

# Spatial Appraisal of the Impacts of Drought on Agricultural Patterns in Karachi

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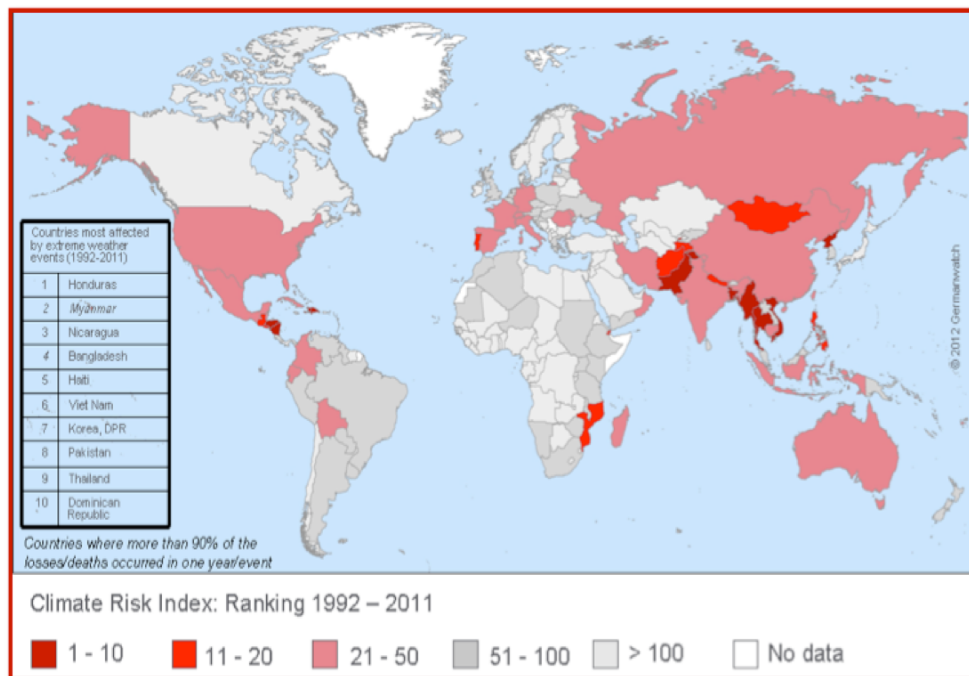
**Abstract:** This paper is aimed at studying the spatial changes in agricultural patterns practiced in the suburbs of Karachi, which is the most densely populated city of Pakistan with high food demands of the inhabitants. This study deals mainly with Physical factors primarily climatic indicators to observe and analyze the changes in the pattern of agricultural production and the types of crops in last 20-30 years. Variability of climate when coupled with anthropogenic factors play important role in the acceleration of problems for farmers. Trends of associated agricultural output observed in different years of high and low rainfall. This study has successfully demonstrated inquisitive approach by using published secondary data from governmental sources and ground verification in recent times. Temporal variation in biomass, was found dependent upon pattern of rainfall and temperature etc. Study reveals that there are clear signs of desertification and drought in the study area.

**Keywords:** Agricultural patterns, Variability of climate, desertification, drought.

## INTRODUCTION

Numerous studies have been made to observe climate change and its implication on food crop

problems due to various environmental challenges. However, calamities such as drought having a very high toll on the agricultural productivity in Pakistan. It is one of the hydro - meteorological hazards and

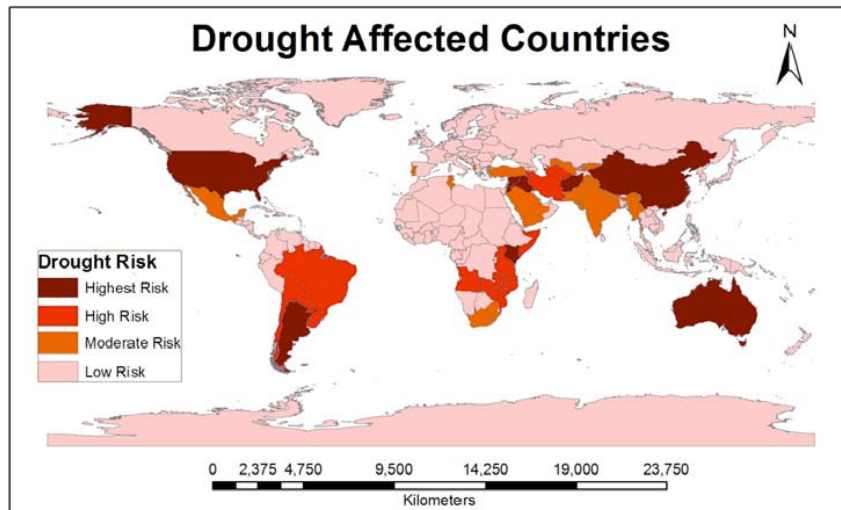


**Figure 1:** Global Climate Risk Index 1992-2011. Source: German Watch 2012.

production. Without any qualms, climate change has become a real threat to agriculture in developing countries such as Pakistan. Agriculture is the backbone of Pakistan's economy which is facing numerous

