilson Center*, Accessible: https://www.wilsoncenter.org/publication/hunger-pains-pakistans-food-ins...
8. ONE United Nations Pakistan (2016). *ONE UN Pakistan Programme II Annual Report*. Accessible: http://www.un.org.pk/wp-content/uploads/2015/07/UN_report_2016_interactive_SIGNED_highres.pdf
9. Zhou, Deyi, et al. "Factors affecting household food security in rural northern hinterland of Pakistan." *Journal of the Saudi Society of Agricultural Sciences* 18.2 (2019): 201-210.
10. Pai, Shilpa, and Kandy Bahadur. "The impact of food insecurity on child health." *Pediatric Clinics* 67.2 (2020): 387-396.
11. Ke J, Ford-Jones EL. Food insecurity and hunger: A review of the effects on children's health and behaviour. *Paediatr Child Health*. 2015;20(2):89-91. doi:10.1093/pch/20.2.89
12. https://www.unicef.org/media/60806/file/SOWC-2019.pdf
13. HelpAge International. 2012. *Ageing in the 21st Century: A Celebration and A Challenge*. New York: UNFPA.
14. HelpAge International, 2015. *Policy Mapping on Ageing in Asia and the Pacific Analytical Report, Chiang Mai: HelpAge International East Asia/Pacific Regional Office.*
15. International Labour Organization. 2018. *World Social Protection Report 2017–19*. Geneva: ILO.
16. *"World Poverty Clock"*. *worldpoverty.io. Retrieved 2021-07-22.*

17. ^ *"UNDP Reports Pakistan Poverty Declined to 17%, Under Musharraf". Pakistan Daily. 7 September 2009. Archived from the original on 26 July 2011. Retrieved 2012-03-12.*
18. ^ "Poverty in Pakistan: Issues, Causes, and Institutional Responses", *Asian Development Bank* (accessed: 2008-05-04)
19. Asghar, Nadia, and Aneel Salman. "Impact of agriculture credit on food production and food security in Pakistan." *Pakistan Journal of Commerce and Social Sciences (PJCSS)* 12.3 (2018): 851-864.
20. Barrett, Christopher B., and Dan Maxwell. *Food aid after fifty years: Recasting its role*. Routledge, 2007.
21.
22. https://www.unicef.org/pakistan/media/1871/file/KeyFindings---NationalNutritionSurvey2018.pdf
23. https://borgenproject.org/5-things-to-know-about-hunger-in-pakistan/
24. Zhou, Deyi, et al. "Factors affecting household food security in rural northern hinterland of Pakistan." *Journal of the Saudi Society of Agricultural Sciences* 18.2 (2019): 201-210.
25. Kheyfets, Boris, and V. Chernova. "COVID-19 pandemic influence on global food security." *Obshchestvoiekonomika* 7 (2020): 86-98.
26. https://pubmed.ncbi.nlm.nih.gov/33410007/

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Degradation of Bioplastics under the Influence of Several Environmental conditions

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Abstract

The increasing threats of plastics to the natural environment encouraged the production of bio-plastics from renewable biomass resources. The premium quality of bio-plastics are mainly produced by treating starch with glycerol. Plastics are basically non-biodegradable synthetic or semi synthetic products. This study aims at analyzing the degradation patterns of bio-plastics. The bio-plastics are ecologically less toxic than the synthetic plastic materials. The bio-plastics can degrade in several environmental conditions including aquatic environment, compost and soil. The bioplastic materials are buried in composite soil or loam sand to analyze degradation activity by taking photographic data and measuring the weight. Effect of weather conditions on the degradation activity was analyzed by recording different weather conditions including temperature, humidity, rainfall sunshine intensity and duration of sunlight. The comparative results portrayed the degradation activity of bio-plastics which was accomplished through hydrophilic enzymes. The initial regenerating material absorbs moisture of soil after saturation and the weight was increased up to 87%. The weight of bio-plastics reduced steadily after the initiation of decomposition. Invasion of soil microorganisms enhance the degradation activity. The environmental features including rainfall, humidity and sunlight intensity also affects the disintegration of bioplastics. The increased intensity of sunshine increased the microbial activity of soil which in turn increased the rate of degradation of bio-plastics.

Keywords

Bioplastic, Degradability and Purified Glycerol.

1. Introduction

Plastics are widely used commercial products made of synthetic and semi synthetic raw materials. Plastics are non-bio-degradable or take centuries to degrade under natural climatic conditions [1]. These are light, versatile, moisture resistance, tough and cost efficient which are commercially used for packaging, textiles and in electronic devices all over the world. Plastics are considered non-biodegradable because it disintegrates in a period beyond human time frame [2]. The petroleum-based plastics have several drastic effects on environment and one of them is destruction of natural beauty of landscape [3]. Persistence of plastics in soil alters the structure of soil and destroys the biota of soil. Littering of plastics in water bodies are a major cause of death of aquatic organisms including zooplanktons, mammals, fish, amphibians and birds depending upon water for fee. Ingestion of any plastic material can cause death of organisms for instance, fish, turtles, whales and birds [4, 5, 6]. The plastics are the most hazardous materials for food chain, and can block drainage channels and sewerage lines if these are not properly disposed off causing breeding of mosquitoes and other vectors in ground which can spread diseases. Thus, this blockage aggravates the chance of floods and cause problems related to waste management [7].

Thus, due to increasing environmental hazards there is a dire need of renewable or degradable packaging materials. One great effort to decrease the life span of petroleum based plastics was to blend these with natural polymers for instance starch. This blending converted the petroleum plastics into bio-plastics. Other polymers including lignin, protein resins and cellulose has also been used to develop bio-plastics [8]. Lipids and animal fats are also used to produce bio-plastics. Particularly the major carbohydrate used for manufacturing bioplastics is obtained from cereals and plant tubers. Starch is abundant and cost efficient naturally but plasticizing increases its mechanical properties including flexibility [9]. Glycerol is used as a plasticizing agent for the breakdown of hydrogen bonds formed between the monomers of starch granules constituting a polymer. Bioplastics including starch blends with biodegradable polyesters like Polylactic acid (PLA), Polycaprolactone & Ecoflex and Thermal plastic starch (TPS) which are high quality bio-plastics manufactured by starch [10]. Glycerol is produced along biodiesel as a byproduct, its direct disposal is hazardous for the natural environment but it has multiple applications in pharmaceutical, polymers, food and cosmetic industry after purification. Using glycerol plasticizer is quite beneficial as it manufactures less pollutant and environment friendly bio-plastics. The bioplastics are introduced as an alternative to non-renewable petroleum based plastics due to their ability to decompose in shorter time as compared to petroleum based plastics. Bioplastics decompose through microbial activity of soil. In soil, microorganisms produce enzymes under optimal conditions to degrade bioplastics [11].

Different factors affecting the decomposition activity of bioplastics including pretreatment, microorganisms and characteristics of polymer. The general characteristics of polymers include molecular weight, mobility, and nature of plasticizers, tactility and crystallinity. The decomposition activity usually takes place in optimal conditions including humid conditions because hydrophilic enzymes usually occur in moist environment. In soil, various organisms including bacteria, fungi or worms secrete amylase enzyme in external environment which breaks down starch [12].

This enzyme degrades the insoluble starch materials to soluble products which are usually absorbed by microbial cells, these products include maltose and glucose. During decomposition, the large polymers are degraded into monomers by breaking hydrogen bonds through enzymes, thus viscosity is reduced and the product is liquefied [13]. Different saccharides are formed in a process known as scarification following the breakage of bonds. The microbial activity of soil is increased in the presence of water, oxygen, temperature and light intensity.

Thus the bioplastics readily degrade in presence of water. The bioplastics are usually coated on paper bags to increase the stability of paper bags and to retain oil and moisture [14, 15, 16].

This study aims at investigation of sequential decomposition/degradation/disintegration of bioplastics at various environmental conditions.

2. Materials and Methods

Study area

This research was done in coastal agricultural region of Karachi during the year 2020. The temperature of this region is high and overall climate is humid. Cassava roots are harvested in the fields to obtain starch [18].

Material and method

Starch is used to manufacture bioplastics using glycerol as plasticizing agent and bioplastics are hydrolyzed using acetic acid or hydrochloric acid. Peels of cassava roots are rich in starch. To obtain starch cassava, roots were treated with 0.1 M NaCl to extract the peel using a warring blender. The homogenate was strained through a muslin cloth. The homogenate was dried in oven for 24 hours at 60°C. Starch was plasticized with glycerol, while glycerol is of two types i.e, Analytical Grade (AG) obtained from local area and purified glycerol obtained from vegetable oil [19].

Reagents

Various reagents were used along glycerol; these reagents include Acetic acid, Nacl, HCl and AG glycerol. For plasticization, 450ml distilled water was added into 35g starch in order to form a mixture to which 0.1M acetic acid (15g) and 10ml of glycerol was added. This mixture was then heated for 45 minutes at 120°C in a 850ml beaker. This mixture was then poured into a tray after cooling. The mixture was spread on tray with the help of rod. The tray was again heated for 18 hours at 60°C. The dried mixture was termed as bioplastics which cut into smaller pieces for laboratorial use [20, 21].

Burying of bioplastics

Before burying bioplastics, the initial weights of pieces was measured. The effect of decomposition was measured by taking photographs and measuring weight of buried bioplastics weekly. In laboratory, bioplastics were decomposed with three methods; in first method, bioplastics were submerged in 100ml of distilled water and poured in a 250 ml beaker at room temperature. In second method, the bioplastics were buried in soil nearly 3 inches deep. In this soil almost 6ml of water was added weekly to retain the moisture level [22, 23]. In the third method bioplastics were observed under natural environment. Then these bioplastics were covered with polyester and buried in

30cm deep soil. Effects of changing weather conditions including rainfall, temperature and humidity are also recorded.

Table 1: Reagents used in Bioplastic Samples

Samples	Starch (g)	Water (ml)	Acid	Glycerol
Bioplastic 1	35	450	HCL	Analytical Grade (AG)
Bioplastic 2	35	450	HCL	purified glycerol
Bioplastic 3	35	450	Acetic acid	purified glycerol

3. Results

The disintegration period of three bioplastics is given in the Table 2. The physical appearance of bioplastics changed when decomposition started. The thickness of bioplastics increased due to absorption of water which darkened the color of bioplastics. Following this, the bioplastics degraded into smaller components until these were completely disintegrated. The disintegration enables the microorganisms to attach to bioplastic components and digest starch. By the fifth week of decomposition, the bioplastics were disintegrated to very small brittle components.

Change in Bioplastic Weight

Weight of buried bioplastics changed by the time. The general trend of decomposition involve increase in weight, further variations in bioplastics due to soil organisms and decrease in weight following the complete disintegration of bioplastics. The initial increase in weight is due to absorption of water in bioplastics by hydrophilic enzyme to start disintegration. As starch is hydrophilic, therefore its weight varies according to the moisture content of soil which in turn depends upon different environmental conditions including rain. After moisture absorption, the microorganism in soil completely degrade the bioplastics. Moisture content plays a significant role in the disintegration of bioplastics as the starch itself and enzyme is hydrophilic as well as microbial activity of soil also require moisture. The weight of bioplastics decrease when microorganisms decompose the bioplastics after three weeks. The first bioplastics were digested by worms; the second one was ingested by termites while the third bioplastics were disintegrated by fungi, all these bioplastics were completely broken down within 10 weeks. There was no significant variation in weight of bioplastics hydrolyzed with local glycerol or acetic acid unlike those who were hydrolyzed with HCL.

Table 2: weekly physical changes in weights of bioplastics under the influence natural environment.

Change in weight	**Week 1**	**Week 2**	**Week 3**	**Week 4**	**Week 5**
Bioplastic 1	**8.03g**	**11.57 g**	**12.19g**	**12.5g**	**7.06**
Bioplastic	**8.03g**	**18.74g**	**19.05g**	**17.06g**	**16.89g**

2					
Bioplastic 3	**8.03g**	**9.09g**	**10.94g**	**9.14g**	**5.48g**

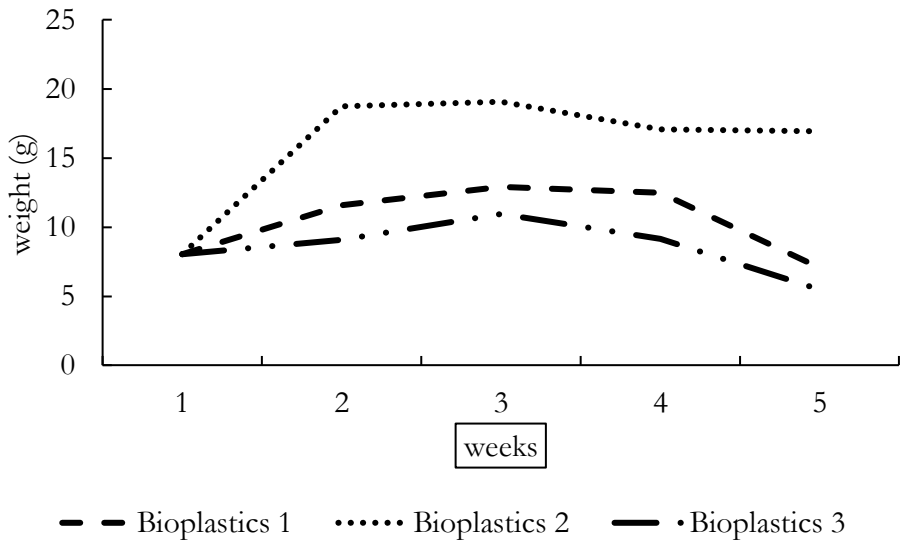

Figure 1. Change in Bioplastic weight over five weeks of degradation period.

The HCL is strong acid which requires massive moisture content to disintegrate into water and free ions which possibly causes the weight of bioplastics to vary greatly.

Effect of Weather on Bioplastic Degradation

During ten weeks of decomposition, the following weather conditions were recorded; average temperature was from 20°C to 43°C, sunshine hours ranged from 0.0 - 12 hrs, average rainfall ranged from 0.0 to 43 mm and relative humidity ranged from 61.5% to 84.5%. Rainfall is closely related to the variations in weight of bioplastics as the rainfall increases the content of water in soil and facilitates the disintegration of bioplastics. For the first bioplastics, temperature play significant role in variation of weight while sunshine hours has positive correlation only with the third bioplastics. While relative humidity had an inverse relation with weight of bioplastics.

Rainfall & Sunshine Hours Contribution to Degradation

The decomposition of bioplastics started with low rainfall volumes i.e, 2.3mm. During first two weeks the weight of bioplastics increased with decreasing rainfall volume. After two weeks, the weight of bioplastics drastically increased when the rainfall volume increased up to 0.05mm. After four weeks, the weight started decreasing due to decreasing rainfall and precipitation rate. Rainfall increases the moisture content of soil which facilitates degradation of bioplastics. Thus rainfall provides optimal conditions for the disintegration of bioplastics through hydrophilic enzymes.

The rate of weight loss was reduced during 4th to 7th week when rainfall level decreased significantly. After the decomposition of larger components, the smaller components created high volume to surface ratio for moisture absorption.

The sunshine affects the microbial activity of soil, facilitates the biological activity and breakdown of biological molecules. The weight of bioplastics increases by the reduction of sunshine. Moderate sunshine expedites the breakdown of bioplastics in soil facilitating the hydrophilic enzymes resulting in an increased decomposition of bioplastics.

Laboratory Degradation Trend for Bioplastics in Water

The weight of bioplastics soaked in water increased during first three weeks. The weight of bioplastics declined from 4th to 8th week during which the substrate was completely dissolved and disintegrated.

Table 3: Weekly physical changes in weights of bioplastics when the substrate is completely dissolved.

Change in weight	Week 5	Week 6	Week 7	Week 8	Week 9
Bioplastic 1	7.06g	6.28g	5.09g	4.95g	4.06
Bioplastic 2	16.89g	12.74g	11.05g	10.06g	8.89g
Bioplastic 3	5.48g	5.09g	4.94g	3.95g	3.18g

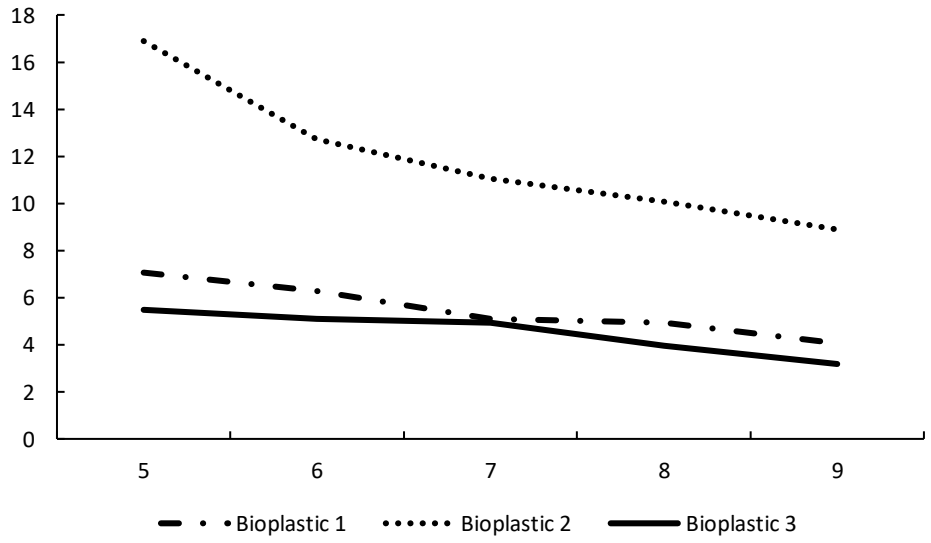

Figure 2: Change in Bioplastic weight from five weeks of degradation period.

The third type of bioplastics were hydrolyzed with acetic acid and decomposed in a shorter time as compared to first two bioplastics. The bioplastics soaked in distilled water had no significant differences.

The laboratory experiments of bioplastics indicated that pure glycerol based bioplastics take less time in decomposition. These experiments suggest that hydrolyzing agents and purity of glycerol affects the rate of decomposition of bioplastics in any medium.

