

# Role of Earth Sciences in Urbanization of Dera Ghazi Khan City, Punjab, Pakistan

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**ABSTRACT:** *The role of the Earth Sciences in urbanization of big cities has become indispensable. The urbanization of Dera Ghazi Khan city has been executed through six maps of environmental Geology to conserve the environment of the area with application of earth sciences. The fast urbanization is due to rapid increase in population has caused severe stress on the environment which demands for more resources for water, mineral and aggregate material resulting in increase of dust, smoke, noise and health hazards in the area. The most striking problem of the area is acute shortage of drinking water in northern part and scientific devices are formulated to overcome this problem.*

*This paper has five maps which will show: i) Quaternary geology, ii) Landform, iii) Resources of construction material, iv) Land-use planning and v) Water resources and its management. The data from these maps can be arranged in better way in which its applications would be helpful to urban designers, planners and financial agencies for speedy development of other cities of the Punjab as well as mega cities of the country with minimizing the environmental degradation.*

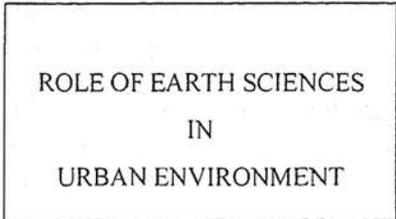
## INTRODUCTION

Cities have been built and have either proposed or declined and died because of the natural attributes of their locations. Only recently has there been much awareness of the role of earth sciences can play in defining the urban environment and in offering alternatives for its development and enjoyment. For example the depletion of mineral and water resources created many ghosts towns in the Pakistan i.e. Manjo-Daro and even some modern cities in the west

have disappeared because of catastrophes such as drought, duststorms, earthquakes and volcanic eruptions.

Modern technology can overcome some resources problems by transporting water, by transmitting energy and fuel, and moving minerals to factories but the direct and indirect costs to Nation's economy and environment are skyrocketing. Keeping in view of these facts the roll of the earth sciences in urbanization of big cities has become very vital.

NATURAL RESOURCES  
GEO-HAZARDS  
POLLUTION



GEOLOGY  
LANDFORM  
LAND-USE PLANNING

The Metropolitan area of Dera Ghazi Khan Quadrangle is a part of Lower Indus plain and partly lies southern part of the Sulaiman Range. The area covers Survey of Pakistan sheet No.39 J/12 and falls between longitudes  $70^{\circ} 30'$  to  $70^{\circ} 45'E$  and latitudes  $30^{\circ} 00'$  to  $30^{\circ} 15' N$  in the

district of Dera Ghazi Khan and its special area, Punjab Pakistan. The Dera Ghazi Khan city is very important city because of it connects Sindh and Balochistan provinces with Punjab by rail and road. Anyhow the area can be approachable by air, rail and road as shown in the Fig.1.