prevailing with great intensity since last few decades in Pakistan and more specifically in the Study Area. In fact drought is a natural phenomenon but if coupled with anthropogenic factors may result in acute shortage of food and water, thus affect the country and transformed in severe socio-economic crises for many years.

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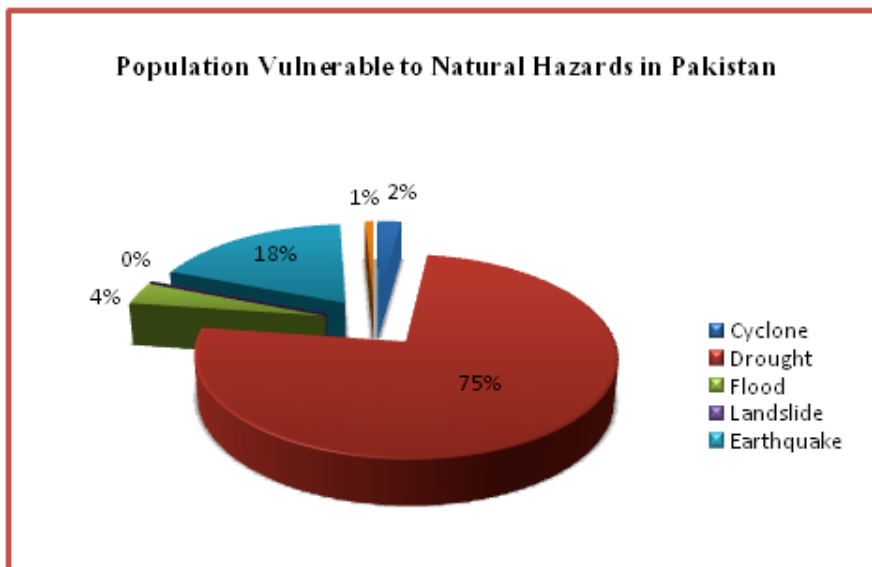
**Figure 2:** Drought Affected Countries. Modified after Eric deCarbonnel – 2009.

Global Climate Risk Index 1992-2011 Figure 1 ranking puts Pakistan among countries vulnerable to climate change. Pakistan has been victim of extreme weather (Drought/Floods) since 1992-2011.

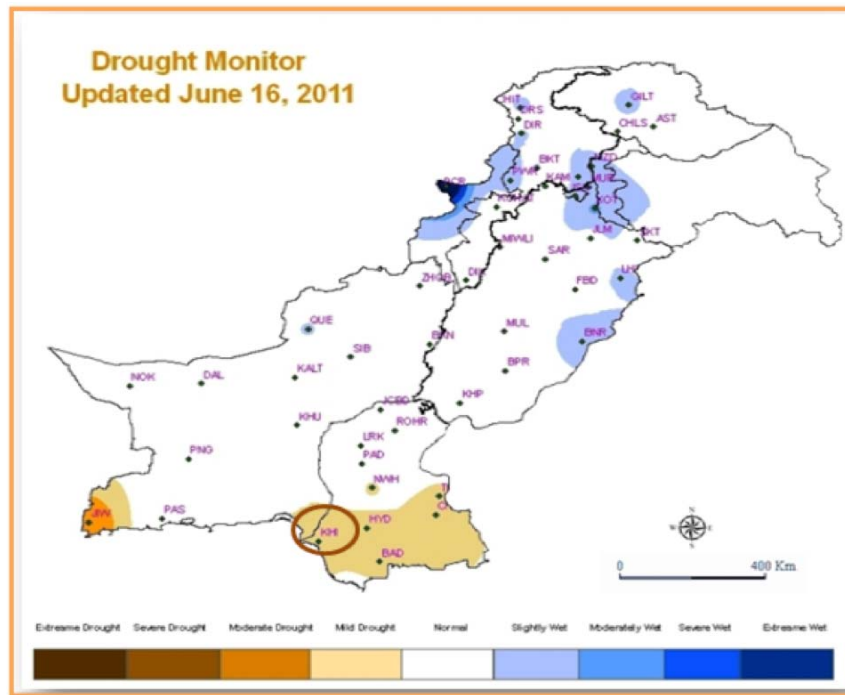
Drought affects countries of almost all climatic regions [1]. This Hydro-meteorological hazard is not only a normal and regular feature of the climate but at the same time is more complex to understand as well. Pakistan is among drought affected countries as mentioned in (Figure 2). It is more difficult to detect the emergence of droughts compared to other natural hazards because of its slow-onset, the absence of a universally accepted definition for drought, and its non-structural impacts. The decline in global food production has been observed which is an indicator to detect drought in agricultural countries [2]. As it has