4. Discussion

Plastics made by renewable plant based materials are termed as bioplastics. These plastics can be obtained from natural resources as well as can be synthesized chemically in laboratories. One of the major biological molecules used for the production of bioplastics is starch. Bioplastics have advantage over petroleum based plastics that they can degrade in shorter time as compared to the petroleum based bioplastics. The pattern of degradation is necessary to understand the time and factors required for the decomposition of plastics and to have an insight of materials used to manufacture plastics with desirable rate of decomposition. The process of decomposition initiates with the hydrolysis of bioplastics and followed by the breakdown of polymers into monomers which are absorbed by microorganisms. Microbial activity of soil is carried out with the help of soil organisms including worms, bacteria, worms and fungi. The decomposition process is facilitated by the soil organisms which may or may not be visible to the human eye. The microbial activity starts in the second week following the increase in weight of substrate and then the weight decreases by microbial activity.

Natural process of decomposition is more effective in comparison to the enzymatic decomposition. Different types of soil comprises of different composition and microbes to facilitate decomposition. The rate of decomposition is doubled in moist and porous soil which hosts greater number of microbes. The rate of degradation of first bioplastics is high and its assimilation period is short. The microorganisms also decrease when the substrate becomes dehydrated. Reduction of rainfall decreases the moisture content of soil and rate of decomposition is also reduced.

The mechanical properties of bioplastics also contribute to the rate of decomposition. The degradation rate of bioplastics is lower with high tensile strength. However, the decomposition rate in water was same for bioplastics with varying mechanical strength.

5. Conclusion

Petroleum based plastics are hazardous for natural environment due to their long degradation period. Thus, fast decomposing material such as starch should be used as raw material for manufacturing of bioplastics. Starch being hydrophilic, decomposes faster in aqueous medium as compared to soil. The bioplastics can also decompose within few weeks in well moist healthy soil with multiple microorganisms. Bioplastics manufactured from starch produced from cassava peel plasticized with glycerol can be decomposed completely within ten weeks under microbial activity of soil. Different environmental factors also affect the degradation activity of bioplastics.

Conflicts of Interest

The author/s declare no conflicts of interest regarding the publication of this paper.

References

[1] Crawford, C.B. and Quinn, B. Plastic Production, Waste and Legislation. In: Crawford, C.B. and Quinn, B., Eds., Microplastic Pollutants, Elsevier Science, Amsterdam,pp:39-56,2017.

[2] Mark, H.F. and Bikales, N.M. Degradation. In: Encyclopedia of Polymer Science and Technology, John Wiley & Sons, Inc., Hoboken, pp: 1-44, 2005.

[3] Gross, M. Plastic Waste Is All at Sea. Current Biology, Vol 23, issue 4, pp: R135-R137, 2013.

[4] Jambeck, J.R., Geyer, R., Wilcox, C., et al. Marine pollution. Plastic waste inputs from land into the ocean, Science, Vol 347, issue 6223, pp: 768-771, 2015.

[5] Derraik, J.G.B. The Pollution of the Marine Environment by Plastic Debris: A Review. Marine Pollution Bulletin, Vol 44, issue 9, pp: 842-852, 2002.

[6] Webb, H.K., Arnott, J., Crawford, R.J. and Ivanova, E.P. Plastic Degradation and Its Environmental Implications with Special Reference to Poly(ethylene terephthalate). Polymers (Basel), Vol 5, issue 1, pp: 1-18, 2013.

[7] Demirbas, A. Biodegradable Plastics from Renewable Resources. Energy Sources, Part A: Recovery, Utilization, and Environmental Effects, Vol 29, issue 5, pp: 419-424, 2007.

[8] Lorcks, J. Properties and Applications of Compostable Starch-Based Plastic Material. Polymer Degradation and Stability, Vol 59, pp: 245-249, 2002.

[9] Sagnelli, D., Hebelstrup, K.H., Leroy, E., et al. Plant-Crafted Starches for Bioplastics Production. Carbohydrate Polymers, Vol 152, issue 5, pp: 398-408, 2016.

[10] Ashter, S.A. Types of Biodegradable Polymers. In: Ashter, S.A., Ed., Introduction to Bioplastics Engineering, William Andrew, Amsterdam, Vol 8, issue 4, pp: 81-151, 2016.

[11] Zhou, X., Yang, R., Wang, B. and Chen, K. Development and Characterization of Bilayer Films Based on Pea Starch/Polylactic Acid and Use in the Cherry Tomatoes Packaging. Carbohydrate Polymers, pp: 222, 2019.

[12] Harma, A.K. Biopolymers in Drug Delivery. Biopolymers Research, Vol 1, issue 1, pp: 1-2, 2017.

[13] Shah, A.A., Hasan, F., Hameed, A. and Ahmed, S. Biological Degradation of Plastics: A Comprehensive Review. Biotechnology Advances, Vol 26, issue 3, pp: 246-265, 2008.

[14] Müller, C.M.O., Laurindo, J.B. and Yamashita, F. Composites of Thermoplastic Starch and Nanoclays Produced by Extrusion and Thermopressing. Carbohydrate Polymers, Vol 89, issue 2 pp: 504-510, 2012.

[15] Singh, J., Dartois, A. and Kaur, L. Starch Digestibility in Food Matrix: A Review. Trends in Food Science & Technology, Vol 21, issue 4, pp: 168-180, 2010.

[16] Emadian, S.M., Onay, T.T. and Demirel, B. Biodegradation of Bioplastics in Natural Environments. Waste Management, Vol 59, pp: 526-536, 2017.

[17] Nuwamanya, E., Baguma, Y., Wembabazi, E. and Rubaihayo, P. Comparative Study of the Physicochemical Properties of Starches from Root, Tuber and Cereal Crops. African Journal of Biotechnology, Vol 10, issue 56, pp; 12018-12030, 2011.

[18] Nanda, M., Yuan, Z., Qin, W., Poirier, M.A. and Xu, C. Purification of Crude Glycerol Using Acidification: Effects of Acid Types and Product Characterization. Austin Journal of Chemical Engineering, vol 1, issue 1, pp: 1004, 2015.

[19] Abolibda, T.Z. Physical and Chemical Investigations of Starch Based Bio-Plastics. Thesis, University of Leicester, Leicester, Vol 29, Vol 479, pp: 2-29, 2015.

[20] Smirnova, J., Fernie, A.R. and Steup, M. Starch Degradation. In: Nakamura, Y., Ed., Starch: Metabolism and Structure, Springer, Berlin, pp: 239-290, 2015.

[21] Rudnik, E. and Briassoulis, D. Degradation Behaviour of Poly (lactic acid) Films and Fibres in Soil under Mediterranean Field Conditions and Laboratory Simulations Testing. Industrial Crops and Products, Vol 33, pp: 648-658, 2011.

[22] Fettke, J., Hejazi, M., Smirnova, J., Hochel, E., Stage, M. and Steup, M. Eukaryotic Starch Degradation: Integration of Plastidial and Cytosolic Pathways. Journal of Experimental Botany, Vol 60, issue 10, pp: 2907-2922, 2009.

[23] Hoshino, A., Sawada, H., Yokota, M., Tsuji, M., Fukuda, K. and Kimura, M. Influence of Weather Conditions and Soil Properties on Degradation of Biodegradable Plastics in Soil. Soil Science and Plant Nutrition, Vol 47, issue 1, pp: 35-43, 2001.

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A Study of Awareness and Practices in Pakistan's Software Industry towards DevOps Readiness

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There are regular conflicts between the traditionally divided software organization i.e. dev and ops teams during the software development process for delivering the software to the end-user. DevOps overcome these conflicts by automating the processes between the development and operations team in such a way that they can build, test, and release the software successfully and efficiently to the end-user. Globally, more and more organizations are adopting DevOps. As Pakistan's software industry is progressively growing while DevOps is a relatively new concept, there is a need for DevOps awareness and understanding towards its adoption and practices. This paper evaluated DevOps awareness and identified the practices adopted in Pakistan's software organizations and suggested generic guidelines for DevOps transition. A questionnaire-based survey is conducted to collect data and various DevOps sub-activities being practiced. The survey analysis and results depicted that Pakistan's Software Industry is making efforts towards the adoption of DevOps but due to lack of its awareness, most of the DevOps practices are not fully adopted yet. According to the DevOps evolution model, only one-eighth of Pakistan's software organizations are at the self-service stage, while the rest of them are still struggling at the normalization and standardization stage.
Keywords: DevOps; development and IT operations; agile; continuous integration and continuous deployment.

INTRODUCTION

Globally, the need for software-intensive products is highly increasing, day by day. Software products that are reliable, smart, secure, useful, and scalable at all times during operational use. Pakistan's software industry is also growing impressively over the past years[1]. Challenges emerge with such growth in the software industry due to the organizational teams involving in software delivery. Conventionally, software organizations are mainly divided into development and IT operations teams[2]. Due to their different roles and responsibilities, conflicts among them occur frequently. Operations tend towards more stable and secure delivery of software and imply that

developers do not make changes frequently, on the other hand, developers are more interested in delivering new changes and features to end-users speedily[3]. Such conflicts can delay the software delivery[4] and make the two groups unaware of each other's problems hence developing stress on work and communication barriers between them. To overcome this problem and bridge the gaps between them is where DevOps comes in, by adjusting the approaches shared for the entire development process.

DevOps is the fusion of words; development (that includes programmers, testers, and quality assurance analysts) and operations (that includes network technicians, sysadmins, and DBAs)[5]. To resolve the critical problems during software development DevOps involves such patterns that improve communication and collaboration among the dev and ops teams. Those critical problems include the fear of frequent changes and making the deployment risky. DevOps reduces the gap between the dev and ops teams, ensuring the detection of issues earlier and providing proper steps to address them in software delivery process[6]. Collaboration among everyone participating in delivering software is a key DevOps tenant[7]. Due to DevOps development, globally, many organizations start to implement DevOps during their development phase. The puppets lab[8]–[16] conducted surveys reporting the immense increase in respondents that are part of DevOps or having started DevOps efforts in their organizations.

Background – DevOps is founded on the idea of frequent agile development[17] changes and deployment cycles. Previously, DevOps had no academic literature but now over the past few years, studies and surveys are conducted globally to discuss DevOps in terms of adoption, benefits, and challenges.

The puppets lab formulated a DevOps evolution model[18] based on the results and analysis of their surveys. Following are the five stages mentioned in the model, based on the practices adopted by successful organizations in the journey of DevOps.

Stage 1 – Normalization: Teams adopting agile methods and properly implementing version control to be ready for continuous integration and deployment[18].

Stage 2 – Standardization: Dev and Ops teams are working together towards the same goal in a way to make sure the complexity of processes is reduced, enabling early collaboration opportunities[18].

Stage 3 – Expansion: At this point, any previously created discrepancies are removed, as the foundation is built for DevOps. The dev team works on the same level as the ops deployed version of the software. Also, the team member can work without wasting time on work approval from outside the team[18].

Stage 4 – Automated infrastructure delivery: The automation of code deployment helps organizations to lessen the conflicts among dev and ops teams. So, when things like security configurations, system configurations, and provisioning are automated, the DevOps team can deliver faster and is better set up for future self-service[18].

Stage 5 – Self-service: The capabilities of this stage are already created and defined in the previous stage, but they are further realized and more resources are made available in the fifth stage. It gives the application developers the authority to deploy testing environments on their own and success metrics are visible to the team[18].

In this global race, further usage of conventional practices may result in loss of business at a minimum, more stress between the teams, inefficiency to deliver the software product continuously on time, and hence collapse of the industry as a worst-case scenario. Researches and surveys are being conducted globally for DevOps regarding adoption, practices, challenges, and benefits, providing evidence that DevOps delivers value and statistics verify fundamental capabilities and techniques that help organizations to improve their software development and deployment[19]. Pakistan's software industry, despite its rapid growth, there is no such account of DevOps literature about the level of DevOps awareness or readiness for the adoption of these practices. Organizations are unwilling in changing their conventional techniques due to lack of such awareness and academic studies and without proper awareness, people are afraid to change their ways because it may cause them a negative impact without knowledge.

The purpose of this study is to analyze the DevOps awareness in Pakistan's software industry, its related practices implemented, and provide the generic guidelines for organizations. So, the researchers and practitioners can understand the importance of DevOps and adoption through this study.

Material and Methods.

A questionnaire-based survey methodology is used for this study for collecting quantitative data regarding the state of DevOps awareness, adoption, and implementation across Pakistan's software industry. After thorough literature review and data collection, the questionnaire design is formulated which consists of questions regarding the software development processes currently practiced by the organizations i.e. about development methods, version control, code integration and deployment processes, about the software teams, and overall employees' satisfaction regarding the work and workplace environment.

Figure 1 shows the overall research methodology of this study. The survey form (using online 'Google Forms') is distributed via different platforms as LinkedIn connections, email, through professional connections, coworkers, and colleagues currently working, in order to get maximum responses. Out of more than 500 practitioners being approached, only 191 responded back as a survey response. The data collected is then validated and processed in a form to be analyzed for generating results and recommendations.

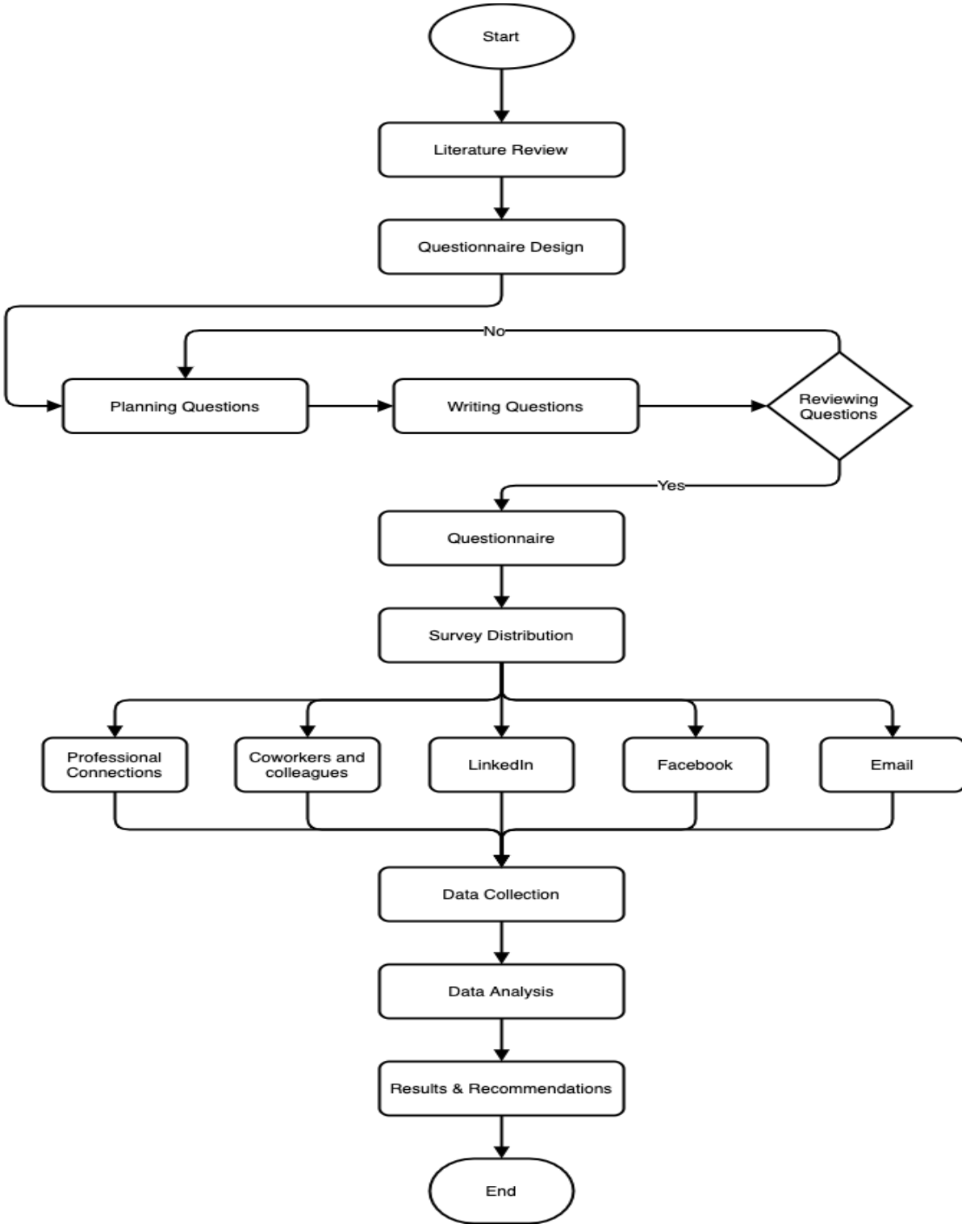

Figure 1. Research methodology.

For this study, a questionnaire-based survey is conducted across Pakistan's software industry. The survey questions are formulated in a way that respondents can easily understand and responds to the best of their knowledge. Survey questions are categorized under the following sections:

Generic – Basic questions about respondents as email, organization, and designation at work.

Company Size – Software organizations vary in different sizes depending upon the number of employees and their respective project needs. Company size plays a key role when it comes to adopting and improving DevOps, by evaluating the DevOps adoption in more or less to happen on its own or needs deliberate steps to implement it. Survey question includes; *what is the number of employees in your organization?*

DevOps – Survey question includes; *rate your level of knowledge about DevOps*. This information will help in determining the other following survey questions that what practices are followed by the organizations belonging to the respondents whether or not having DevOps knowledge.