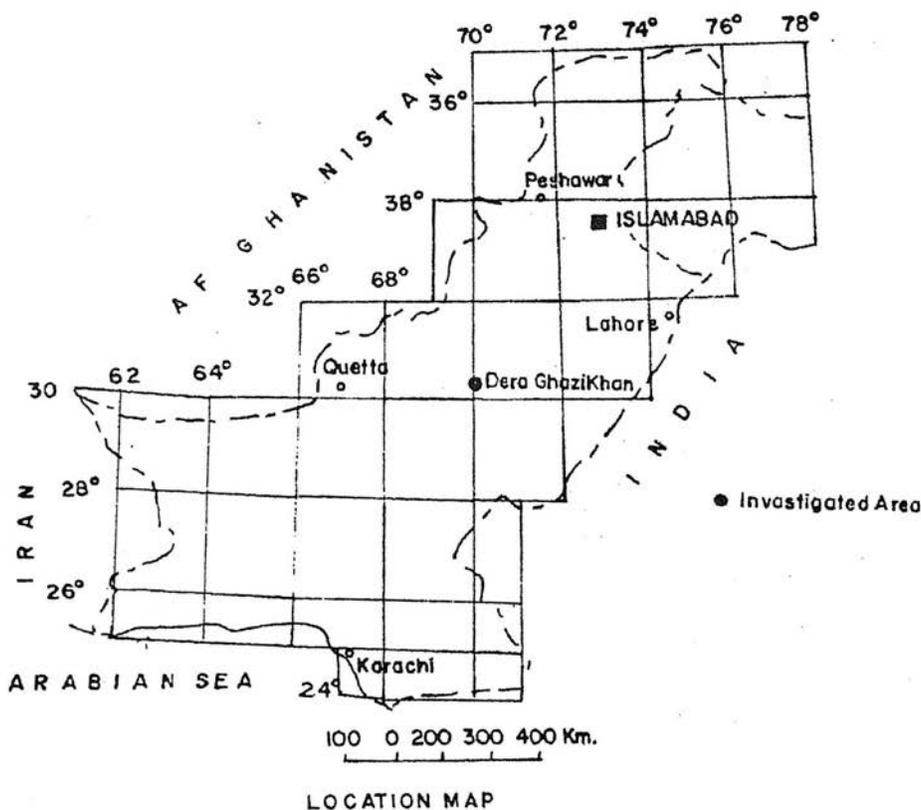


Fig. 1. Role of earth sciences in urbanization of Dera Ghazi Khan city Punjab, Pakistan.

The population record of Dera Ghazi Khan city formerly name "Ghazi Khan Mirrani" brings out definite periods of population growth given below:

Year	Population	Percentage
1951	630,694	
1961	776,620	2.1
1972	1,142,448	3.4
1981	1,582,584	3.9
1990	1,550,537	3.1(estimated)

The record of urban population showed a slow increase in population during 1972-1981 census period and annual growth rate was 3.9 percent. According to unofficial estimate of municipal corporation, the population of city has risen to about 0.5 million which indicates increase of 4% during the first eight years of the current census period.

After establishing new link with Mutan through by newly constructed bridge on Indus river at Ghazi Ghat. Now Dera Ghazi Khan city

has become a hub center for business and other government activities in the province. This development has given an incentive to rural area and then, migration of people from rural area started. The agriculture area is being converted into urban area and which has resulted great stress on environment. The city of Dera Ghazi Khan city is continuously expanding and reached to level that older flood plains are encroached by people too.

The area has swelling soil at places (in basin) otherwise it is good for construction purposes. The swelling soil has developed here due to presence of evaporites deposits in the Sulaiman Range.

### PREVIOUS WORK

- Mahmoodul Hasan and Sheikh Iqbal (1983) described the geology of eastern parts of the Sulaiman Range.
- Sheikh Iqbal and Afaq Khan (1990) carried out environmental geological studies of metropolitan area of the Dera Ghazi Khan Quadrangle.
- Sheikh Iqbal (1992) carried out environmental geological studies of Shadan Lund area District D.G.Khan and its special areas Punjab.
- Sheikh Iqbal and Saleem Bajawa (1995) described the Geology and Health Hazards of the Dera Ghazi Khan city Punjab.

### LANDFORM

The landform of Dera Ghazi Khan Quadrangle consists of combination of plains and hilly terrain. Major part of the area is occupied by plains of Lower Indus plains whereas the northern part is hilly terrain which includes the low hills of Chaudhwan formation of Pliocene age with terrace gravel deposits and alluvial fans deposits. The plain land comprises alluvial plain covered by dune sand at places.

The clay and gravel play an important role in the urban environment as they control firmness of the foundation of the buildings. In addition to this, gravel is also good for aquifers. The altitude of the area increases northward with local relief about 300 meters with minimum and maximum heights of 450 and 750 meters ASML\* respectively. (ASML for Average, Sea, Mean, & Level).

Drainage of area is controlled by Indus river and its tributaries, including Chobri Wah, Johli nala, Rod koli and Phullar streams which form a dendritic drainage pattern.

Geomorphically, the area has eleven divisions as shown in the Map No.1. which are briefly described in ascending order, i) **Stream channels**: The surface is flat, unstable and has no vegetation. ii) **River flood plains**: Comprises dominantly level plains and has small channel remnants. iii) **Basins and channel infills**: It is plain concave in shape and has poor drainage. iv) **Recent piedmont plains**: Consists of fissured surfaces due to torrential streams. v) **Gently sloping plains**: The surface is level and gently sloping surface and occur below the piedmont plains. vi) **Gently undulating plains**: Occur in the troughs of the sand dune. vii) **Basin**: It is level surface and usually concave. viii) **Terraces**: Plains are covered by gravels. ix) **Piedmont plains**: Fan shaped bodies of gravel-rich alluvium near the mountain front where streams emerge from steep gorges and deposits sediments. x) **Sand dune**: Occurs as a sheet of sand formed by action of wind. xi) **Gentle hills covered with cobbles and gravel**: Rolling hills with slopes are covered with thin soil of sand and rounded cobbles and gravel, derived from weathering of the overlying rocks.