been reported by International Organizations that in the last 100 years there has been an increase of the 0.6°C in the global temperature [3, 4]. The Indian meteorological department has also reported that there has been rise of 0.4°C/100 year in the surface air temperature in India and its surrounding areas [5].

According to UNESCO Pakistan being a subtropical country and having arid to semi arid climate is prone to drought and ranked 4<sup>th</sup> globally in the vulnerability of this hazard [6]. There has been many long dry spells or drying trend recorded over the various tropical regions of Earth during the last few decades [7]. Severe water shortage is an alarmingly threat for the country already strikes in many areas of Pakistan. Pakistan is swiftly converting from being a “water stressed country to a water scarce country”, mainly due to its rapid



**Figure 3:** Natural Hazard Risk profile; Modified after Global Assessment Report, UN 2009.



**Figure 4:** Drought Monitor update. Source: After PMD, 2012.

population growth. According to the World Bank's 2006 and 2009 Studies, Pakistan is more water stressed than Ethiopia. It is really an astonishing fact that among the 25 most populous countries in the world "South Africa, Egypt and Pakistan were found to be the most water-limited nations" [6].

In Figure 4 Drought monitor update released by Pakistan Meteorological Department study area falls under moderately affected drought areas of the country; as more than 50 % of Pakistan receives less than 10 mm of average rainfall, thus aridity generally increases as we move southward [8].

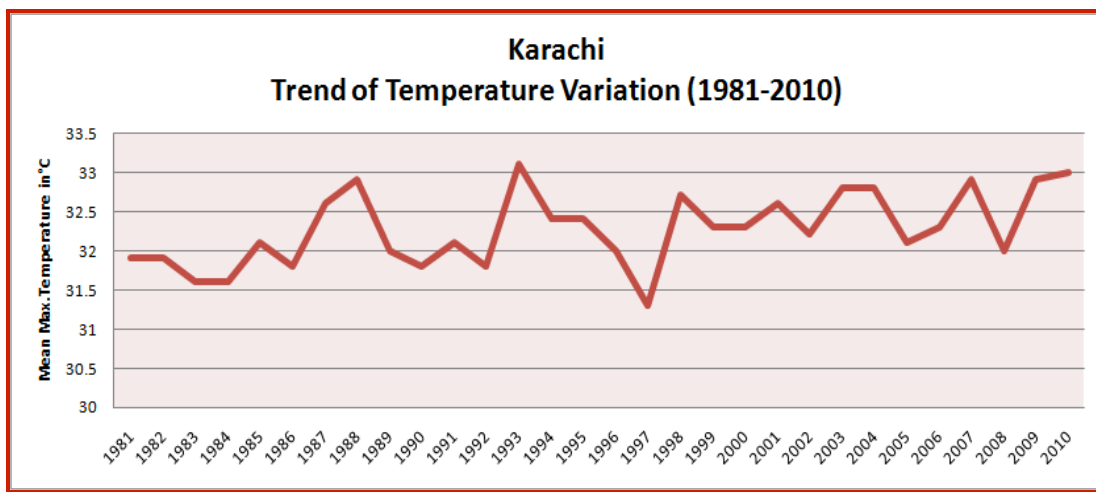
Being the rain fed region, groundwater is the main source of irrigation to carry out farming activities in Karachi. Moreover, variability and unreliability of rainfall have created an immense shortage of water which is a big threat to the future crop production. Declining soil moisture and depleting ground water reserves are turning the cultivated areas into a barren uncultivable land. This condition is alarming as it is compelling the natives to switch their attention to other professions, such as sand and gravel excavation, inland fishing, transport, or migrating to the city center to work as labour to earn money.