Agile Methodology – Agile and DevOps involve different teams and departments, having different approaches for the development of software[20]. They are not mutually exclusive as DevOps is a culture, focusing more on continuous integration and deployment along with collaboration and sharing between all teams that are involved in the development and operation of the software. While agile is on the development side maintaining productivity and rapid releases of changes or new features. Even though, agile and DevOps are relatively different with respective goals, when they are used together in any organization, provides more reliable and efficient results[20]. Survey question includes:

1. *Does your organization employ Agile development?*
2. *Which Agile development methodologies have been employed by your organization?*

Working Environment – Working environment of any software organization can be identified by knowing the type of teams/groups, the team's collaborations, and sharing of the tools, discoveries, and lessons among all team members. Survey question includes:

1. *Does your organization have separate teams/groups for development, operations, quality assurance, etc.?*
2. *Is there any regular collaboration between your Development and Operation groups?*
3. *How well does your organization share?*

Employee Work Satisfaction – Employee work satisfaction is all about the employee working in a comfortable environment that is stress-free and relaxed, and doing work that's challenging and meaningful, and empowered to practice the skills and findings. Employee work satisfaction also highly correlates with DevOps practices and culture. Survey question includes:

1. *Overall organizational environment?*
2. *Organizational working process?*

Version Control – Version control is managed by software tools that help the software team to maintain track of changes to source code over time. One of the ways to successful DevOps teams is version control, reducing development time, and increasing the rate of successful deployments[21]. It helps software teams to collaborate more rapidly as required by today's frequently shifting IT environment. According to [10] version control is one of the top 5 tools used to support DevOps initiatives. Survey question includes:

1. *Is version control practiced?*
2. *Do you use Git or any other tool for version control?*
3. *How often do you use Git (or the other tool) for version control?*

Continuous Integration & Continuous Deployment (CI/CD) – Version Control is a prerequisite for continuous integration and continuous deployment i.e. everything required to reproduce the production environment must be checked into version control.

Continuous integration makes developers merge more often their changes back to the main branch. These changes or updates are validated by creating a build, eliminating the integration challenges that can happen when changes are merged into the release branch on release time. Survey question includes:

1. *Do you integrate code continuously?*
2. *How often do you merge all the changes into a shared control repository?*

Continuous deployment is a step further from continuous integration. With continuous deployment, all the changes or updates are released to the end-user bypassing all the stages of the production pipeline. It eliminates the stress on team members so that developers can focus on building software, not on release stress, and they can see their work go live within minutes after they've finished working on it. Survey question includes:

1. *Do you deploy the code manually?*
2. *Do you deploy the code automatically?*

Results and Discussions.

The survey conducted involves IT professionals and practitioners belonging to different companies and groups/teams across Pakistan's software industry. A total of 191 responses are collected, and the respondents belong to the following different categorizations, as shown in Figure 2.

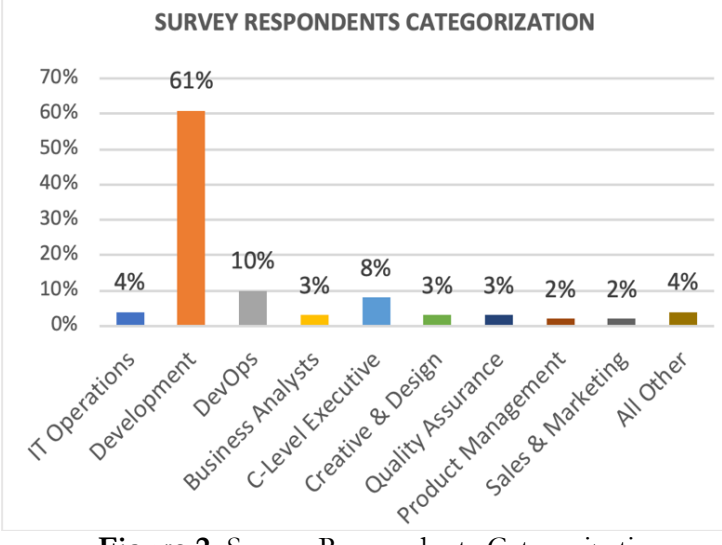

Figure 2. Survey Respondents Categorization.

Table 1 shows the overall summary of all the responses collected. It is observed that:

1. 68% of respondents belong to medium to large-scale companies.
2. 42% of respondents have good enough knowledge about DevOps.
3. 84% of respondents do practice agile in their organizations.

4. 35% of respondents do have separate Ops teams in their organizations, and only 13% of them do collaborate and share regularly.
5. 67% of respondents are satisfied by their working environment and working processes.
6. 32% of respondents fully practice version control at all times for all projects, and 57% of them partially practice version control.
7. 15% of respondents do automatic CI/CD, and 32% of them do both automatic and manual CI/CD.

Table 1. Survey Responses Summary

Survey Topics	Categories	Total Responses
Company Size	Small-scale	22%
	Medium-scale	35%
	Large-scale	33%
	Large Enterprises	9%
	Uncertain	1%
DevOps Knowledge	Good enough knowledge	42%
	Not enough knowledge	58%
Agile Methodology	Do practice agile	84%
	Do not practice agile	16%
Working Environment	No Ops Teams, Collaboration & Sharing Insignificant	65%
	Dev & Ops Teams with Collaboration & Sharing	13%
	Dev & Ops Teams with No Collaboration & Sharing	9%
	Dev & Ops Teams with Indeterminate Collaboration & Sharing	13%
Employee Work Satisfaction	Satisfied	67%
	Dissatisfied	18%
	Indeterminate	15%
Version Control	Yes, do practice (fully)	32%
	Yes, do practice (partially)	57%
	Do not practice	2%
	Indeterminate	9%
CI/CD	Automated	15%
	Manual	2%
	Both (Automated & Manual)	32%
	Indeterminate	51%

According to Table 1, the survey response for 'DevOps Knowledge' indicates that approximately more than half of respondents do not have enough DevOps knowledge. Respondents may be working along the practices of DevOps in their organization but due to no awareness, the respondent may not know about it and the other way around. To observe and analyze the data for both types of respondents, we divide overall responses data into 2 groups as shown in Figure 3. It is important to observe and analyze the 2 groups (Group A & B) separately to have better insight for DevOps awareness and their respective organization software development patterns.

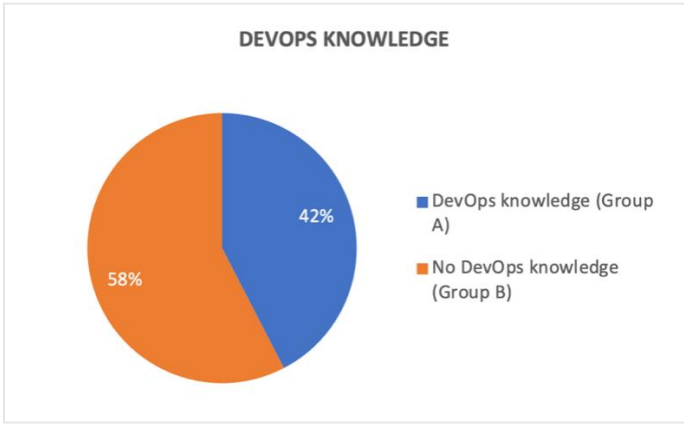

Figure 3. Group A & B.

Figure 4 shows that the majority of respondents (Group A ~ 63% while Group B ~ 71%) belong to medium to large-scale companies, it is better to adopt DevOps practices much earlier. Small and medium-scale companies can adopt DevOps much faster than large-scale companies if provided with the resources and are likely to adopt cultural change. For large-scale companies, it is a must to start adopting DevOps practices in sub-pilot base projects if the old projects are reluctant to adopt change. Because large-scale companies are having more employees and teams that need to collaborate and they must be on one page to deliver successful software without any hindrances.

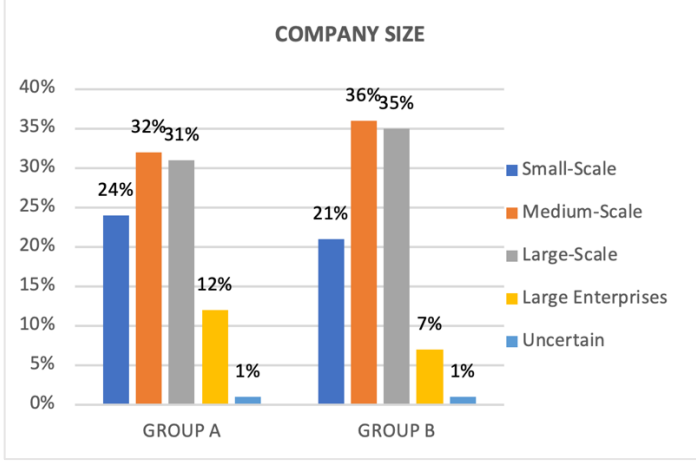

Figure 4. Company Size Comparison of Group A & B.

Figure 5 shows that the majority of respondents' organizations are implementing agile (Group A ~ 94% while Group B ~ 77%). Implementing agile means more rapid changes in work and delivery to customers. Which is of great value only on the dev side. Doing planning with the dev and ops team has more chances of knowledge sharing and collaboration, which reduces the gap between the dev and ops team. The ops team gets a better idea of the logic and the end deliverable, and suggests a solution to the dev on which both teams agree to work. Agile with adopted DevOps makes it much more beneficial for organizations.

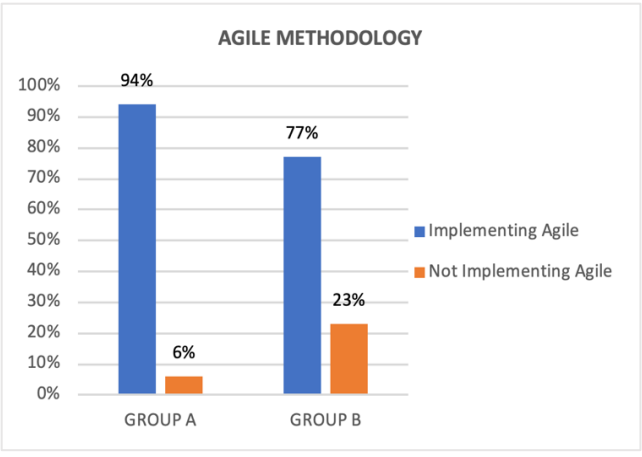

Figure 5. Agile Methodology Comparison of Group A & B.

Figure 6 shows that approx. one-third of the organizations have separate ops teams with limited collaboration and sharing among the teams (Group A ~ 17% while Group B ~ 8%). Organizations having only a dev team doing all the work with no-ops teams are more likely to exist in small-scale companies where resources are scarce. Hence there is no debate about the conflicts of dev and ops teams. But it makes a huge burden and pressure on one team if they are doing things the manual way. The statistical figures show that the organizations having ops teams also seems to have limited collaboration and sharing among them (which is a drawback as communication gap).

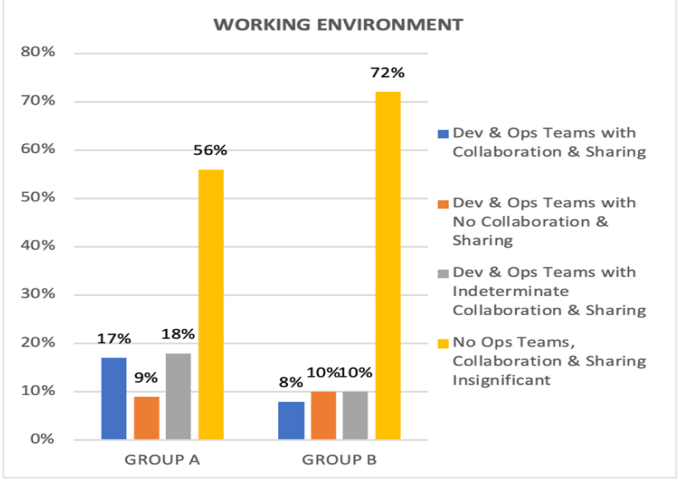

Figure 6. Working Environment Comparison of Group A & B.

Figure 7 shows that the majority of group A respondents (Group A ~ 83%) are satisfied by their organizational working processes, which reflects the fact that the practices adopted by their organizations are making them feel stress-free of the conflicts and they focus more on work rather than fixing and handling conflicts among the teams. Group B approx. half the respondents (Group B ~ 54%) are satisfied while the remaining half of them are dissatisfied or indeterminate about their organizational working processes and environment which is a straight fact for time to change the manual processes into continuous and automatic processes.

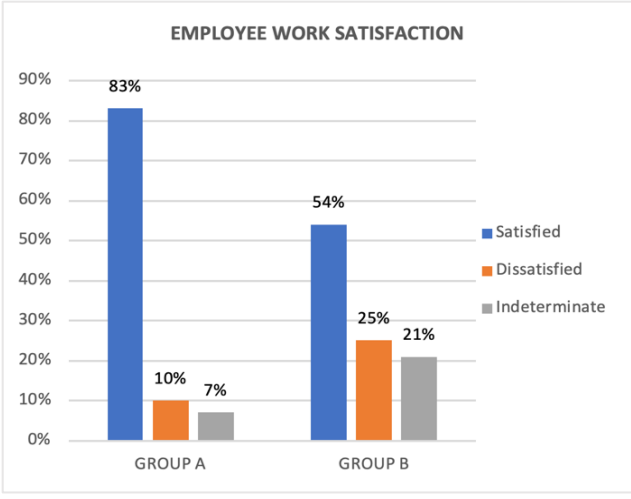

Figure 7. Employee Work Satisfaction Comparison of Group A & B.

Figure 8 shows that the majority of respondent's organizations are practicing version control either fully (Group A ~ 37% while Group B ~ 28%) or partially (Group A ~ 54% while Group B ~ 59%), that is the most common and basic step towards the DevOps journey. It is a must to have 100% full version control being adopted for all the projects in all organizations, for fast code shipment and integration.

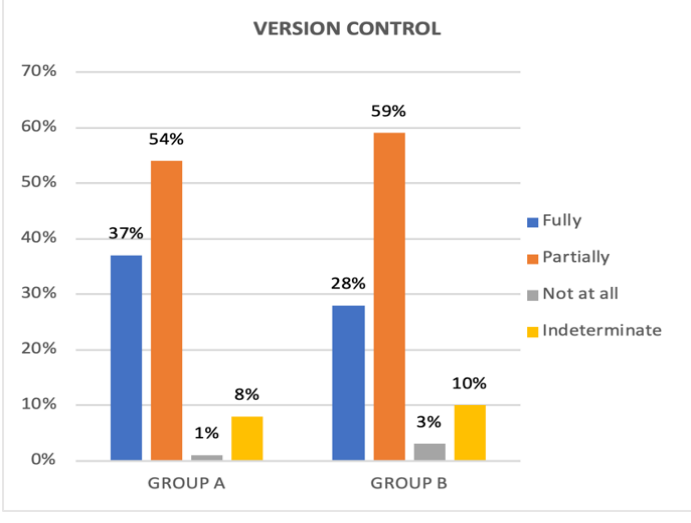

Figure 8. Version Control Comparison of Group A & B.

Figure 9 shows relatively low statistics for automated CI/CD for both groups as organizations practicing CI/CD either fully (Group A ~ 22% while Group B ~ 9%) or partially[1] (Group A ~ 31% while Group B ~ 34%). Version control is linked with CI/CD as it provides the master repository for continuous integration and leads to continuous deployment. The organization must focus more on after version control to CI/CD to increase deployment rate and reduce manual resource effort.

[1] *Practicing automated CI/CD only for some projects not for all.*

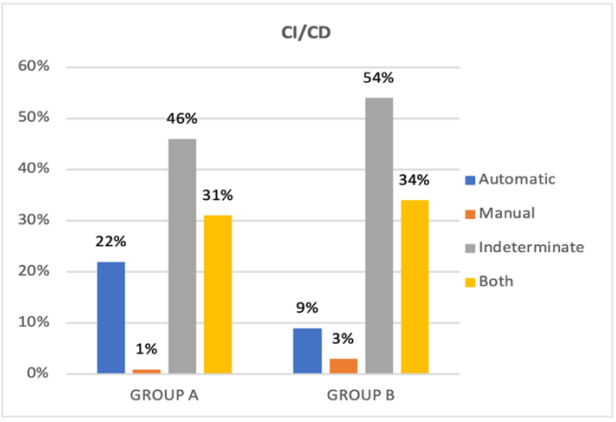

Figure 9. CI/CD Comparison of Group A & B.

Based on the above discussion, it is observed that Group A is on right track[2] towards the DevOps journey, and Group B is struggling at the initial stages of the DevOps journey. Even though group A is better than group B but the statistics show similarity between them (to some extend), clearly indicating the lack of DevOps awareness among group B. According to 'DevOps Evolution Model':

A. Group A – only 17% of organizations are at the self-service stage of the DevOps evolution model. The rest of them are still struggling at normalization to standardization.
B. Group B – only 8% of the organizations are at the expansion stage of the DevOps evolution model. The rest of them are still struggling at normalization to standardization.

Overall generic guidelines for all Pakistan's software organizations are:

I. To adopt 100% version control as it is the backbone for dev and ops, their first step towards the DevOps journey should be version control, as its the code that will be deployed to the server by the ops team and it will be hard to rollback without version control, plus both teams can work on same code when there is version control.
II. Without CI/CD the DevOps life cycle is incomplete, it's easy for a company to do CI/CD as they are already in the managed lifecycle. Automating continuous deployments provides several benefits that directly contribute to high performance. The more reliable, secure, automated CI/CD leads to a happy dev environment and it is only possible when the Ops team taking care of operation and the dev team only doing the code without worrying about anything else.

Conclusion.

In this study, we analyzed the state of DevOps awareness across Pakistan's software Industry and the relative practices being adopted. DevOps is rarely an exposed concept to university and small to medium-scale companies. The division of data into two groups[3] also shows that both the groups are adopting the same practices[4] but the

[2]Although DevOps practices are not fully adopted yet.
[3] based on the DevOps awareness
[4] To some extend like version control, automated continuous integration, and continuous deployments.

only difference is that they do not have the proper awareness of this concept. In this study, we analyzed the state of DevOps awareness across Pakistan's Software Industry and the relative practices being adopted. According to [18], only 13% of the organizations are at the self-service stage of the DevOps evolution model while the rest of them are still struggling from the stage 1 (Normalization) to stage 2 (Standardization). Only 15% of them adopted DevOps practices including separate experts for handling the DevOps tools and practices across the dev and ops teams. 32% of them are partially adopting DevOps depending upon projects while the rest of 53% belong to the manual or the indeterminate state of DevOps indicates that they are still not adopting DevOps or not sure of practices adopted by their organizations, that is why collaboration and sharing among teams are important.