### GEOLOGY

The stratigraphic sequence in the area is marked by sedimentary rocks of Siwalik Group and quaternary period. The rock of Siwalik Group were deposited in fluvial conditions, comprising Chaudhwan formation and exposed in the north western end. The remaining part is Quaternary

deposits having age of Pleistocene to Recent as shown in the Map No. 2.

### SIWALIK GROUP

#### Caudhwan formation

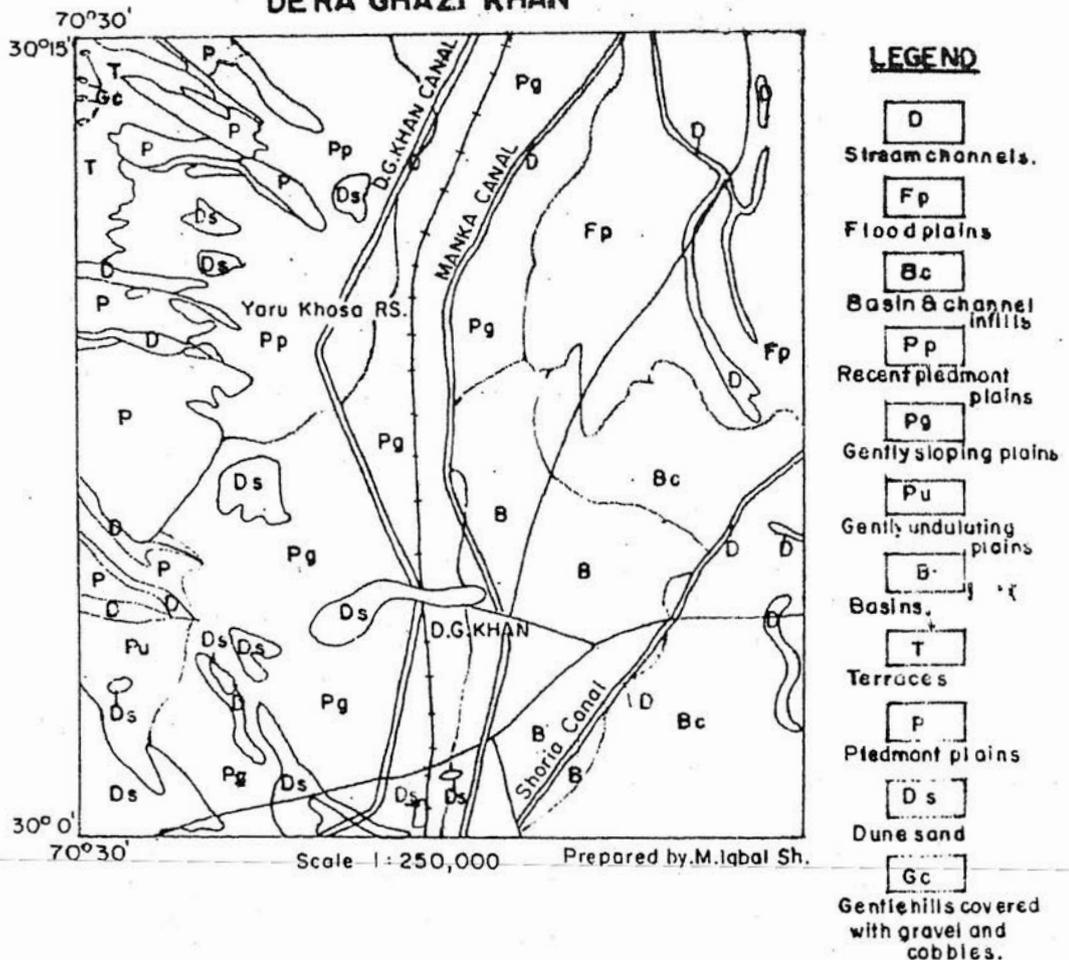
The oldest formation exposed in the area is the Chaudhan formation, the base of which is not exposed. The formation comprises conglomeratic sandstone, sandstone and claystone.

The conglomeratic beds are dominant in the formation which are hard and compact, developed in the upper part of the formation. The conglomeratic sandstone composed of medium to coarse grained sandstone, thin to

thick bedded and hard. It forms more resistant ridge in the area at places. Lenses of sandstone are also present within the conglomeratic body.