Karachi is a mega city with high food demand is being affected by food shortage year by year. Its sub-tropical location with high temperature and variable

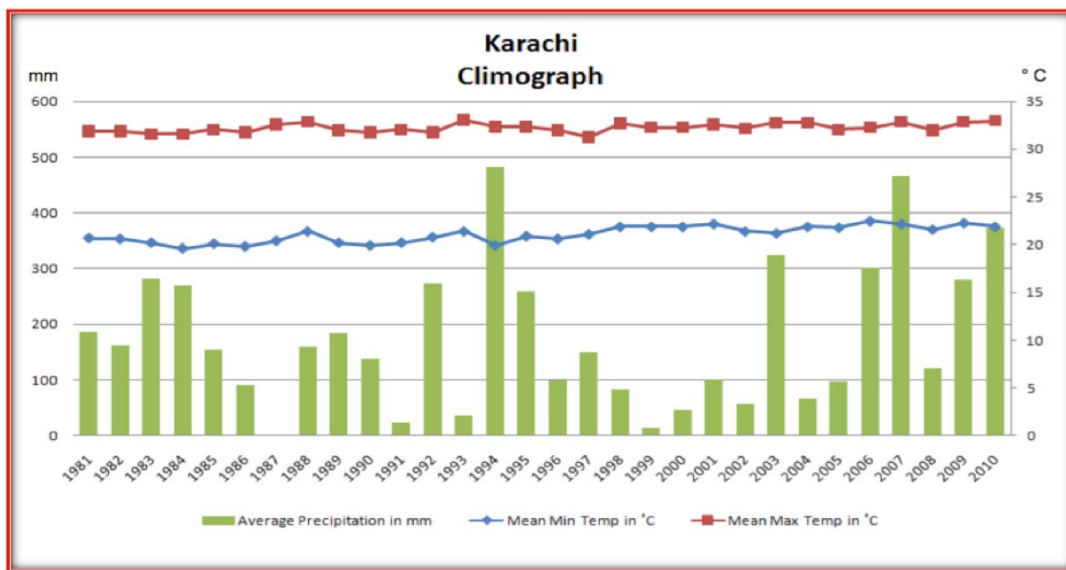
(time, amount and distribution) low rainfall is unreliable for *Barani* farming. Its arid climate makes it prone to drought physically but it is always aggravated by the unplanned anthropogenic activities as well. Regular monitoring and assessment is needed to minimize the loss. As drought is a process not an incident that is why, it can not only be predicted well before time but its devastating impacts on the environment, people and economy could also be reduced.

It is obvious from the trends of 30-years' annual average temperatures in Karachi, Figure 5a it has been inferred that there is a continuous fluctuation in weather parameters temperature shows the increasing as well as decreasing trends in different time periods. Temperature variations are mainly associated with the Global environmental factors, resulting climatic hazard such as the onset of desertification under the influence of water scarcity caused in Karachi.

Climate data Figure 5b shows huge variations in the annual rainfall of the study area, some years showing spells of dryness while some years show extraordinary high amount of rainfall. 30 years trend of rainfall is very fluctuating, which makes it unreliable for *barani* farm land of Karachi. The Data helps to analyze short and long term drought condition as 1987 was the driest year when no rain occurred at all, followed by two more drought years when only less than 20 mm of rainfall was reported in 1991 and 1999. The highest amount of



a



b

**Figure 5:** a. Trend of Temperature Variation in Karachi. b. Climograph for Karachi.

rainfall was observed in 1994, 2007 and 2010 respectively, when more than 450 mm rainfall caused havoc in the form of flash floods in Karachi. Temperature in Karachi remains moderate due to maritime influence. Mean Annual minimum temperature remains between 20-25°C while maximum ranges between 32-34 °C.

**MATERIAL AND METHODS**

A critical review approach is adopted in this study involving the collection and understanding of secondary data. For easy and quick interpretation and analysis at a glance tables, bar graphs and scatter diagrams were prepared for drawing final conclusions concerning changing trends of agricultural patterns. Most of the

sources used were government-published or released statistical reports, surveys, books, magazines, newspapers and periodicals (Figure 6) [9-13].

For the confirmation of changes in land use co lateral information is essentially required, in this context in-situ information were also collected. The main areas of interest are the agricultural lands of Karachi located along *Malir, Sukkan* and *Hab* rivers. These areas include *Deh Hudarwah, Thano, Malh, Langheji, Konkar* and *Thaddo*. Figure 8 depicts the evidences from the field visits, modes of irrigation etc. were taken to see the trend of cultivation. Furthermore, through a structured questionnaires the perception of the local farmer was also recorded to know the ground realities. The majority of farmers stated water shortage and