Based on observation and discussions with IT practitioners, we agree that people are getting aware and trying to follow up with the DevOps trends but there is still a lot of confusion about the concept 'DevOps' due to lack of awareness. The statistics also show that if provided with proper knowledge of DevOps and the readiness of organizations to adopt the changes, it can boost Pakistan's software industry in a much better and faster way.

In the future work, we will extend the study to the evolution of DevOps across Pakistan's software industry over the years and see the implications, benefits, and challenges involved in the DevOps journey.

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Author's Contribution.

The idea for this study was conceptualized by Dr. Muhammad Sohail Khan. The study was performed under his supervision and contributed in analyzing and writing up the paper. Khadija Saleem conducted the study i.e. survey questions design and formulation, data collection, data processing and article writeup.

Conflict of interest. No conflict of interest for publishing this manuscript in IJIST.

REFRENCES

[1] https://www.pasha.org.pk/knowledge-center/industry-stats/

[2] J. Hamunen, "Challenges in Adopting a Devops Approach to Software Development and Operations MSc program in Information and Service Management Maisterin tutkinnon tutkielma Joonas Hamunen 2016 Tieto-ja palvelutalouden laitos Aalto-yliopisto Kauppakorkeakoulu," pp: 69, 2016.

[3] Y. Liu and Y. Zhou, "The Challenges and Mitigation Strategies of Using DevOps during Software Development," pp: 8-78, 2017.

[4] M. Hüttermann, “Introducing DevOps ”, pp: 15-31, 2012.

[5] https://www.chef.io/blog/what-devops-means-to-me

[6] J. Wettinger, U. Breitenbücher, and F. Leymann, “DevOpSlang - Bridging the gap between development and operations,” in *Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics),* vol. 8745 , pp: 108–122, 2014.

[7] Ernest Mueller, “What Is DevOps? | the agile admin,” 2010.

https://theagileadmin.com/what-is-devops/.

[8] Puppet Labs, “Take the 2012 DevOps Survey | Puppet.com,” 2012. [Online]. Available: https://puppet.com/blog/take-2012-devops-survey/. [Accessed: 19-Mar-2020].

[9] Puppet Labs, “2013 State of DevOps Report | Puppet.com,” 2013. [Online]. Available: https://puppet.com/resources/report/2013-state-devops-report/. [Accessed: 19-Mar-2020].

[10] Puppet Labs, “2014 DevOps Report | Puppet.com,” 2014. https://puppet.com/resources/report/2014-state-devops-report/.

[11] Puppet Labs, “2015 State of DevOps Report | Puppet.com,” 2015. https://puppet.com/resources/report/2015-state-devops-report/.

[12] Puppet Labs, “2016 State of DevOps Report | Puppet.com,” 2016. https://puppet.com/resources/report/2016-state-devops-report/.

[13] Puppet Labs, “The 2017 State of DevOps Report is here | Puppet.com,” 2017. https://puppet.com/blog/2017-state-devops-report-here/.

[14] Puppet Labs, “Introducing the 2018 State of DevOps survey and our new research focus | Puppet.com,” 2018.

https://puppet.com/blog/introducing-2018-state-devops-survey-new-research-focus/.

[15] Puppet Labs, “2019 State of DevOps Report | presented by Puppet, CircleCi & Splunk | Puppet.com,” 2019.

https://puppet.com/resources/report/state-of-devops-report/.

[16] Puppet Labs, “2020 State of DevOps Report | presented by Puppet, & CircleCi,” 2020. https://puppet.com/resources/report/2020-state-of-devops-report/.

[17] "Adopting DevOps in Agile: Challenges and Solutions." http://www.diva-portal.org/smash/record.jsf?pid=diva2%3A1228684&dswid=-7281.

[18] P. L. DevOps Evolution Model, "The 5 Stages of DevOps Evolution: A Guide for CIOs | Puppet," 2018.

[19] L. E. Lwakatare, "DevOps adoption and implementation in software development practice : concept, practices, benefits and challenges," *undefined*, 2017.

[20] S. C. Wang and C. Liu, "Adopting DevOps in Agile," 2018.

[21] L. Leite, C. Rocha, and F. Kon, "A Survey of DevOps Concepts and Challenges," 2019,

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Evaluation of tectonic geomorphology of Awaran in Baluchistan, Pakistan using SRTM data.

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An earthquake of September 24, 2013 with a magnitude of 7.7Mw destroyed extensive region of Awaran district located in province Baluchistan in southern Pakistan, the earthquake was nearly 10km deep below the surface of earth. This convulsion brought a havoc in the inaccessible and remote regions and victimized nearly 810 families. This tremor destroyed the non-engineered human structure within 100 km of the earthquake which caused tremendous loss of human lives. In this paper Digital elevation model (DEM) was utilized to study active deformation and mapped the isobase, relative relief, drainag density incision and vertical dissections which indicates that Awaran Fault sinisterly active in NNE-SSW direction and the deformations were highlighted. The high value of drainage density was observed on northern east and in the central region of southern west region of Awaran district. The drainage density is elevated by accelerated erosion in surrounding region. DEM and remote sensing tools proved efficient to study the region efficiently.

Keywords: Awaran Earthquake, Surface dynamic maps, SRTM DEM, Awaran Fault, Isobase Map.

Introduction

Earthquakes have been a cause of tremendous loss of property and lives multiple times in Pakistan [1]. It is because Pakistan is located in a seismically active region of the world. Various regions of Pakistan are at high risk of earthquakes. Earthquakes can either be too low can go unnoticed or too high to wreck the entire city [2]. Pakistan has experienced several tremors at various regions ranging from a magnitude of 7.3 to 7.8 in the northern and southern regions due to dynamic faults [3,4,5]. In these regions nearly half of the community survives with a threat of earthquakes [6].

Nearly 90% of earth's seismic activity takes place when two or more active tectonic plate pass slides or collides with each other within close belts [7,8,9]. The Tibetan pleatues and the Himalayan mountain ranges were formed because of collision of Indian and Eurasian Plate nearly 50 million years ago [10]. Chaman Fault is a major seismically active fault that runs along Pakistan and Afghanistan in nearly 850 km [11]. Pakistan geologically comprises of Europe-Asian and Indian plates [12].

These geological plates have been divided through faults into left and lateral

strike slip faults. Along the Chaman fault the Indo-Australian fault slips towards north [13]. Due to this elementary transform, the boundary of such plates are called as transpersonal boundary. Due to the collision of Indian plate with the Europe-Asian plate the, Chaman fault comprises of compressional elements [14].

The Indian plate joins with Europeasian plate in a counter clockwise spinning motion and the rate of joining decreases western region of India [15]. These plates are separated on the western side due to change in river profile with Chaman fault zone. The Chaman faults consists of 160-325 km wide belt and it is connected to other faults [16]. This belt is dramatically extended to the marginal line in western boarder of Indian-Europe and Asian plates [17, 18, 19].

Chaman fault is the left side strike slip fault which changes to transgressive side in the Europe-Asian and Indian plates. Makran fault located in the southern side of Chaman fault shorten these plates [20, 21, 22]. Indian and Europeasian plates move at the rate of 26mm per year while these faults move at the rate of 5-8mm per year. The earthquakes show distortion in the seismic regions [23, 24, 25].

The aim of this study was to utilize Remote Sensing techniques to analyse surface deformation through remotely sensed datasets and the deformations were maked with maps the regions having high drainage density, surface deformation and incision leasing to severe tremors which can destroy human engineered structures and can lead to loss of hundreds to thousands of lives.

STUDY AREA

Awaran is a city located in Baluchistan, a province in Pakistan. This city is also serving as a tehsil headquarter. Before 1981, the city was a sub division of district Khuzdar. Awaran was proclaimed as a district on November 1992. This district comprises of two tehsils which include Awaran and Mashkae [26]. The study area is mapped in Figure 1.

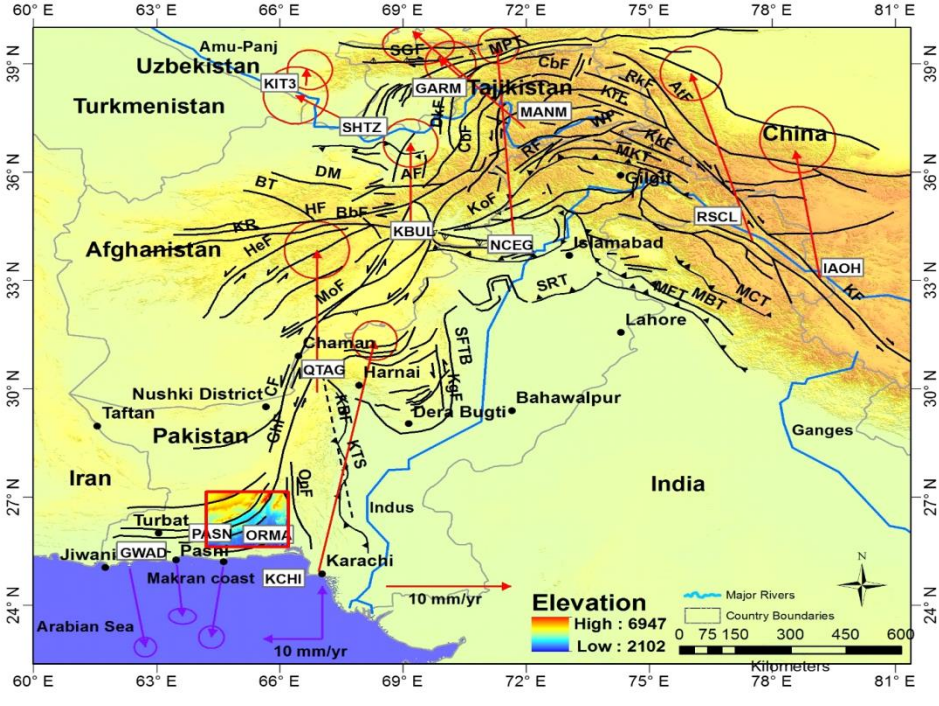

Figure 1: The regional tectonics structures mapped in the context of continental plates of India -Eurasian plate.

The district consists of an unpopulated sub tehsil JhalJhao. The district is expanded in a region of nearly 29510 km^2. The district lies between northern latitudes of 25° 26 and 27° 28 and at eastern longitude of 64° 08 and 66° 10.

MATERIALS AND METHODS

Data Acquisition and Processing

In this paper the SRTM DEM and Vector data is utilized to map Awaran district.

Digital Elevation Model (DEM)

The Earths elevation can be represented digitally by DEM. The DEM is represents topographic variations in hight vertically. This model accurately displays the topography of plains. The following softwares accurately represents the data and portray results in an effective manner [27, 28, 29, 30].

Software Used

Following Softwares are used in this research to attain accurate results.

Table.1 List of Softwares which has been used for this thesis.

S.No	Name of software	Purpose of usage
1.	Arc GIS	Digitizing,
2.	ENVI (4.7)	Mosaicing, Classification, importing of shades of hill, for Importing and Exporting(.img to .geotiff), AOIs Truncation
3.	MATLAB 7.6.0.324 (R2008a)	The Stream Staller order, to Extract geomorphic Indices and DEM Processing
4.	River Tools IDL 2.4	river network analysis of river as well as D8 algorithm
5.	Google Earth 7.1	Areas Identification
6.	Coral Draw	Graph fix up

Hypsometric Integral (HI)

Hypsometry is globally known for the measurement of geographical features of the surface of earth. The hypsometric terms are used to assess elevations and depths of various structures of earth. It is also used to compare various drainage basins without using any dimension. The specificity of this method is to describe landscape elevations or area of drainage basins. Figure 2 shows the variations in Hypsometrical Integral and shows the elevation and drop of drainage areas [31, 32, 33, 34].

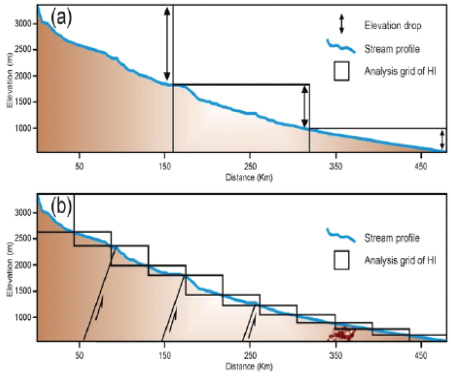

Figure.2: (a) The Elevation Drop and Hypsometric Integral's variation (b) The watersheds are divided in minor chunks in order to evaluate the variation of local Hypsometrical Integral.

Following equation can be used to determine the value of Hypsometric Integral,

$$HI = \frac{Elev_{mean} - Elev_{min}}{Elev_{max} - Elev_{min}}$$

The value of HI ranges from 0 to 1 and the Hypsometric curves show the HI value, the convex shape indicates high HI value whcih indicates the uplift tendency and young active tectonic [35, 36, 37].

RESULT AND DISCUSSION

The Analysis of Drainage Density

The value of drainage density is high on NNE side near Sheerin Aab, Taftan and Mastun. The drainage density can have higher values in the central region of SSW of GidarSurab Road and NeemraghKand. The erosion accelerated in surrounding conditions can elevate the drainage density.

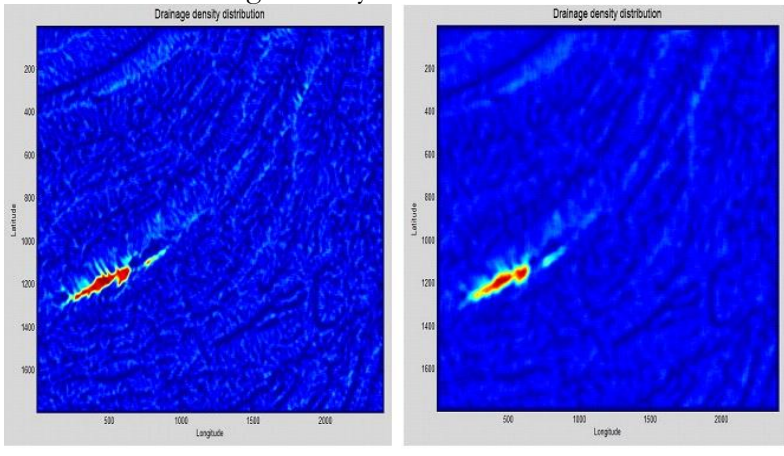

Figure 3: The Drainage density map of zone of awaran's screen shorts using Matlabhaving window size 1km and 2 km.

The regions having defrosted vegetation has high drainage density due to low rate of absorption of water by cover basins and well organized channel system. Eroded lands have a greater chance of floods and high drainage density due to high runoff.

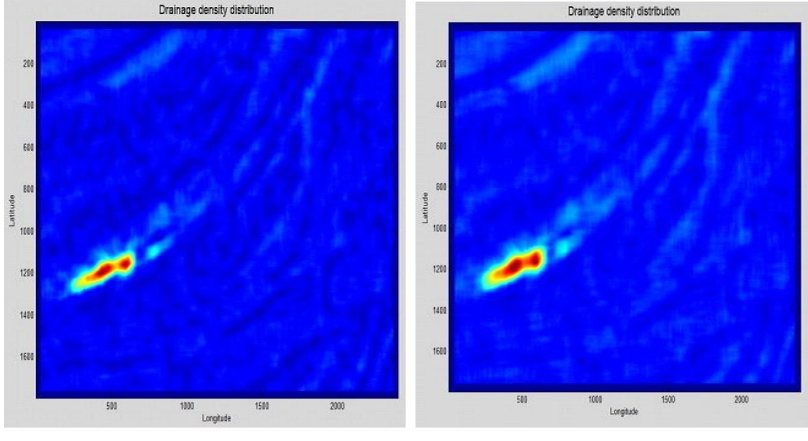

Figure 4: The description of map about the Drainage density of the zone of awaran's screen shorts using Matlab having window size 3km and 4 km.

Thus the drainage density and erosion goes side by side, increase in any of these factors increases the vulnerability of these regions to natural disasters. Figure 3 and 4 shows the hotspots of high drainage density in Awaran region using maps obtained through Matlab at different windows.

The NWW side of NeemraghKand has low value of drainage density. Lower values of drainage density means lower risk of floods. As the drainage density increases the surface deformation and surface roughness is also increases which increases the risk of natural disasters in seismically active regions. The hotspots are shown in Figure 5 which illustrates the isobase map of study site obtained through Matlab.

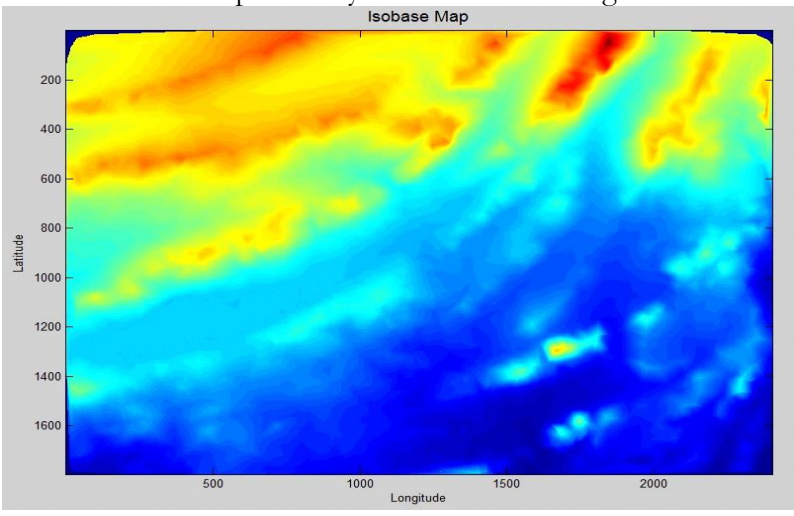

Figure 5: The Isobase level map Screen Shorts of of Awaran zone using Matlab.