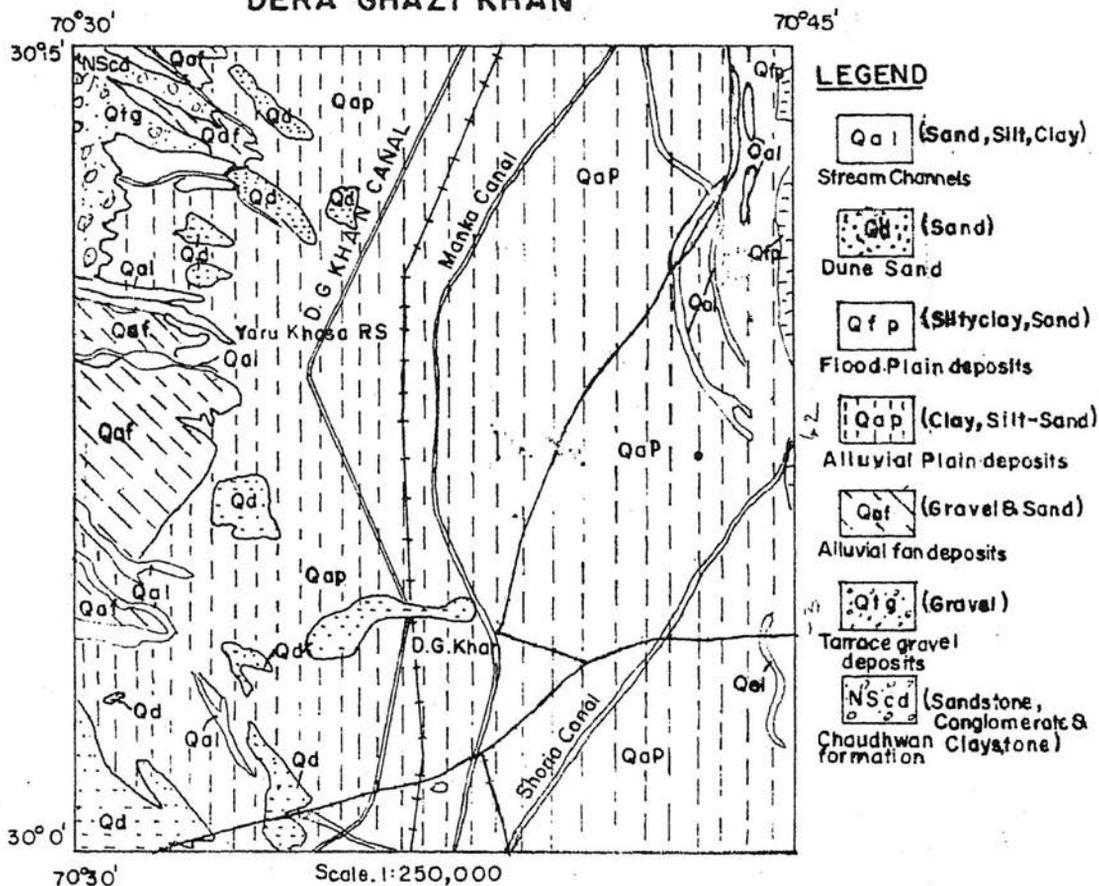
The sandstone is light to medium grey in color, medium to coarse grained, medium bedded and calcareous. The sandstone is mainly composed of subangular to angular grains of quartz, feldspar, epidote and tourmaline. Some beds of sandstone are hard and compact. The claystone beds are interbedded with sandstone and conglomeratic sandstone. The claystone is light brown to brownish red in color and friable on the weathered surfaces and calcareous. The upper contact with the terrace gravel deposits is unconformable.

### DERA GHAZI KHAN



Map 1. Landform map of Dera Ghazi Khan Area.

## DERA GHAZI KHAN



Map 2. Geological map of D.G. Khan.