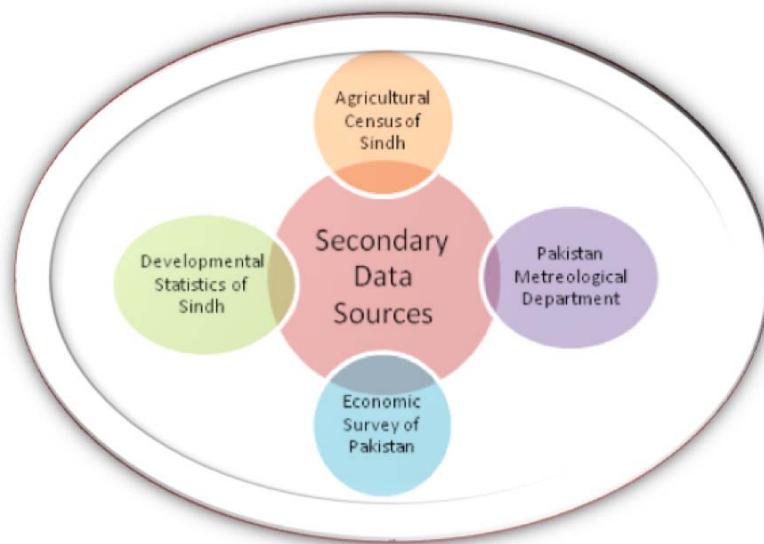


Figure 6: Secondary data sources used in the Analysis.

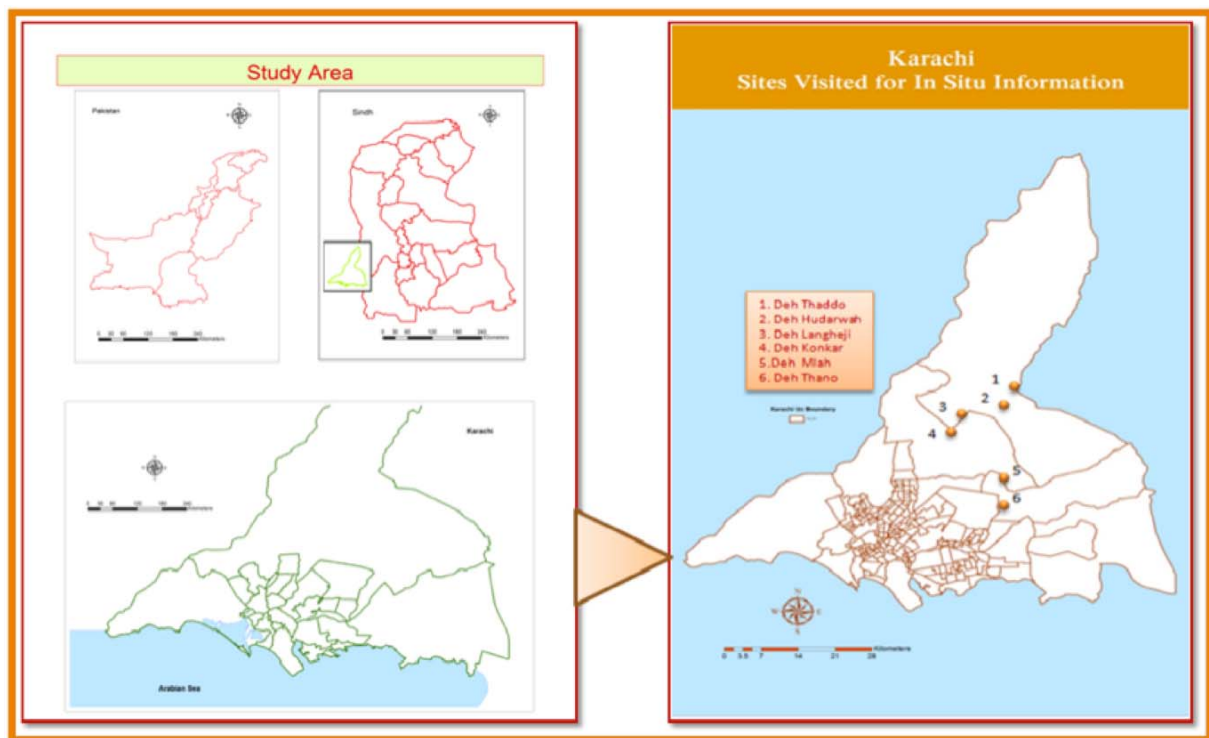


Figure 7: Study Area and Farming Sites, Source: Author.

lowering of the water table as the most common problem which has affected their farm productivity and profits to the great extent. As depicted in Figure 7, the sites (*Dehs*) surveyed are quite diversified in a small study area.