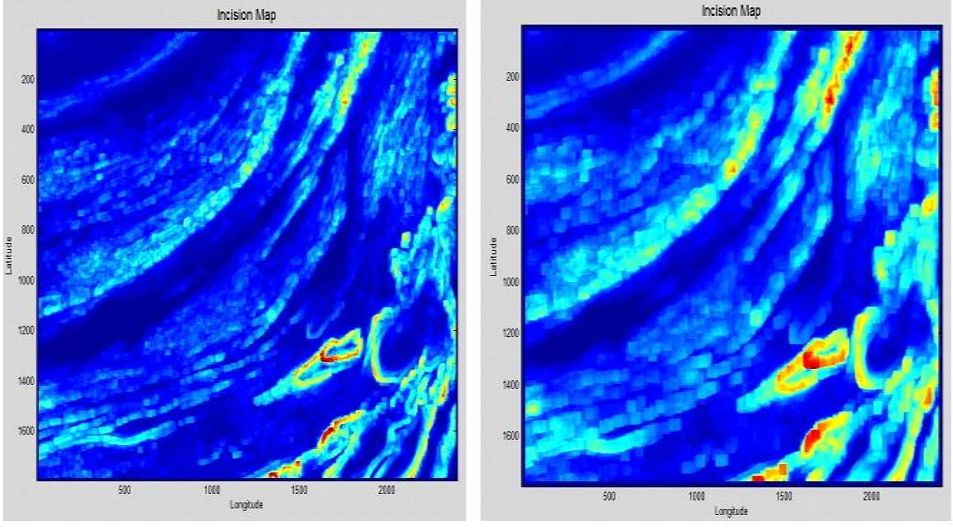

Figure 6: The description of map of relative relief's about Awaran region having window size 1 km and 2 km by using Matlab.

Bed rocks of Krastic regions have high fluvial deposits, thus the floors of valley are highly weathered and lower height and flood volume. Figure 6 and 7 shows the incision mapped in the study area using Matlab. Incision has been mapped using DEM.

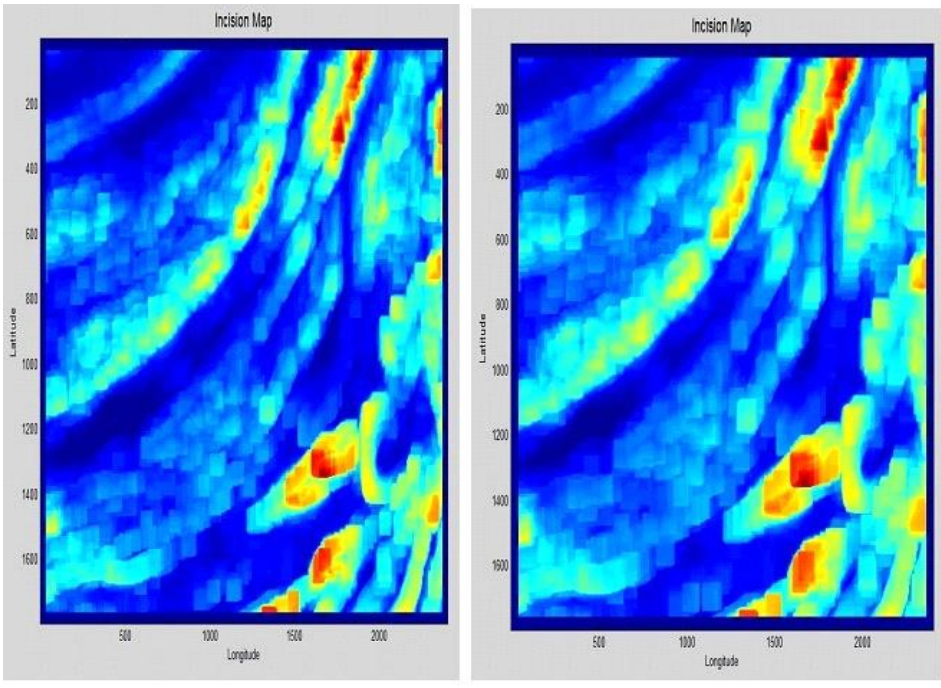

Figure 7. The description of map about Relative relief's Screen Shorts of region of Awaran of size of window that is 3 km and 4 km by using Matlab

The high deposition of fluvial materials in the stream bed leads to the vertical incision of streams which deepens the floors of networked streams leading to cutting down and increased surface roughness in stream networks.

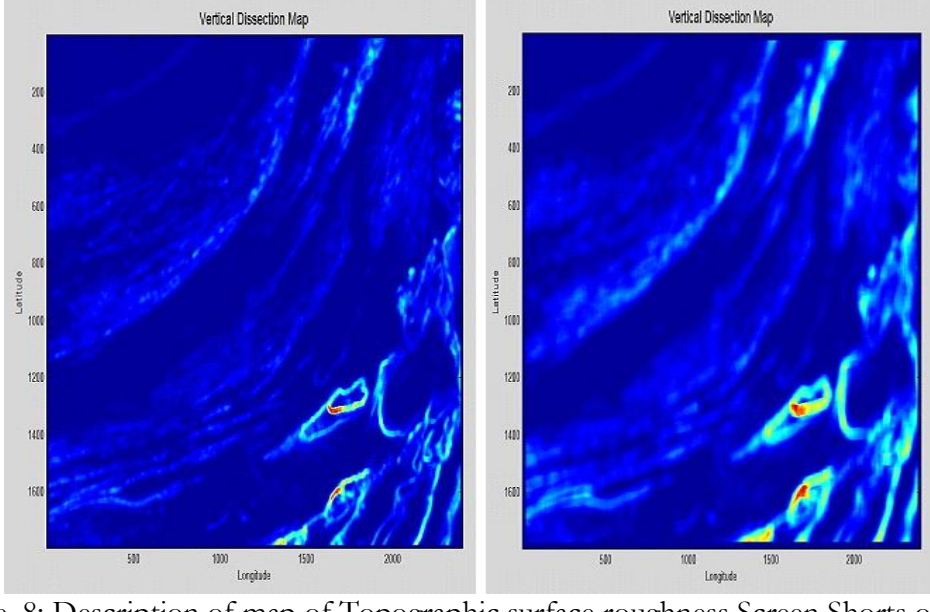

Figure. 8: Description of map of Topographic surface roughness Screen Shorts of zone of Awaran with size of the window 1 km and 2 km by using Matlab.

The regions with low fluvial deposits and high erosion indicates more topographic surface roughness and surface deformation. Figure 8 and 9 shows the vertical dissection map of study site.

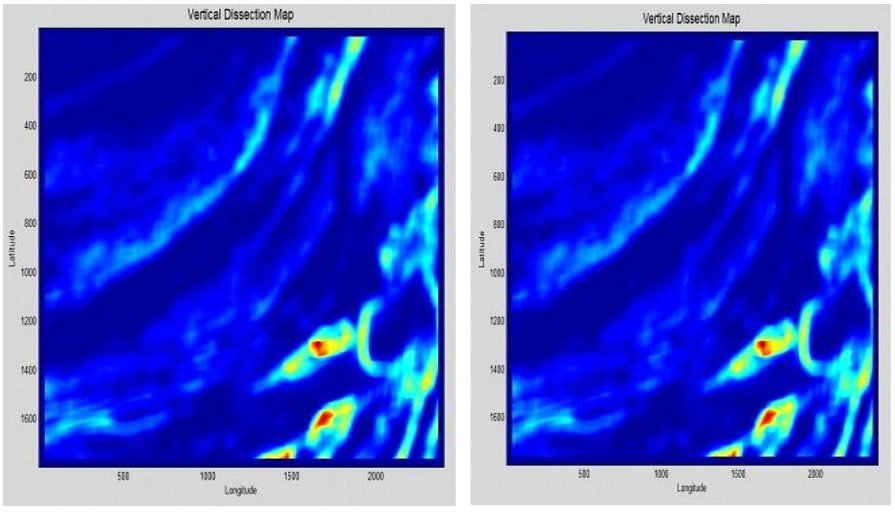

Figure 9: The Topographic surface roughness map Screen Shorts of Awaran zone having window size 3 km and 4 km by using Matlab.

The Hypsometric Analysis

The significant information regarding geomorphic indices can be obtained through Hack stream length gradient index and Hypsometry. These methods can provide significant data regarding slanting, regional uplift and local topographic uplift which may cause surface deformation.

Hypsometry is a method widely used for the assessment of lithological features, intensity and strength of active tectonics and the effect of climate on geomorphology. It also illustrates different elevations present in drainage basin. DEM can be used to determine the value of HC and HI through geographical information system.

The HI and HC values have been used multiple times to investigate, intensity and potency of tectonic activism and elevations at drainage basins. However the HI values have some conflicts. HI values are significantly dependent on geometry and elevation of basin and upon the drainage area of basin.

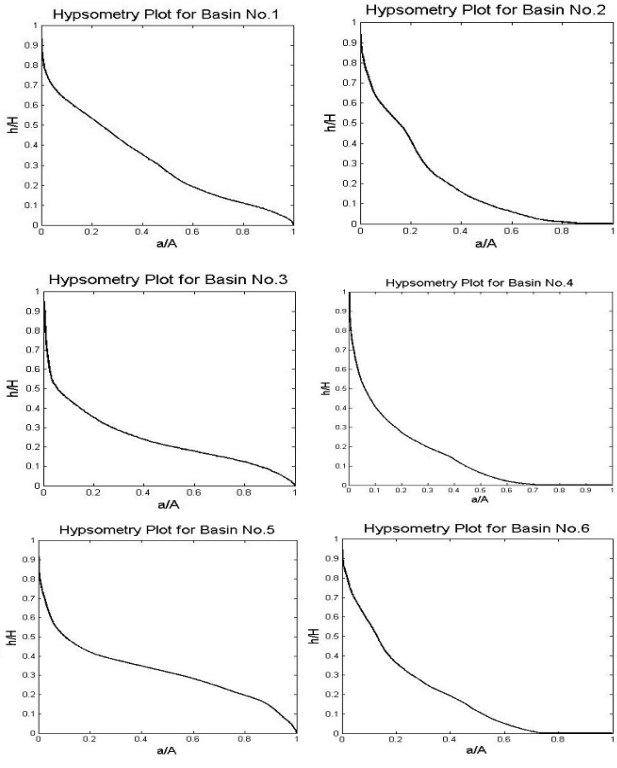

Figure 10: Hypsometric curves (HC) for different basins of order 6

The parameters which can disturb the topography of any region can be analyzed significantly utilizing Hack stream length gradient index and Hypsometry. Hypsometric analysis is an initial geomorphic indices which can provide vital information regarding relative uplift, regional uplift and local topographical uplift. It is widely used to analyze the intensity of active tectonics and their impact on geomorphologic parameters.

Hypsometry illustrates different elevations in the river basins. The HC and HI values are analyzed utilizing digital elevation model. The HI value is highly dependent on basin elevation, basin geometry and drainage areas. Figure 10 illustrates HC values for different basins. Instead of basins, the grid values are used to calculate HI values. In Pakistan, the most seismically active zone is Baluchistan, which has HI value up to order 4. The severe history of earthquakes lies in the lower region of Arabian Sea Syntaxes, it is a region where Indian and Europe-Asian plates collide. The tectonic activity can be determined using different features of Hypsometric Integral which are freely available on the website. SRTM and DEM with a spatial resolution of 90m is used in this study.

Earthquakes occur usually as a result of strike slip of faults. The western regions of Pakistan are experiencing left lateral strike slip along Chaman fault at higher velocity as compared to other regions of country. Destructive tremors are often related to strike slip faults. Chaman fault runs in the western region of Pakistan which is seismically active fault. Baluchistan is considered the most vulnerable province because of seismically active Chaman fault which comprises of Indian and Europe Asian plates that move at the rate of 26 mm per year. The collusion of these plates causes destructive earthquakes. In September 24, 2013 the earthquake hit Awaran with a magnitude of 7.7 M as a consequence of lateral strike slip at shallow depths. It killed nearly 60 thousand people and destroyed the human engineered structures in the region. The tectonic geomorphology of Awaran district makes it highly vulnerable for natural disasters most prominently the earthquakes. The tectonic geomorphology of Awaran district is dependent on several parameters including drainage density, erosion and incision etc.

Conclusion:

The earthquake in the Awaran region had a magnitude of 7.7 Mw which added to the seismic activity along the subduction zone in the Chaman fault and Makran zone and also enhanced the neo tectonic activity in South east and northern region. This incident activated various other faults. These tectonic activities can be analyzed using remotely sensed techniques which are helpful in generating maps and analyze surface deformation precisely.

REFRENCES

1. Altamimi, Z., X. Collilieux, J. Legrand, B. Garayt, and C. Boucher, A new release of the International Terrestrial Reference Frame based on time series of station positions and Earth Orientation Parameters. Journal of Geophysical Research, Vol 112, 2007.
2. Apel, E., R. Burgmann, P. Bannerjee, and B. Nagarajan, Geodetically constrained Indian plate mo- tion and implications for plate boundary deforma- tion, Eos Trans. AGU, Vol 87, issue 52, pp: T51B-1524, 2006.
3. Ambraseys, N., and R. Bilham, Earthquakes and associated deformation in Northern Baluchistan 1892–2001, Bull. Seismol. Soc. Am., Vol 93, issue 4, pp: 1573–1605, 2003.
4. Atkinson, G.M., An Overview of Developments in Seismic Hazard Analysis. Proceedings of the 13th World Conference on Earthquake Engineering, Vancouver, 2004.
5. Ambraseys, N., and R. Bilham, Earthquakes and associated deformation in northern Baluchistan, Bull. Seismol. Soc. Am., Vol 93, pp: 1573 – 1605, 2003.
6. Bender, F. K., and H. A. Raza (Eds.), Geology of Pakistan, Beitr. Reg. Geol. Erde, vol. 25, pp: 414, 1995.

7. Banks, C. J., and J. Warburton (1986), 'Passive-roof' duplex geometry in the frontal structures of the Kirthar and Sulaimanmountain belts, Pakistan, J. Struct. Geol., Vol 8, pp: 229 – 237, 1986.
8. Bernard, M., B. Shen-Tu, W. E. Holt, and D. M. Davis (2000), Kinematics of active deformation in the Su- laiman lobe and range, Pakistan, J. Geophys. Res., Vol 105, issue 13, pp: 253–13,279, 2000.
9. Bullard, E.C., Everett, J.E. & Smith, A.G., The fit of the continents around the Atlantic, Phil. Trans. R. Soc. London, Ser. A., Vol 258, pp: 41–51, 1965.
10. Bilham, R. Earthquakes in India and the Himalaya: tectonics, geodesy and history. Annals of Geophysics, Vol 47, pp: 839–858, 2004.
11. Beun, N., P. Border, and I. Carbonnel, Premieres donneesquantitatives relative au coulissage du crochement de Chaman, Afghanistan du sud-est, C. R. Seances Acad. Sci., Ser. D, Vol 288, pp: 931–934, 1979.
12. Bannert, D., A. Cheema, A. Ahmed, and U. Schaffer, The structural development of the western fold belt, Pakistan, Geol. Jahrb., Reihe B, Vol 80, pp: 60, 1992.
13. Griesbach, C. L. On the geology of the country between chappar Rift and Harnai in Baluchistan. Geological Survey of India, Vol 26, pp: 113-147, 1893.
14. Garcia, M. E.,W. Szeliga, and R. Bilham, Modeling vertical deformation associated with the 1931 Mach earthquake, Pakistan, Eos Trans. AGU, Vol 87, issue 52, 2006.
15. Haq, S. S. B., and D. M. Davis, Oblique con- vergence and the lobate mountain belts of western Pakistan, Geology, 25, 23–26, 1997.
16. Howard, A.D., Dietrich, W.E., and Seidl, M.A., Modeling fluvial disintegration on provincial to mainland scales: Journal of Geophysical Research, v. 99, pp. 13 971–13 986, 1994.
17. Howard, A.D., Dietrich, W.E., and Seidl, M.A., Modeling fluvial erosion on regional to continental scales: Journal of Geophysical Research, vol 99, pp: 13 971–13 986, 1994.
18. Ahmad. I, Waqar. A, et al., "EVALUATING FOCAL MECHANISM OF SEPTEMBER 24, 2013 AWARAN EARTHQUAKE WITH GEOSPATIAL TECHNIQUES". International Journal of Innovations in Science & Technology, Vol 02 Issue 03: pp 108-124, 2020.
19. Jackson, J., and D. McKenzie, Active tectonics of the Alpine-Himalayan Belt between Turkey and Pakistan. Geophysical Journal of the Royal Astronomical Society, Vol 77, issue 1, pp: 185–264, 1984.
20. Kazmi, A. H., Active Fault system in Pakistan. In: Farah, A.& DeJong, K. A. (eds.) Geodynamics of Pakistan. Geology Survey of Pakistan, Queta, pp: 333-340, 1979.
21. Lawrence, R. D., R. S. Yeats, S. H. Khan, A. Farah, and K. A. DeJong, Thrust and strike slip fault interaction along the Chaman transform zone, Pakistan, Geol. Soc. London Spec. Publ., Vol 9, pp: 363–370, 1981.
22. Lawrence, R. D., Khan, S. H. and Nakata, T., Chaman Fault, Pakistan- Afghanistan. AnnalesTectonicae, Vol 6, pp: 196– 223, 1999.
23. Lawrence, R. D., S. H. Khan, and T. Nakata, Chaman fault, Pakistan-Afghanistan, Ann. Tectonicae, Vol 6, pp: 196–223, 1922.
24. Lawrence, R. D., S. H. Khan, and T. Nakata, Chaman fault, Pakistan-Afghanistan, Ann. Tectonicae, Vol 6, pp: 196–223, 1992.
25. Kazmi, A.H. and Rana, R.A. Tectonic Map of Pakistan, Geological Survey of Pakistan, 1982.