### QUATERNARY DEPOSITS

The Quaternary deposits comprising six units including:

- i) **Terrace gravel deposits:** These include gravel beds in the form of raised terraces, lying at the junction of alluvial fans with rock exposures. The gravel are sub angular to sub rounded and comprise mainly of limestone, quartz and sandstone.
- ii) **Alluvial fan deposits:** Comprise poorly sorted, sub angular to rounded boulders, cobbles of limestone, sandstone and quartz in unconsolidated sandy and silty matrix. The alluvial fan deposits are developed in front of Sulaiman Range where they form fan shape morphology.
- iii) **Alluvial plain deposits:** Consist of dominantly clay, loamy clay, sand and minor gravel. The clay is earthy grey to light brownish grey and calcareous having kankers at pockets. The loamy clay beds are softer and badlands topography developed at eastern parts of Quadrangle. The estimated thickness of clay is 5-7m in the area. Major part of the unit has converted into farmland except other parts covered

with the eolian sand, where wheat, cotton, sugar cane, rice and seasonal vegetables are grown. The alluvial plain deposits are cut by the tributaries of major rivers of the area. The clay is silty, calcareous and plastic at places and is used for making bricks and pottery.

- iv) **Younger flood plain deposits:** Consist of light brownish clay, silt and sand and occur only in the north eastern parts of the area. The younger flood plains are confined only at the course of the Indus River and some parts are developed as agriculture land for seasonal vegetables. Sugar cane, rice and wheat are main crops of this unit.
- v) **Dune sand:** Occur in the form of low lying stabilized dunes of different sizes in the western and southern parts of area, The sand is composed of light brownish grey to light grey, medium to fine grained, having sub rounded to sub angular grains. The sand has grains of quartz, epidote, muscovite (very fine flanks ) and minor heavy minerals. It is covered by gravel of older rocks at places. Wind blown ripple marks present at the surface of dunes show a regular pattern of parabolic type dune. Wild growth of green shrubs and small trees are typical feature of this unit.
- vi) **Stream channel deposits:** Occur in stream and river beds and comprise unconsolidated sand, silt and clay with boulders, cobbles of limestone sandstone and quartzite.

#### CONSTRAINTS AND OPPORTUNITIES IN LAND-USE PLANNING BY EARTH SCIENTISTS

Man has lived and surmounted material hazards and finite resources problems without any planning. The total dependency of urbanization and technology is based on natural resources and its development, its potential and utility.

Land-use planning is an integral part of a broader planning, termed comprehensive, general or master planning of urban areas. The

land-use planning process consists of five distinct phases: i) identification of problems and definition of goals and objectives ii) data collection and interpretation, iii) plan formulation, iv) review and adoption of plans and v) eventually plan implementation. Future development can minimize natural hazards by avoiding high risk areas.

The existing pattern of Land-use in the Dera Ghazi Khan metropolitan area as shown in the Map No. 3.

#### **Cultivated land C**

The alluvial plains are usually cultivated land and comprises loamy clay and clay having fine texture with minor sand and stones. This unit covers almost 70% of the area and is irrigated through Dera Ghazi Khan and its branches. This land is easily converted to urban use. Primary crops are wheat, cotton, sugar cane, rice and seasonal vegetables.

#### **Grassy land G**

The grass land unit comprises of alluvial, gravel, sand, silt and loamy clay. The main purpose of plantation of grass and trees is to control the soil erosion some extent. This unit is not good for urban area because it is difficult to excavate and has little water.

#### **Stony Land and scrub forest S**

The stony land and scrub forest comprises the area covered by terrace gravel deposits, having stones with grass and scattered forest. This area can be developed for parks.

#### **Rocky land R**

The rocky land is composed of Chudhwan formation and is covered with grass and bushes. It cannot be converted into urban use, being difficult to excavate and lack of water.

#### **Barren land B**

The barren land comprises the area covered by dune sand. This area is covered by bushes, little grass and scattered small trees. This land can be used for grazing and is converted into farmland and urban use.

### Drainage ways D

The drainage ways comprise streams and D.G.Khan and Shobra canals. The main function of these streams and canals is to carry out excess water and outwash from the mountains to the lowlands and finally into river.

### Saline and Waterlogged land S

Areas are dominated by excess of water due to seepage from canals and rapid evaporation. This land is not suitable for agriculture use and can be reused for urban as well as industrial uses.

### Transportation T

This unit includes all links through which city is

connected with all parts of city as well as country.