**RESULTS AND DISCUSSION**

Most of the farms are confined to the cultivable land along the Malir and Thaddo river basins in Union

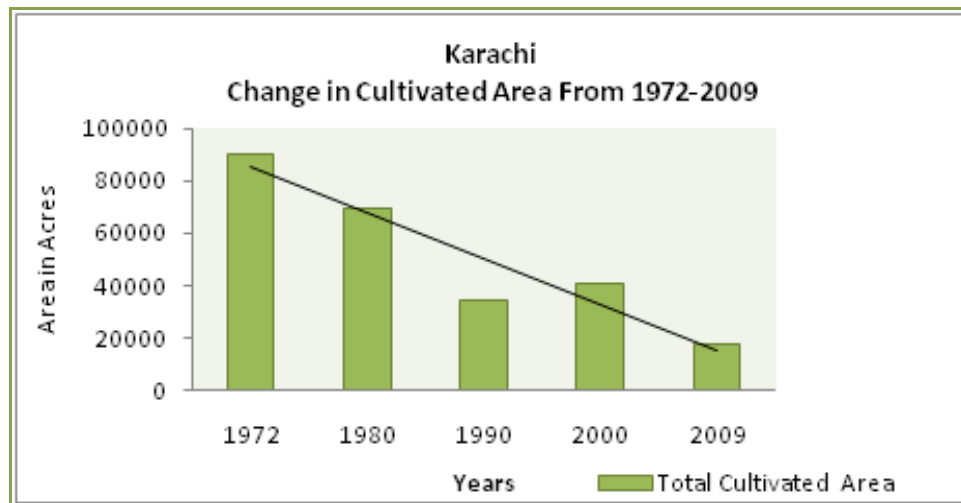
Council of Gadap Figure 7. Small patches of cultivated areas at the western border of Karachi are also emerged since 2007 meant these areas are new farmlands drained by Hab. Due to drought years of 1999-2005 Total cultivated area in Karachi has also decreased from 90,078 acres to 37,000 acres during 1972-2009, see Figure 9.

Degradation in agricultural areas in Karachi is alarming and variation in both total agricultural and





**Figure 8:** Farming Activities in Deh Huderwah, Gadap, Karachi, Source: Author.



**Figure 9:** Change in Cultivated Area in Karachi, Source: Agricultural Census reports.

cultivated areas is noticed. Though the population of Karachi has increased tremendously but cultivated land is not increasing to the desired level due to various problems such as desertification, water scarcity caused by low and unreliable rainfall, lowering of ground water table, sand and gravel excavation from river and stream's bed accelerate runoff which results in less water percolation and recharge of ground water aquifers.

Karachi was famous for its variety in fruits production in 70's. Malir basin was significant producer of fruits like (Guava, Mango, Mulberry, Papaya and bananas) and vegetables (Brinjal, Tomatoes, Spinach, Pumpkin, Okra etc). It has now shown an immense decline in these fruits and vegetable production due to scarcity of water thus gradually losing its prime

signature. The Statistics shown in Figure 11 as reported by Ministry of Food is supplementing this fact that there is noticeable decline in fruit production and their varieties from 1972-2000 [9]. It is seen that Apple, Grapes, Apricots, Peach and Pomegranates farms have not been increased rather vanished till 1990s and 2000s. It is also noticeable that there is now production of those fruits which require less water like dates, guava etc. Coconut was reported in 1972 only while Sapodilla (*cheeku*) was the new fruit grown since 2000 in Karachi Papaya farms have also been declined drastically till 1990 then little improved later. The Overall number of farms and fruits varieties have shown huge fall in production due to unreliability of rainfall in its time, amount and distribution and lowering of ground water table thus demand of local urban dwellers is met by import at high cost of transport.

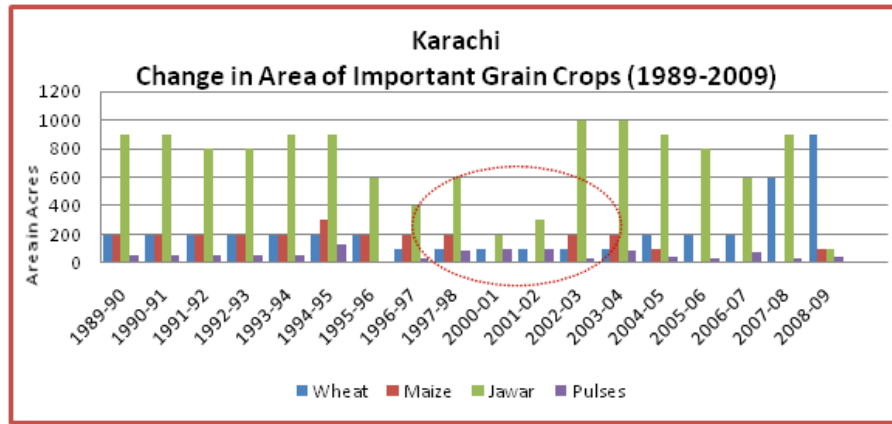


Figure 10: Change in Area of important Grain crops into Karachi, Source: Agricultural Census reports 1990-2010.