26. Lawrence, R .D. and Yeats, R. S. Geological reconnaissance of the Chaman fault in Pakistan. In: Farah. A. &Dejong. K.A. (eds) Geodynamics of Pakistan, 1979.
27. Molnar, P., and Tapponnier, P. Cenozoic tectonics of Asia: Effects of a continental collision, Science, Vol 189, issue 4201, pp: 419– 426, 1975.
28. Molnar, P., and J. M. Stock, Slowing of India's convergence with Eurasia since 20 Ma and its im- plications for Tibetan mantle dynamics, Tectonics, Vol 28, 2009.
29. Oldhem T. A catalugue of indian earthquakes from the earlieat time to the end of A D 1869. Memoirs of the Geological Survey of India, Vol 19, issue 3, pp: 163-215, 1982.
30. Oldham, R. The Cutch (Kutch) earthquake of the 16th june 1819 with the revision of the great earthquake of the 12 june 1897. Memoirs of the Geological Survey of India, vol46, pp: 163- 213, 1926.
31. Power, E. O. F., & Subprojects, T. QUETTA ELECTRIC SUPPLY COMPANY FOR AUGMENTATION & EXTENSION OF POWER TRANSFORMER SUBPROJECTS, *2013*.
32. Quittmeyer, R. C., Farah, A. and Jacob, K. H. The seismicity of Pakistan and the relation to surface faults. In: Farah, A. and Dejong, K. A. (eds.) Geodynamics of Pakistan. Geological Survey of Pakistan, Quetta, pp: 351-358, 1979.
33. Szeliga, W. M., Historical and modern seismotectonics of the Indian plate with an emphasis on its western boundary with the Eurasian plate, 2010.
34. Szeliga, W., R. Bilham, D. M. Kakar, and S. H. Lodi (2012), Interseismic strain accumulation along thewestern boundary of the Indian subcontinent, J. Geophys. Vol 117, 2012.
35. Sarwar, F., Iqbal, S., Qaisar, M., Rehman, A., Akhtar, F., & Raza, S. M. Earthquake Statistics and Earthquake Research Studies in Pakistan, (May), pp: 97–104, 2016.
36. Schelling, D., Structural geology of the Bolan block, western Pakistan, Tech. Rep. 5-20885-99, Energy and Geosci. Inst., Univ. of Utah, Salt Lake City, 1999.
37. Treloar, P. J., and Coward M. P., Indian plate motion and shape: constraints on the geometry of the Himalayan orogeny. Tectonophysics, Vol 191, pp: 189–198, 1991.

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Bioaccumulation Efficacy of Heavy Metals In Body Organs of Rainbow (Oncorhynchus Mykiss) And Brown (Salmo Trutta Fairo) Troutsof Gilgit-Baltistan

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Heavy metals are chemical elements that are poisonous and toxic comprising of both necessary and unnecessary trace metals. All aquatic organisms require very low amount of these metals yet in case where these values exceed to certain range, threshold harmful effects are levied upon the ecosystem. The aim of this study was to estimate the bioaccumulation of heavy and trace metals (Cr, Mn, Ni, Fe, Pb, Cu, Cd, Zn) in fish using Atomic Absorption Spectrophotometer (AAS). Samples of fish were procured from Ghizer and Astore districts of Gilgit-Baltistan region of Pakistan. The concentration of Cr, Pb, Cu and Cd were almost same and depicted low tendency of bioaccumulation as per WHO guidelines. The fish from Ghizer was having high concentration of Zn and Fe in intestine. While the concentration of Fe in muscles and intestine from the Astore species was slightly high. The highest concentration of Ni (10.09 ppm) was found in liver tissues of rainbow trout, while the lowest concentration (6.74 ppm) was in the fins of fish from Astore. In case of Cr, the highest concentration (3.8 ppm) was found in liver from both sampling sites, but the lowest concentration (0.24 ppm) was in the muscles of Ghizer Rainbow trout. The highest concentration of cu (6.09 ppm) was in the muscles of fish from Astore, but the lowest concentration (2.32 ppm) was found in many organs of fish from both study sites. Although the concentration of Zn, Mn and Fe were within the limits, however, the highest concentration of Pb (0.79 ppm) was in the muscles and the highest concentration of Cd (0.38 ppm) was in the skin of Ghizer rainbow trout. Concentration of Lead exceeded the limits of FAO/WHO in every organ of fish in both study areas, while all the other metals were in the maximum limits.

Keywords: Bioaccumulation, Brown trout, Fresh water, Heavy metals, Ghizer Rainbow trout

INTRODUCTION

Heavy metals are chemical elements that are poisonous and toxic comprising of both necessary and unnecessary trace metals. All aquatic organisms require very low amount of these metals yet in case where these values exceed to certain range, threshold harmful effects are levied upon the ecosystem [1]. The presence of heavy metals in the tissue of fishes indicate that the aquatic environment is polluted which has been considered a major threat to the aquatic organisms [2].In the last few decades, the rapid development of industry and agriculture has resulted increased heavy metal pollution which is significant environmental hazard for invertebrates, fishes and humans [3].

Fishes are the loftiest consumers in the aquatic food web and their body collects large quantity of heavy metals [2]. Heavy metals being highly persistent and potentially toxic for living organisms, have a particular significance in eco-toxicology [1]. Heavy metals are the well-known pollutants of aquatic environment, and these are accumulated in different tissues of aquatic organisms. Fishes are the most vulnerable aquatic animals of environmental pollution. Therefore, it is necessary to prevent water bodies from accumulating water pollutants. Fishes act as bio-indicators of heavy metal pollution in aquatic environment [4] that are found at high trophic level and are essential source of food [5]. Moreover, fishes are the most important source of protein as well as other essential nutrients for balanced nutrition.

Gilgit Baltistan has enormous freshwater resources. Its rivers, streams and freshwater lakes have a wide range of native and exotic fish species. Twenty different species of freshwater fish are found in the cold waters of GB including 17 native, three exotic and four are endemic species in GB region [6].The exotic species include Rainbow trout. In this region, freshwater resources are the main sources to accomplish major necessities of biodiversity which include glaciers, springs, rivers, ponds and lakes [7]. In GB, fish species are not in large number owing to high water turbidity, speed, low water temperature and low benthic productivity [8].

Major threats for fish in this region are human activities including logging, pesticide use, road construction and diversion of water to irrigation channels [9, 10].The status of heavy metals and contamination in aquatic ecosystems is currently a significant source of concern, because they become poisonous if they exceed permissible limits. Metals enter the aquatic system primarily by air deposition, natural weathering, and anthropogenic activities such as industrial effluents, domestic sewage, and mining waste disposal [11, 12].

Deposition of industrial wastes in rivers, lakes and ultimately into ocean is a significant cause of pollution in aquatic ecosystem. Heavy metal accumulation by aquatic biota can damage tissues which can have adverse consequences in both aquatic organisms as well as in humans [13]. Exposure of aquatic life to the significant amount of heavy metals may result in reduced growth and development, reduction of survival chances of fishes and can disturb the level of oxygen in aquatic system.

Consumption of heavy metals by humans through fishes and other sources may have severe health issues. These metals prove toxic and damage human organs. Effects of toxic heavy metals include nervous disorders, birth defects, gastrointestinal infections, kidney infections, skin lesion, immune system dysfunction and cancer. The physical symptoms of heavy metal assimilation include nausea, abdominal pain, diarrhea, vomiting, chills, weakness and shortness of breath [12, 13].

Furthermore, histopathological changes in various fish tissues are used as indicators of the effects of anthropogenic contaminants and as a reflection of the ecosystem's health [14]. As a result, there is a growing interest in using fish as biological indicators to assess the integrity and quality of the aquatic environment [15].

The aim of this study is to estimate the concentration of different heavy metals accumulated in different organs of fishes studied in this research. The estimated concentrations are compared with standard values of heavy metals given by WHO and FAO at which aquatic organisms can survive without any health hazard.

Material and Methods

Study Site.

This study was conducted in two districts of Gilgit-Baltistan namely Ghizer and Astore during October 2018 where bio-accumulation of heavy metals in the tissues of rainbow trout was determined. Concentration of heavy metals in Ghizer's rainbow trout was compared to Astore.

District Ghizer is located in the Hindukash region of Pakistan in the North part of Gilgit-Baltistan, between latitude 36° N to 37°N and longitude 73°E to 74°E having total area of 12042 km^2 with the estimated elevation above sea level is 3661 meters. The region is divided into four tehsils i.e. Gupis, Iskoman, punial and Yasin [16]. Iskoman valley is the beautiful and scenic valley of this district which is located at the distance of 140 km from Gilgit capital city and 65 km from Gahkuch. The valley is gifted with natural beauty in the form of alpine meadows, massive glaciers and perennial streams with high mountain valley surrounded by snow caped peaks at the altitude from 7000 to 12000 ft in the Hindukush and Karakorum Ranges while the highest peak near Ishkoman is Shiniki peak that can be visible from Ishkoman Valley.

District Astore is one of the famous places in Gilgit-Baltistan region, which is located in the North of Pakistan. It is located at a distance of 60 km in the Southeast of Gilgit and about 484 km far from Islamabad the capital city of Pakistan. Total area of this district is about 7221 km^2 and the total population of this area is 100400.This district is divided into two tehsils i.e. Astore and Shounter. The people of the area depend upon agriculture and livestock farming for their livelihood while they also earn money from seasonal activities. The climatic conditions of the area vary from season to season i.e.in summer season the temperature is not very hot and the overall area has moderate climate, whereas the winters are very cold with heavy snow fall in the region.

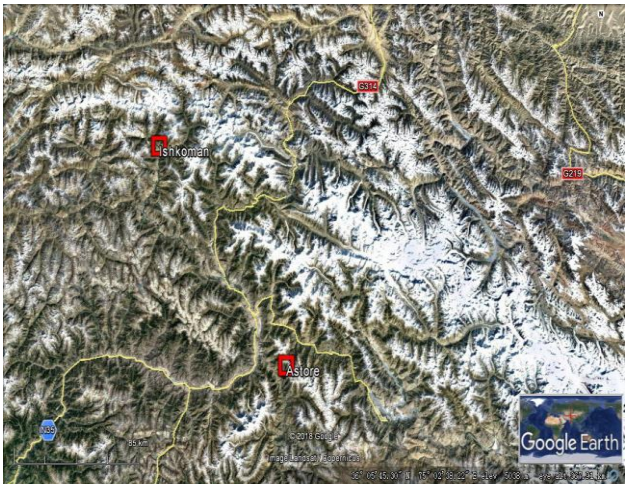

Figure1. Map of study area

Sampling of Fish.

The fish samples were taken from different fish farms located in the districts. Twenty samples were taken from the districts. Fish were captured from the fresh water of study sites using a hand net with the help of local fisherman. The height and location of study sites were recorded with the help of digital GPS. For further analysis, samples were brought to the research laboratory, Department of Environmental Sciences, Karakoram International University, Gilgit.

Laboratory Treatment and Analysis of Fish Samples

Digestion.

Before the analysis of samples, body weight and length of each fish sample were measured with the help of weighing balance. The samples were dissected, and different organs of fish (muscles, intestine, fins, gills, liver, and skin) were separated in the labeled plastic crucibles. Samples were washed thoroughly with distilled water. All the samples were air dried for 24 hours at 10°C temperature in the oven then ground with the help of grinder machine. The fish samples were digested by the method used Podolski [17].This involves digestion of 10g part of ground samples with 10mL HNO3 and 2mL HClO4 and was heated for one hour on a hot plate until all material was dissolved. After complete digestion, the residue was dissolved and diluted with 0.2%V/V HNO_3 to 100mL with distilled water. Digested samples were filtered using whatsman filter paper (size). Digestate was stored in a pre-cleaned polyethylene vials until further analysis.

Preparation of stock solution.

Standards of Zn, Cu, Fe, Mn, Pb, Ni, Cd and Cr were obtained from the Department of Agriculture & Food Technology laboratory and concentration was made as1000 ppm. Before analysis of fish samples for heavy metals, 100 ppm stock solution was prepared from1000 ppm solution.

Sample Analysis.

Heavy metals in all the digested samples were analyzed at the Hi-tech Laboratory of the Department of Agriculture & Food Technology, Karakoram International University,

Gilgit, using Atomic Absorption Spectrophotometer (Varian AA55). Prior to analysis, the instrument was calibrated using standard solutions already prepared in the Laboratory of the Department of Chemistry. The absorption wavelength of the selected heavy metals Zn, Cd, Mn, Pb, Cr, Fe & Ni were noted and results were presented as mean values. The information assimilated for statistical analysis of data was carried out using MS excel in tabulated form afterward transferred to MS word used to evaluate the concentration of heavy metals in the various body organs of fish.

Result and discussion.

Concentration of Heavy Metals in Body Organs of Rainbow Trout Fish. This study showed significant variation of concentration of heavy metals (Cu, Fe,Cr,Cd,Mn,Zn,Ni, Pb) in liver, gills, muscles, intestine, fins and skin of trout fish collected from the areas of Ghizer and Astore. Mean concentration of Zn, Fe, Cr, Cu, Cd, Ni, Pb and Mn in Astore's fish tissues were in the following range of 7.45-10.09 ppm, 0.26-0.38 ppm, 2.32-6.09 ppm, 2-5 ppm, 0-1ppm,1-6 ppm,0.42-0.62 ppm and 0.25-0.30 ppm, respectively. Figure 2 illustrates the mean concentration of several metals in different organs of fishes studied in two different areas i.e, Astore and Ghizer. The order of heavy metal concentration in the Astore's fish samples decreased in the sequence for gills as Mn > Cd > Cr > Pb > Fe > Zn > Cu >Ni,for the Muscles as Mn > Cr > Cd > Pb > Zn > Fe > Cu >Ni, for the liver asMn > Cd > Cr > Pb >Zn > Fe > Cu > Ni, for the intestines as Cd > Cr > Pb > Mn >Zn > Cu > Fe> Ni, for the skin as Mn >Cd > Cr >Pb >Fe > Cu > Zn > Ni, for the Fins as Cd > Cr > Pb > Mn > Zn > Cu > Fe >Ni. While the average concentration of heavy metals in the samples, caught from Ghizer were in the range of 6.74-10 ppm, 0.24-0.65 ppm, 2.32-5.25 ppm, 1-12 ppm, 0-1ppm, 1-14ppm, 0.45-0.79 ppm and 0.29-0.38 ppm. Furthermore, the trend of distribution of heavy metals in the Ghizer, fish samples reduced in the sequence for the gills as Mn > Cd > Cr > Pb >Fe > Cu > Zn >Ni, for the muscles as Cr > Cd > Pb > Mn > Fe > Zn > Cu > Ni, for the liver as Mn > Cd > Cr > Pb > Zn > Cu > Fe > Ni, for the intestines as Cr > Cd > Pb > Mn > Cu Ni > Zn > Fe, for the skin as Mn > Cr > Cd > Pb > Fe > Cu > Zn > Ni, for the fins as Cd > Pb > Cr > Mn > Cu > Fe > Zn > Ni.

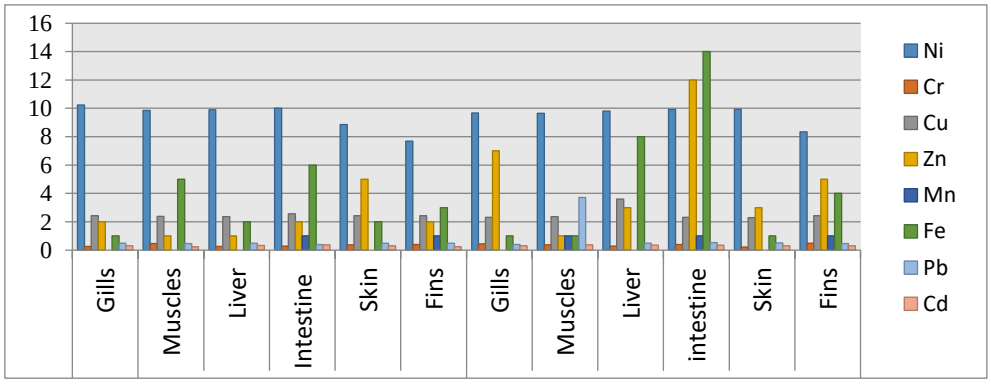

Figure 2. Concentration of heavy and trace metals from Astore and Ghizer regions

The current study revealed the concentration of heavy metals in the different organs of rainbow trout from Astore and Ghizer. The determination of heavy metal concentration in the tissues of fish is a good indicator of pollution status in aquatic environment [18]. The result of this research indicated that all the heavy metals were found in little amount, except Pb which was detected in higher amount in all the parts and tissues of fish procured from both the sampling sites.

Comparison of Heavy Metal Concentration in Various Organs of Rainbow Trout.

Nickel is also an important element and found in soil, air, water and biosphere. This element is essential for living organism, when it is in small amount, but the high amount of nickel is dangerous for human and can cause chronic lung cancer, respiratory failure, nose cancer, asthma, birth defects, and cause many other diseases [19].The sources of nickel emission include mining effluents, domestic effluents, industrial effluents, leaching of heavy metals from solid waste dump and garbage [20].The results of this study investigated that the mean highest concentration on Nickle was found in the liver and skin from both sampling sites (Figure 2a). The highest concentration in liver was (10.09-9.91 ppm), while in skin the concentration was (10-9.95 ppm) from both sampling sites, While the lowest concentration was in the fins (6.74 ppm) of Ghizer rainbow trout. The sequence of distribution of metals in different organs of rainbow trout from both sampling sites were Liver >Skin > Gills >Intestine > Muscle > Fins, although the concentration of Nickle was within the limit of FAO/WHO [21]. Figure 3 shows the mean concentration of copper in different organs of fishes.

Chromium is highly toxic for fish when it enters the body of fish its body surface is covered with mucus, which harms gill epithelium and sudden death is occurred due to suffocation. The traces of chromium in various organs of Rainbow trout from both sites varied from 0.65 to 0.24 ppm (Figure 2b). It was detected that the amount of chromium in different organs was varied from one organ to another from both the Districts. The highest and lowest concentration of Cr was detected in the fins (0.65 ppm) and muscles (0.24 ppm) of Ghizer rainbow trout fish, however the concentration of Cr in all the organs of fishes from both sites were within the limit of FAO/WHO. Uwem et al [22] conducted a study on fresh water fishes in Nigeria, they investigated that the maximum and minimum concentration of Cr that varied from 0.35 $\mu g g^{-1}$ to 0.03 $\mu g g^{-1}$ in different fresh water fish species.