### Urban Area U

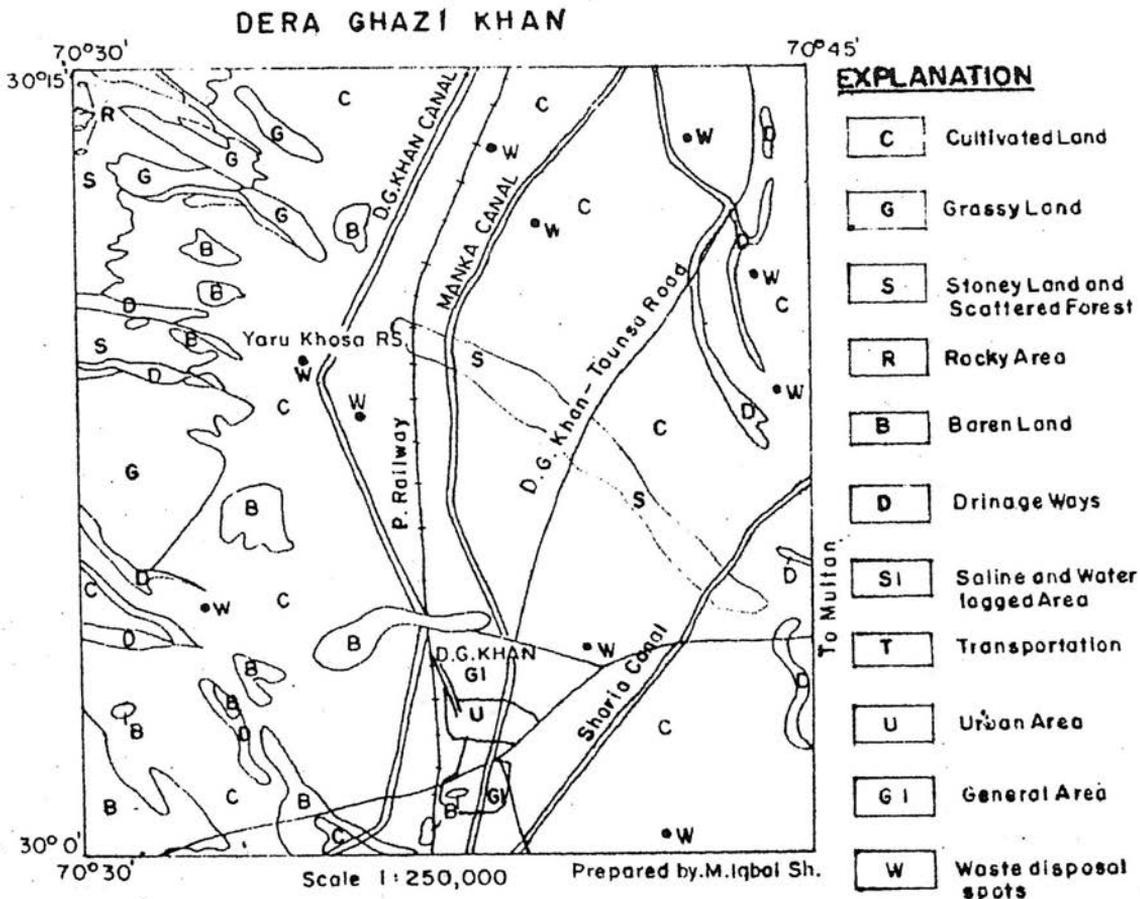
The area comprises Govt residential and new constructed colonies of metropolitan area of Dera Ghazi Khan city.

### General Urban area GI

It includes the down town and the new localities in its surrounding area. It is thickly populated and polluted due to less civil amenities.

### Waste Disposal areas W

These are spots where domestic and industrial waste is being dumped daily.