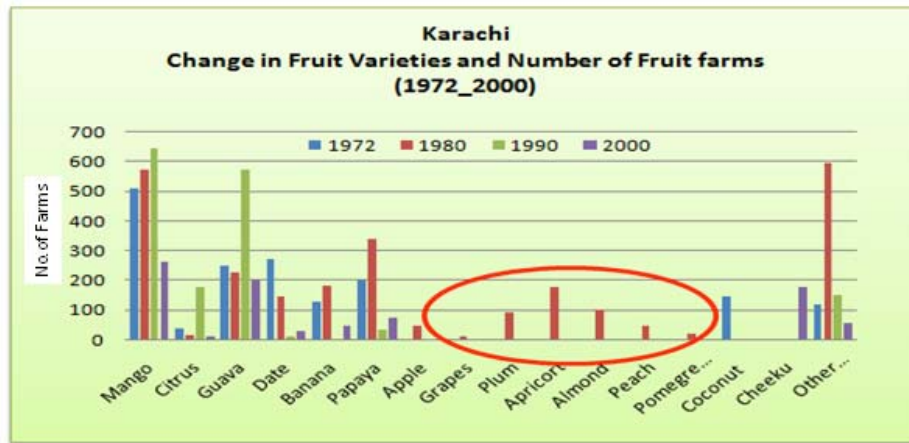


Figure 11: Change in Fruit varieties and number of fruit farms; Data Source: Ministry of Food, Islamabad, 2010.

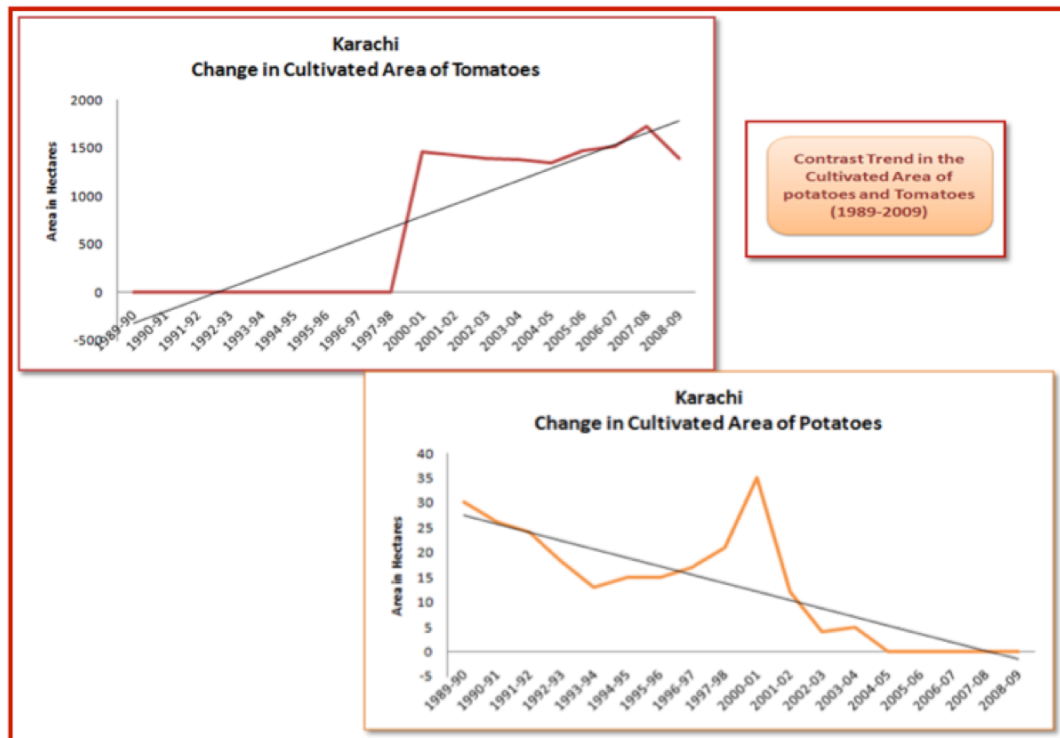
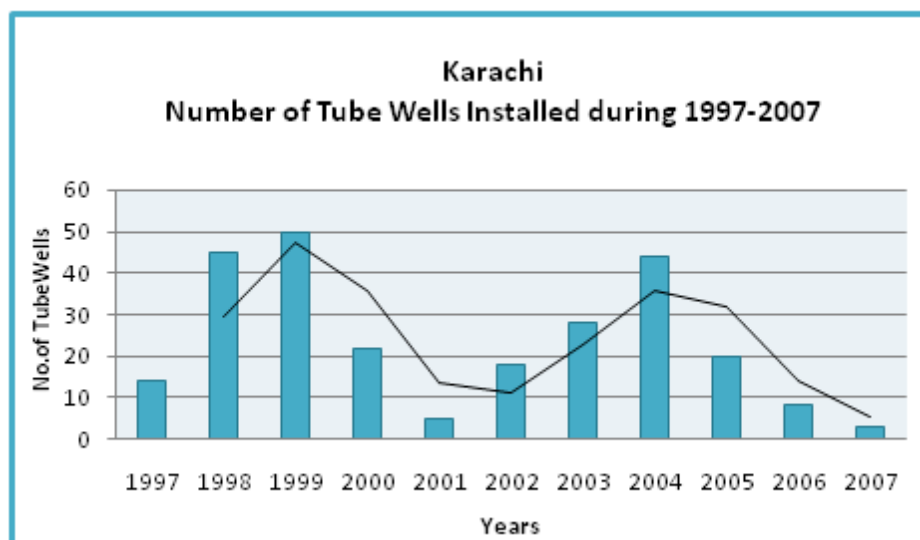