Table 1. Comparison of heavy metal concentration in different organs of Brown trout from district Astore and Ghizer

Metal	Astore Brown Trout						Ghizer Brown Trout						WHO/ FAO (ppm)
	Gills	Muscles	Liver	Intestine	Skin	Fins	Gills	Muscle	Liver	Intestine	Skin	Fins	
Ni	10.2	9.8	9.9	10	8.8	7.68	9.67	9.64	9.81	9.9	9.95	8.34	80

Cr	0.2	0.4	0.2	0.2	0.3	0.40	0.45	0.3	0.2	0.4	0.2	0.4	1
Cu	2.4	2.4	2.3	2.5	2.4	2.4	2.3	2.3	3.6	2.3	2.2	2.42	2
Zn	2	1	1	2	5	2	7	1	3	12	3	5	NA
Mn	0	0	0	1	0	1	0	1	0	1	0	1	5.5
Fe	1	5	2	6	2	3	1	1	8	14	1	4	43
Pb	0.49	0.47	0.49	0.39	0.48	0.48	0.39	3.72	0.49	0.54	0.52	0.47	1
Cd	0.3	0.2	0.3	0.3	0.3	0.2	0.3	0.4	0.35	0.3	0.3	0.2	0.2

Copper is an indispensable element and play avital role in enzyme activity and other cell components having an important role in the formation of hemoglobin [23]. But the abundance of copper in human body is lethal and cause health hazards to human as well as animals. Excessive intake of Cu will be source of food poisoning, nausea, acute stomach pain diarrhea and fever. The National Council Research Center has computed that up to 1.5-3.0 mg daily intake of copper would be safe and adequate [24]. While the current study investigated that the highest concentration of copper was in muscle tissues (6.09 ppm) in the Astore rainbow trout, while in Ghizer rainbow trout the highest concentration of Cu was in Liver (5.25 ppm) (Figure 2c). Liver is the largest organ for the accumulation of heavy metal whereas all the tissues contain the maximum level of copper from both the study areas. The accumulation of copper among the fish tissues was determined in both sites in the decreasing order of Muscle > Liver > Intestine > Fins > Skin > Gills. The permissible limit for cu set by FAO/WHO is (30 ppm), so the concentration of copper in this study was within the permissible limit.

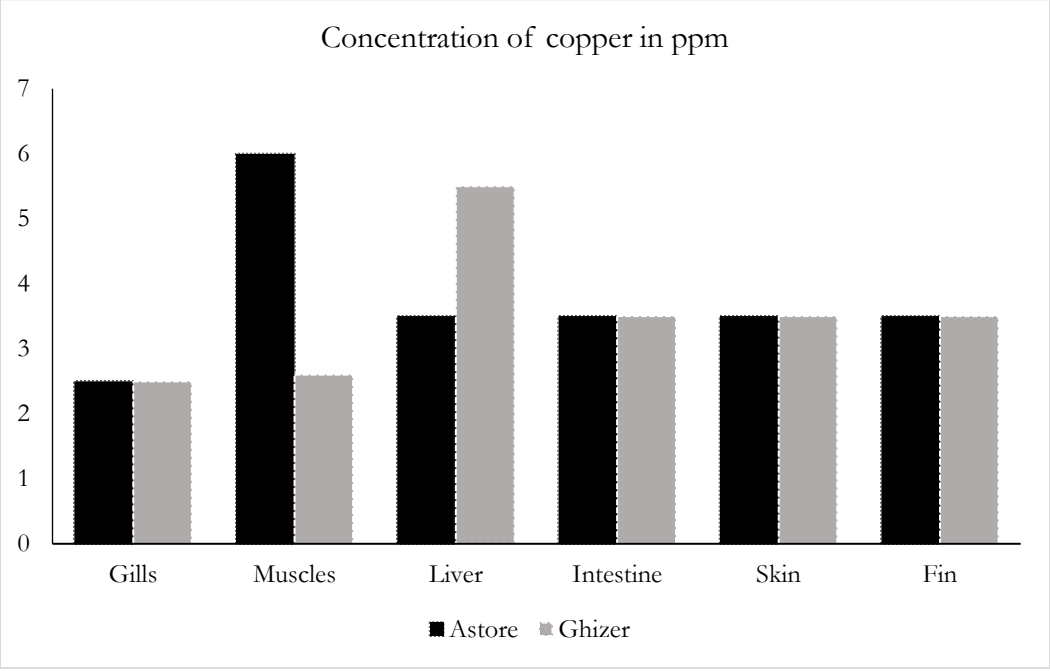

Figure 3: Concentration of copper in different organs of fishes in ppm.

Zinc is also an essential metal and required in a small quantity for a body to perform

a normal metabolic function. When the concentration of Zinc is in excess it is harmful for living organisms as well as fish [25]. However, the data of the current study determined that the maximum concentration was present in intestine (12 ppm) of Ghizer rainbow trout (Figure 2d). While the lowest concentration was in the different organs of fish (1ppm) from both the study areas. The accumulation pattern was in order of Intestine > Gills > Fins > Skin > Liver > Muscles. Concentration of Zinc in the present study was found lower than the permissible limit reported by FAO/WHO.

Manganese is an essential metal and its low level is necessary for human, when it is found in excess amount it can induce oxidative stress and toxic effect in aquatic organism [26]. In this study, the concentration of Mn was not detected in many organs from both districts, while some organs contain a little amount of Mn in intestines, fins and muscles from both areas and the concentration were within the limit of FAO/WHO (Figure 2e). According to [22], concentration of Mn in freshwater fish was below the standard limit of $0.7 \mu g g^{-1}$ reported by Charbonneau [27].

Iron is the fourth plentiful component in the earth's atmosphere. In water, it is present in the form of ferrous or ferric state [28]. It is assumed as one of the essential metals due to its biochemical and physiological role in hemoglobin synthesis and as cofactor of many enzymes [29]. However, high amount of Fe in living organism can increase the level of Fe [30]. The maximum concentration of iron in the current study were (14 ppm) in the intestine of Ghizer rainbow trout, while the lowest concentration was in various organs of fish from both study sites of current study (Figure 2f). The standards set by FAO/WHO are 43 ppm and the results of the current study fall within this limit. So, the current study revealed that lead (Pb) is the only element that exceeds the standards set by FAO/WHO.

Lead is one of the non-essential elements for living organism and can cause neurotoxicity in human being. The result of the current study revealed that the highest mean concentration of Pb was 0.79 ppm, which was found in the muscles of Ghizer rainbow trout fish, while the lowest concentration was in the gill (0.42 ppm) of Astore Rainbow trout (Figure 2g). From both sampling sites the order of Pb accumulation was, muscle > liver >intestine > Skin >fins>gills. WHO suggested that the dietary Pb should not exceed 0.3 µg/g and a recommended limit of 450 µg of Pb per day for adults [31].The concentration of Pb were high in all the organs according to permissible level of FAO/WHO limit (0.3 ppm). Figure 4 shows the concentration of Lead in different organs of fishes in ppm.

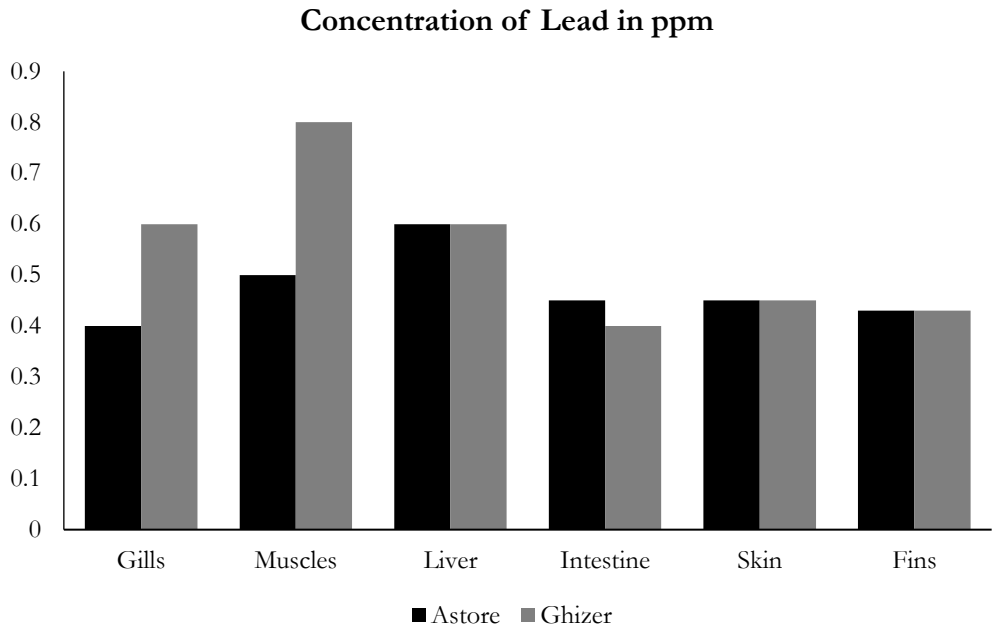

Figure 4: Concentration of lead in different organs of fish in ppm.

Cadmium is the poisonous and non-essential element in food and natural water and mostly this metal is accumulated in the liver and kidney of fishes [32] and is considered lethal and cause chronic lung diseases, kidney damages, high blood pressure and destruction in the formation of red blood cells etc. This study investigated the highest concentration of Cd (0.38 ppm) in the skin of Ghizer Rainbow trout, while the minimum concentration was in the intestine (0.25 ppm) of Astore trout (Figure 2h).However, all the organs of both the sampling sites have maximum level of cadmium which was within the permissible limit of WHO/FAO (0.5ppm).

Concentration of Heavy Metals in Body Organs of Brown Trout Fish.

Heavy metals in fresh water that is used by brown trout (*Salmo trutta fairo*) in District Ghizer and Astore were assessed. Amount of heavy metals in different parts of Astore trout are summarized in Table 1.Heavy Metal Concentration Comparison in Various Organs of Brown Trout. Heavy metals are formed from both natural and manmade activities [33].In aquatic environment, contamination of heavy metals come out through agricultural discharges, weathering of rocks, municipal discharge, industrial waste etc. [34]. Amount of heavy metals in various organs of Brown Trout is as under:

Nickel is a crucial metal that is present in air, soil and water, also occur in biosphere. Nickel is released into atmosphere through natural cycles and anthropogenic practices. Nickle is accessible in natural environment and it is also released by industries. In the current study, the amount of nickel is maximum in the gills (10.22 ppm) followed by intestine (10 ppm), liver (9.9 ppm), muscles (9.8 ppm), skin (8.8 ppm) and fins (7.6 ppm)**.** Pollutants can also be discharged into the environment by coal and oil-fired power plants [35]. Ni forms complexes with ligands in atmosphere turning into a heavy metal. Whereas, in most

organisms nickel is an important component if it is in small quantity. While when its quantity is increased, it becomes poisonous [36]. Nickel can also cause respiratory issues declared by medicinal institution [37].The concentration of Ni falls below the permissible limits of WHO/FAO (80ppm) in all organs of Brown Trout.

Chromium is also a necessary nutrient metal, which is essential for carbohydrates metabolism [38]. Cr enters aquatic environment through different methods like (mining, textiles, metal finishing leather tanneries pharmaceutical industries etc. WHO [39] Reported Lead in close water reservoirs has been as a result of poor treatment of industrial and other effluents, where it is generally present at harmful levels for fish. [40]. Hexavalent chromium and Oxidation state trivalent chromium are stable forms of Cr. Hexavalent chromium has an ability to cross cell membrane and considered to be more poisonous [7].The chromium in all the organs of Brown Trout is found below the set standards of WHO/FAO (1 ppm).

Copper being key constitution of metabolic enzymes, is a vital trace metal for cellular metabolism in organisms [41]. On the other hand, it can be very harmful when it is in high amount and go above the maximum level [42]. Copper Sulphate is used in recreational and commercial ponds to control growth of phytoplankton and filamentous algae and diseases of fish [43]. In the current research, gill and some other tissues of fish copper was detected. Copper is also found below the WHO/FAO (3ppm) guidelines in all organs of Trout Fish.
Zinc is a rich trace metal and is essential heavy metal even if it is present in very low amount in living organism. It is involved in nucleic acid synthesis and present in each cell of the body. It is also involved in many other functions like neurotransmission, immune system and in medicines the Zn its compounds are widely used [44]. Figure 5 illustrates the concentration of zinc in different organs of fishes in ppm. The concentration of Zinc was lower than the permissible limit set by WHO/FAO. Common sources of Zn include galvanized ironwork, zinc chloride used in plumbing and use of Zn containing paints [45].

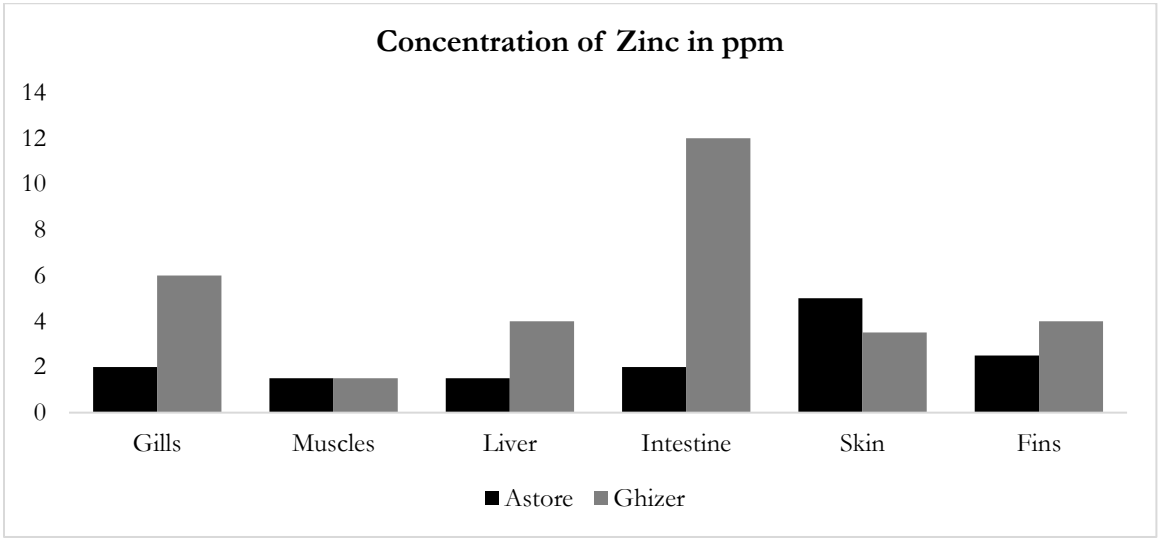

Figure 5: Concentration of Zinc in different organs of fishes in ppm.

Mn can be consumed through water and food resources. Mn does not enter into the skin, and it does not get mixed into the air. As a result, swimming and showering in Mn-containing water does not contribute to increase the exposure. High contact to Mn has been linked with toxicity to the nervous system and syndrome producing. Mn can also be the cause of other diseases like cancer, and it also damage the reproductive system. As compared to the elder, younger children absorb more Mn. So, it is important for children and pregnant women to drink clean water. One of the big problems of water resources is water pollution. Infected rivers have broad impacts; a little manure/chemical fall can have an uneven effect on animals as well as people through harvesting and storage of rainwater in water tanks, runoff may be reduced. The concentration of Mn also falls below the standard set by WHO (5.5 ppm).

Iron is common part of mining and industrial effluents that is released into fresh water. Liver and gonads show the highest concentration of iron while the heart, muscle and liver show the low concentration [46]. In recent times [47], it is found that the mark organ for iron is the fish liver. Feasible method for iron poisoning is physical blockage of gill through accumulation of metals. For the reason that the surface of fish gill tends to be alkaline, respiration is slow down when gills are cover by mucus [48]. Figure 6 illustrates the concentration of iron in different organs of fish in ppm. The high concentration of Fe can cause serious effect on fish by blocking and reducing its gills which spoil the respiratory system consequently it causes sudden death.

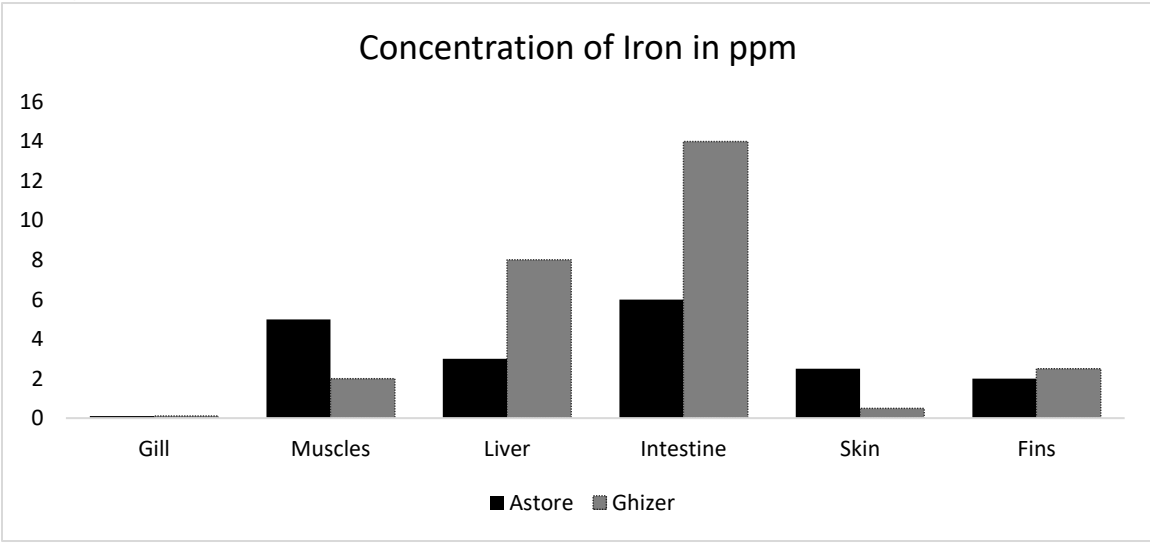

Figure 6: Concentration of iron in different organs of fishes in ppm.

The increased content of iron compound has a significant impact on fish. Fe was found below the permissible limits of WHO/FAO (43ppm) in the body parts of Trout Fish. Concentration of iron in organs of fish is below the WHO permissible limit (4ppm).Lead is a constant and naturally occurring heavy metal. The concentration of lead in environment is increased by anthropogenic activities like (Pb-based paint, manufacturing of mining etc) [49]. Pb may emitted in water through industrial effluents and discharges, when lead dust falls out,

through precipitation, through pesticides which contain lead, runoff or through waste water of municipal [50].