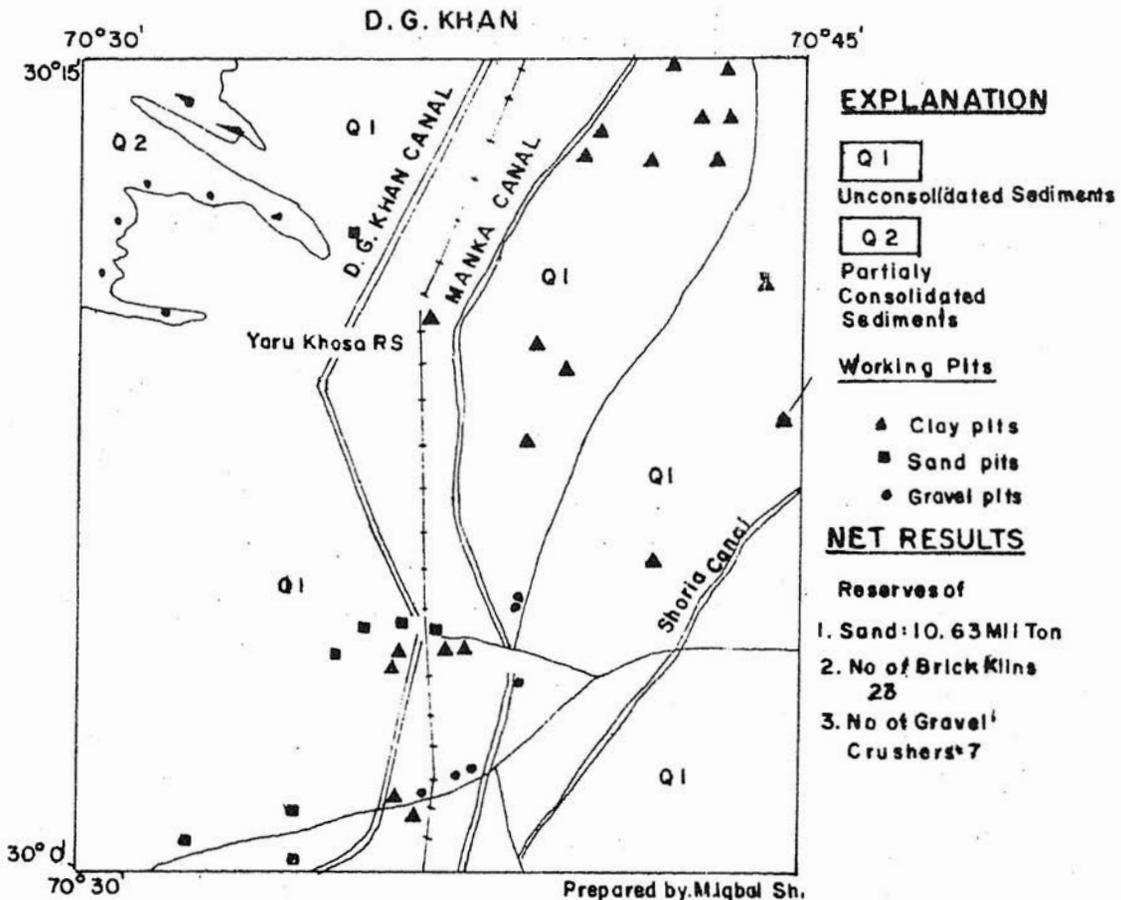
Map 3. Landuse planning map of Dera Ghazi Khan.

## NATURAL RESOURCES

Natural Resources are the basis for urbanization. Without construction materials cities could not be built, without mineral, industries could not developed, without fuel factories would close and houses would be cold. Finally without a potable water supply, society could not function. It is important that they be identified and developed for urban areas.

### I. Construction Materials Resources

Construction material resources are essential to urban growth. By grace of Allah, Dera Ghazi Khan city has reasonable reserves of clay, sand and gravel, gravel is for aggregate, sand for mortar and clay for bricks, tiles and pottery. The area is divisible into two parts on the basis of deposition i.e. the Q1 is alluvial clay and sand and Q2 is for alluvial gravel with sand and silt as shown in the Map No.4.



Map 4. Construction material resources map of D.G. Khan.

### Aggregate

The aggregate material is obtained from alluvial gravel, gravel terraces and stream channels. The gravel is being used as crushed stone and aggregate for construction and road buildings.

There are 7 crushers, working in the area along Saki Sarwar and D.G.Khan and Taunsa G.T.Roads.

## **Sand**

Sand is being mined from Vidor, Saki Sarwar Road and Kucha Wandani localities by locals and DMD Department. The leases are run by DMD. Sand is medium to fine grained and suitable for construction purposes in the city. The estimated reserves of sand is 10.63 million tons in the area.

## **Clay**

Alluvial clay is dominantly used for brick industry. The clay is well exposed in the area and comprises silty clay with calcareous characteristics. Brick kilns are widely scattered along Taunsa, Saki Sarwar and Muzhfarghar roads. All production is carried out by manually and on mechanical system is utilized. Almost 23 brick kilns are working in the area where clay is fine plastic and calcareous.

## **Fossils Fuels**

The area has no sources of oil and gas but alternative energy resources for the people requirements are to be maintained.

## **Water Resources and its managements**

The increase of population want more food production which requires preservation of good agricultural land and water supplies. Urban area of Dera Ghazi Khan city compete for existing water supplies from streams including Dera Ghazi Khan Canal, ii) Shora Canal and Manka canal, few small reservoirs and older flood plain of Indus River.