Figure 12: Change in Cultivated Area of Potatoes and Tomatoes; Data Source: Ministry of food Islamabad, 2010.



**Figure 13:** Tube wells Installed in Karachi during 1997-2007; Source: Development Statistics of Sindh.

Another interesting fact seen by closely observing the change in the area allocated for Potatoes and tomatoes cultivation during 1989-2009, Production of tomatoes begun in 1998 while from the same year there was a sharp decline seen in the farm area used for Potatoes, refer Figure 12 which is showing contrast in the trends of both as potatoes reach till zero and tomatoes which were not grown since 1989-1997 at all were occupying large number of hectare and plainly replaced Potatoes area till 2009. One important reason for this trend is the sensitivity of potatoes to moisture stress and sold at low rates thus less profitable. Moreover, Potatoes are produced in bulk in southern Punjab and are available at cheap cost so easily taken to Karachi. On the other hand tomatoes are grown all the year round and sold at a higher rate in the adjoining urban areas as compare to Potatoes. Farmers switched their preference in order to combat aridity and generate more profits.

Orchards and fodder share has shown a remarkable increase in the year 1990 mainly due to installation of tube wells by private owners in order to meet the growing demands. In Karachi, *barani* (rain dependent) farming is practiced with ground water as the most common source of irrigation. As rainfall is unreliable and insufficient thus there is a noticeable increase in the installation of tube wells in low rainfall years to continue farming activities. Figure 13 shows that more tube-wells were installed in the years 1998, 1999 and 2004, as obvious from climograph Figure 5a to compare the declining trend of rainfall in these years.

Depth of wells ranging 175-200 feet and gradual decline in the water table has compelled farmers to

bore wells in further depth to acquire water for their fields. This method is not only expensive putting economic burden on the farmer but at the same time depleting the ground water aquifer which is an example of environmental degradation of resources. In Figure 8, photographs showing modes of irrigation and some farming practices in the study area. Apart from tube well now Sprinklers are also commonly used in Gadap area as an efficient mode of irrigation because it uses less water and ensures better crop yield in arid regions.

On the other hand, perception surveys of the Farmers' confirming these drastic changes and pointed out the high poverty, un-employment, loss of agricultural land, shrinkage in the cattle size along with gigantic sand and gravel mining, which lead to this menace of desertification.

## CONCLUSION

It has been revealed from the study that the variability of rainfall has a strong and direct impact on the agricultural practices. Long spells of droughts in Barani land have compelled the farmers to change their plans. Following main findings have been discovered:

- In last 20 years noticeable Change in Crops varieties and Production was observed mainly due to variability of rainfall. Farmers prefer mainly Rabi Crops which require less water like wheat maize, *jawar* and pulses.
- This was identified that there was an inverse relationship between amount of rainfall and installation of Tube wells during 1997 and 2007.



- Contrast trend of production of Tomatoes and Potatoes in last 20 years was also observed.
- Varieties of fruits for example Apple, Plum, Apricot, Almond, Peach, Pomegranates etc showed tremendous decline since 1980s onwards resulted in the loss for orchards farming.
- Cultivated areas have also shrunk from 90,078 acres in 1972 to 37,887 acres in 2010 which is a clear sign of prevailing desertification and drought.

The results of the study serve one of the pragmatic example of time series analysis through different secondary data sources, which effectively demonstrated the spatial change in the historic and current status of Agricultural patterns and might be helpful to predict the events of drought.

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