The amount of lead is mostly dependent on its absorption into the natural organic matters, into the sediments, on the hardness, alkalinity and pH of water. Aquatic organisms bio-accumulate Pb from water and diet, even though there is proof that Pb deposition is originated from polluted water as compared to food. In gills, kidneys, liver and digestive tract lead is accumulated [51] while the concentration of lead in fish organs is below the WHO permissible limit. While the muscles exceed WHO limit.

Cadmium is nonessential trace metal which occurs naturally. Environmental distress is increased when Cd affinity to bio-accumulate in living organisms up to a dangerous level [52]. During 20 century Cd manufacture, Cd use and emission have increased to the environment considerably, due to industries for example (uses of plastic stabilizers and batteries etc.) and pollution of aquatic life. The contamination of water is also occurred due to the use of fertilizers, pesticides, sewage mud in land, agricultural chemicals which contain cadmium [53, 54]. As a non-degradable increasing impurity, Cadmium is considered capable of changing water trophic levels for centuries. In freshwater fishes, about 75% heavy metals are accumulated in gills, kidney and liver, and also accumulate in hearts and other organs then cause changes in liver, gills and kidney. Figure 7 illustrates concentration of cadmium in different organs of fish in ppm. The cadmium in the body organs of Trout Fish exceeded the standards set by WHO/FAO (0.2 ppm).

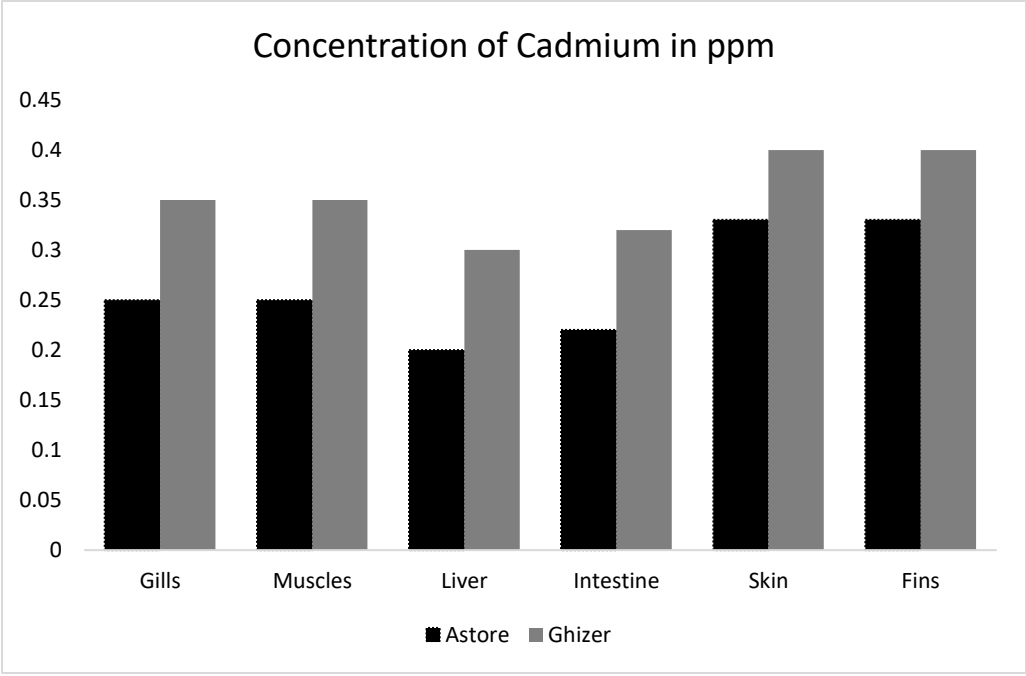

Figure 7: Concentration of cadmium in different organs of fish in ppm.

Conclusion

This study concludes that some heavy metals were accumulated in a few organs of Brown Trout Fish. Results revealed that fish organs contained the maximum level of heavy

metals. Concentration of nickel is high in all the organs of Brown Trout from both the sampling areas. Fe and Zn was found higher in the intestine of fish from Ghizer than those from Astore. The concentration of Pb (3.72ppm), Cd (0.37ppm), Cu (2.35 ppm) were exceeded the standard limit set by WHO/FAO.While the concentration of Cu is exceeded from WHO limit (2ppm) in all organs of Brown trout from both sampling areas. This research clearly showed the significant buildup of metals in organs of fish. Consumption of heavy metal contaminated fish should be monitored and avoided to refrain from adversative health effects. Overall contamination of heavy metals was due to natural process but there were certain anthropogenic causes of contamination such as open use of water resources for washing purpose, domestic use and addition of sewage water directly in water resources without proper treatment etc. The concentration of Lead (Pb) dominated all the studied metals and has exceeded the permissible value of FAO and WHO in all organs of fish from both areas of sampling, while all the metals in the various body organs of Astore and Ghizer fishes were within permissible values prescribed by FAO/WHO.

Author's Contribution. All the authors contributed equally.

Conflict of interest. We declare no conflict of interest for publishing this manuscript in IJIST.

REFRENCES

References

[1]. Ali, S., Begum, F., Hussain,SA.,Khan, SA., Ali, H., Khan,T., Raza, G.,Ali, K., Karim, R. Biomonitoring of HeavyMetals availability in the Marine Environment of Karachi, Pakistan, UsingOysters(*Crassostrea* Sp.).*International Journal of Biosciences*, Vol.4, issue 7,pp:249-257, 2014.

[2]. Nair, M., Jayalakshmy, K. V., Balachandran, K. K., & Joseph, T. Bioaccumulation of toxic metals by fish in a semi-enclosed tropical ecosystem. Environmental Forensics, Vol 7, issue 3, pp: 197-206, 2006.

[3]. Authman, M.M.N., Zaki, M.S. Khallat, E.A., Abbas, H.H. Use of fish as bio indicator of the effect of heavy metals pollution. J Aquac Res Dev., Vol 6141,issue 328, 2015.

[4]. Chezhian, N., Kabilan, T., Kumar, T.S., Senthamilselvan. Impact of chemical Factory Effluent on the structural changes in gills of estuarine fish, Mugil cephalus, World Appli Sci J., Vol 9, pp:922-927, 2010.

[5]. Storelli, M.M., et al. Accumulation of mercury, cadmium, lead and arsenic in swordfish and bluefin tuna from the Mediterranean Sea: A comparative study. Baseline / Mar Pollut Bull., Vol 50, pp:993-1018, 2005.

[6]. Govind, P., Madhuri, S. Heavy metals causing toxicity in animals and fishes, Res. J. Anim Vet Fish Sci., Vol 2, issue 2, pp:17-23, 2014.

[7]. BAT, Heavy metal in black sea published by Turkish marine research foundation (TUDAV). Istanbul, Turkey, pp: 71-107, 2014.

[8]. Rafiq, M. Fish Fauna of Gilgit-Baltistan Areas of Pakistan. Final Report Submitted to Gilgit Baltistan Fisheries Department. Pak Mus Nat Hist., pp: 1-114, 2013.

[9]. Ahmed, M.K., Kundu, G.K., Al-Mamun, M.H., Sarkar, S.K., Akter, M.S. Chromium (VI) induced acute toxicity and genotoxicity in freshwater stingingcatfsh, Heteropneustesfossilis.Ecotoxicol Environ Saf., Vol 92, pp:64-70, 2013.

[10]. Rafique, M. Fish diversity and distribution in Indus River and its drainage system. Pak J Zool., Vol 32, pp:321-332, 2000.

[11]. AKRSP/DFID. Development of a Fisheries Strategy for the AKRSP. Draft Consultancy Report No. 14, AKRSP. and Conservation of the Deosai Plateau, Northern Areas, Pakistan. Bioaccumulation of heavy metals in fish tissues of a freshwater lake and Conservation of the Deosai Plateau, Northern Areas, Pakistan. Pp: 27,33-61, 2000.

[12]. Woods, C.A., Kilpatrick, C.W., Rafiq, M., Shah, M., Khan, W. Biodiversity and Conservation of the Deosai Plateau, Northern Areas, Pakistan. Biodiversity of Pakistan. Pakistan Museum of Natural History, Islamabad, Pakistan, pp: 33-61, 1997

[13]. Miretzky, P., Saralegui, A., & Cirelli, A. F. Aquatic macrophytes potential for the simultaneous removal of heavy metals (Buenos Aires, Argentina). Chemosphere, Vol 57, issue 8, pp: 997-1005, 2004.

[14]. Laxmi Priya, S., Senthilkumar, B., Hariharan, G., Paneer Selvam, A., Purvaja, R., & Ramesh, R.. Bioaccumulation of heavy metals in mullet (Mugil cephalus) and oyster (Crassostrea madrasensis) from Pulicat Lake, south east coast of India. Toxicology and Industrial Health, Vol 27, issue 2, pp: 117-126, 2011.

[15]. Yancheva, V., Velcheva, I., Stoyanova, S., & Georgieva, E. Histological biomarkers in fish as a tool in ecological risk assessment and monitoring programs: a review. Applied ecology and environmental research, Vol 14, issue 1, pp: 47-75, 2016.

[16]. Van der Oost, R., Beyer, J., & Vermeulen, N. P. Fish bioaccumulation and biomarkers in environmental risk assessment: a review. Environmental toxicology and pharmacology, Vol 13, issue 2, pp: 57-149, 2003.

[17]. Rahim, I., Ali, S.M., Aslam, M., GIS Based Landslide Susceptibility Mapping with Application of Analytical Hierarchy Process in District Ghizer, Gilgit Baltistan Pakistan. J Geosci Environ Protect. Vol 6, pp:34-49, 2018.

[18]. Poldoski, J.E. Determination of lead and cadmium in fish and clam tissue by atomic absorption spectrometry with a molybdenum and lanthanum treated pyrolytic graphite atomizer. Anal Chem., Vol 52, issue 7, pp:1147–1151, 1980.

[19]. Abarshi, D.A. Bioaccumulation of heavy metals in some tissues of croaker fish from oil spilled rivers. Asian Pac J Trop Biomed., Vol 7, issue 6, pp:563–568, 2017.

[20]. Arya, S., Singh, J., Sharma,H.B. Bioaccumulation in tissues of fresh water fish Cirrhina mrigala on chronic. Int J Environ Rehabil Conser., pp: 1-8, 2012.

[21]. FAO, Review of Heavy Metals. Report No. 22, on the 9 steering committee meeting, Gaborone, Botswana, pp: 13-16, 1996.

[22]. FAO, Cultured Aquatic Species Information Programme. *Oncorhynchus mykiss*. Fisheries and Aquaculture Department, Cultured Aquatic Species Information Programme, 2012.

[23]. Uwem, G.U. Bioaccumulation of heavy metal in three fresh water fishes caught from cross. European J Exp Biol., Vol 3, issue 3, pp:576-582, 2013.

[24]. Sivaperumal, P., Sankar, T.V., Nair, P.G.V. Heavy metal concentrations in fish, shellfish and fish products from internal markets of India vis-`a-vis international standards. Food Chem. Vol 102, pp: 612-20, 2007.

[25]. Li, Lan., Zhang, K., Gill, R.A., Islam, F., Farooq, M.A., Wang, J., Zhou, W. Ecotoxicological and Interactive Effects of Copper and Chromium on Physiochemical, Ultrastructural, and Molecular Profiling in *Brassica napus* L. BioMed pp: 17, 2018.

[26]. Ardakani, S.S., Jafari, S.M. Assessment of heavy metals (Cu, Pb and Zn) in different tissues of common carp (Cyprinuscarpio) caught from Shirinsu Wetland, Western Iran J Chem Health Risks. Vol 4, issue 2, pp:47-54, 2014.

[27]. Vieira, M.C., Torronteras, R., C´ordoba, F., Canalejo, A. Acute toxicity of manganese in goldfish Carassiusauratus is associated with oxidative stress and organ specific antioxidant responses. Ecotox Environ Safe. Vol 78, pp :212-700, 2011.

[28]. Charbonneau, C.S., Nash, T. Contaminants program, Mingo National Wildlife Refuge (Region 3), contaminants survey results. U.S. Fish and Wildlife Service, 1993.

[29]. Ghulman, B.A., EL-Bisy, M.S., Ali, H. Ground water assessement of makkah al-mokarama. Proceedings of the 12th International Water Technology Conference, Umm Al-Qura University, Makkah, pp: 1515-1527, 2008.

[30]. Gorur, F.K., Keser, R., Akcay, N., Dizman, S. Radioactivity and heavy metal concentrations of some commercial fish species consumed in the Black Sea Region of Turkey. Chemosphere, Vol 87, pp:356-61, 2012.

[31]. Edward, J.B., Idowu, E.O., Oso, J.A., Ibidapo, O.R. Determination of heavy metal concentration in fish samples, sediment and water from Odo-Ayo River in Ado-Ekiti, Ekiti State, Nigeria. Int J Environ Monit Anal., Vol 1, issue 1, pp:27-33, 2013.

[32]. Chi, Q.Q., Zhu, G.W., Alan, L. Bioaccumulation of heavy metals in fishes from Taihu Lake, China. J Environ Sci., Vol 19, pp:1500–1504, 2007.

[33]. Velayatzadeh, M.J. (2013) Determination of heavy metals and trace elements in the muscles. J Anim Plant Sci., Vol 23, issue 3, pp:786-791, 2013.

[34]. Bauvais, C., Zirah, S., Piette, L., Chaspoul, F., Domart-Coulon, I. sponging up metals: Bacteria associated with the marine sponge Spongiaoffcinalis. Mar Environ Res., Vol 104, pp: 20-30, 2015.

[35]. Demirak, A., Yilmaz, F., Levent, Tuna, A., Ozdemir, N. (2006) Heavy metals in water,sediment and tissues of Leuciscus cephlaus from a stream in southwesternTurkey. Chemosphere, Vol 63, pp: 1451-1458, 2006.

[36]. ATSDR (Agency for Toxic Substances and Disease Registry), Agencyfor Toxic Substances and Disease Registry, Division of Toxicology, CliftonRoad, NE, Atlanta, GA, 2004.

[37]. Friedrich, A.R., Filice, F.P. Uptake and accumulation of the nickel ion byMytilus edulis. Bull. Environ. ContamToxicol., Vol 16, pp:750-755, 1976.

[38]. Nielson, F.H. (1977) Nickel toxicity. John Wiley and Sons Inc, New York.

[39]. Pacheco, M., Santos, M.A., Pereira, P., Martínez, J.I., Alonso, P.J., Soares, M.J.,Lopes, J.C. EPR detection of paramagnetic chromium in liver of fish(Anguilla anguilla) treated with dichromate(VI) and associated oxidative stress responses-Contribution to elucidation of toxicity mechanisms. Comp BiochemPhysiol C., Vol 157, pp:132-140, 2013.

[40]. WHO (World Health Organization), Chromium, Nickel and Welding.International Agency for Research on Cancer. IARC Monographs on theEvaluation of Carcinogenic Risks to Humans, France, 1990.

[41]. Eisler, R. 2000. Handbook of chemical risk assessment: Health hazards tohumans, plants, and animals.

[42]. Michael, P., (1986) Ecological methods for field and laboratory investigations.TATA McGraw-Hill Publishing Company Ltd., New Delhi.

[43]. Boyd CE (1990) Water quality in ponds for aquaculture. Alabama AgriculturalExperiment Station, Auburn University, USA.
[44]. Arellano, J.M., Storch, V., Sarasquete, C. Histological changes and copperaccumulation in liver and gills of the Senegales Sole, Solea senegalensis.Ecotoxicol Environ Safe., Vol 44, pp:62-72, 1999.
[45]. Alabaster, J.S., Lloyd, R., Water quality criteria for freshwater fish. Second edition. London, FAO. Pp: 456, 1982.
[46]. Farombi, E.O., Adelowo, O.A., Ajimoko, Y.R., Biomarkers of oxidative stressand heavy metal levels as indicators of environmental pollution in African catfish (Clariasgariepinus) from Nigeria Ogun River. Int J Environ Res PublicHealth., Vol 4, pp:158-165, 2007.
[47]. Abbas, H.H., Zaghloul, K.H., Mousa, M.A.) Effect of some heavy metalpollutants on some biochemical and histopathological changes in Blue tilapia,Oreochromis aureus. Egypt J Agric Res., Vol 80, pp:1395-1411, 2002.
[48]. Omar, W.A., Saleh, Y.S., Marie, M.A.S) Integrating multiple fish biomarkersand risk assessment as indicators of metal pollution along the Red Sea coastof Hodeida, Yemen Republic. Ecotoxicol Environ Saf. Vol 110, pp :221-231, 2014.
[49]. Peuranen, S., Vuorinen, P.J., Vuorinen, M., Hollender, A. The effects of iron,humic acids and low pH on the gills and physiology of Brown Trout (Salmotrutta). Ann Zool Fennici. Vol 31, pp: 389-396, 1994.
[50]. Cretì, P., Trinchella, F., Scudiero, R.) Heavy metal bioaccumulation andmetallothionein content in tissues of the sea bream Sparus auratafrom threedifferent fish farming systems. Environ Monit Assess., Vol 165, pp:321-329, 2010.
[51]. Katti, S.R., Sathyanesan, A.G.) Lead nitrate induced changes in lipid andcholesterol levels in the freshwater fish Clariasbatrachus. Toxicol Lett., Vol 19, pp:93-96, 1983.
[52]. Fernandez, P, J., Roman, A., De las Rivas, J., Bustelo, X.R., Dosil, M.) The 90S preribosome is a multimodular structure that is assembled through a hierarchical mechanism. Mol Cell Biol., Vol 27, pp:5414–5429, 2007.
[53]. Melgar, M.J., Perez, M., Garcia, M.A., Alonso, J., Miguez, B. The toxic andaccumulative effects of short-term exposure to cadmium in rainbow trout (Oncorhynchus mykiss). Vet Hum Toxicol., Vol 39, pp:79-83, 1997.
[54]. Ali S., Rubina, Hussain S. Assessment of Freshwater Springs, Associated Diseases, and Indigenous Perception in District Ghizer, Pakistan. Pak J Med Sci.; vol 34, issue 1, pp:121-124, 2018.