The Metropolitan area is divisible into two parts i.e. the western part has scare water resources whereas eastern part has plenty of water for domestic as well as industrial use. The water in the western portion of D.G.Khan basin marked by Peidmont plains where Torrents coming from the Sulaiman Range and are source of groundwater.

Details of tube wells, open wells and hand pumps in the area is as under:

Total Tube wells = 52, Rural area tube wells = 21 & hand pumps = more than hunders.

During investigations, 43 samples of water were conducted for its ppm value regarding to World Health Organization. On the basis of distribution of Total Dissolved Salts in the water of the project area can be divided into three main zones as shown in the Map No.5.

1. Excellent Water 0-500 mg/l.
2. Fresh Water 500-1500 mg/l.
3. Saline Water More than 1500 mg/l.

## **Geo-Hazards**

Natural hazards are taking an increasing toll of life and property. Following are hazards of the area:

- Urban Flooding
- Debris Flow
- Seismic Risk

## **Urban Flooding**

Dera Ghazi Khan city is located on basin and flood plain of Indus river where no proper drainage is developed. During rainy season in monsoon, roads and lanes have come under water for days due to no drainage of rainy water. Developing the natural drainage along roads can mitigate the local load of flood in rainy season.

## **Debris Flow**

The rural area of D.G.Khan Quadrangle also suffer heavy losses due to sand and debris accumulation in the monsoon season. Sometimes Saki Sarwar Road is blocked due to sand and water accumulation.

## **Seismic Risk**

The metropolitan area of Dera Ghazi Khan area does not fall in tectonic active zone of Sulaiman Range whereas it is a part of Lower Indus plain. (Kamzi 1982).

## **POLLUTION**

Pollution is due to dumps of garbage, waste, effluents in the industrial water and smoke from vehicles, factories and brick kilns in the atmosphere. These agencies are constantly breathing out fumes, gases and black smoke which are injurious to human life.



## Remedies

1. Install treated plants for municipal and industrial waste water.
2. Carbon absorbers or filters may be fitted in the vehicles.
3. Smoke absorbers may be fitted on the tops of brick kilns.
4. Install dust collectors for cotton, textile and wood factories.

## Water Contamination

The municipal corporation of Dera Ghazi Khan city drain all its sewage in the Manka Canal without treating which is not operated by the Irrigation department now-a-days. This sewer water is polluting subsurface water by filtering.

## Effects

Many diseases like gastro-enteritis, typhoid and dysentery may be dangerous to health.

## Noise

Dera Ghazi Khan city has more noise except urban and its surrounding areas. Dera Ghazi Khan city has noise level is 70-80 dBA. (Sound is measured in terms of sound waves on ear drum and scale is logarithmic. This unit is the (dB) decible.)

## Remedies

Install sound absorbers at suitable spots.  
Planting neem trees along roads.

## Status of Earth Sciences in the Urban Environment

Geologists, hydrologists, and topographers, through nationwide mapping programs that have identified mineral, water, and energy resources, that are provided the basis for current urban and technological development.

Today, earth scientists are becoming more active in relating their work directly to urban problems. More scientists, at all levels of government and in the private sector, are working in urban areas, making their studies more easily understandable to nonscientists, and participating in the public. Consequently, many

people now have realized the role that the earth sciences can play in governing the quality of life in the urban environment.

Geologists are now similarly employed in LDA, WASA, Lahore, and the many urban areas of the province that have adopted controls to limit the further withdrawal and degradation of ground water resources.

Private industry, which had employed geologists, hydrologists, and geotechnical engineers largely to correct costly foundation failures, now is employing an increasing number of private consultants in advance of site selection and development. Earth scientists can contribute not only of the siting and do construction of major urban related structures such as dams, powerplants, highways, and office and apartment buildings, but also take part to the planning and designing of new communities.

## The Future

As people continue to concentrate in cities, earth science becomes increasingly important in maintaining an acceptable environment. Urbanization, already so dependent on limited mineral, water energy, and agricultural resources, will stagnate and wither unless critical resources are conserved, new resources are found, and wither unless critical resources are conserved, new resources are found, and the effects of potential catastrophic natural disasters are minimized. The future also affords many new opportunities to correct past mistakes and avoid new ones.

As the use of earth science grows, so it will increase the ability of the earth sciences to devise means of collecting and applying knowledge. Computer assisted mapping and display techniques are evolving that combine a variety of earth science. New geophysical techniques, remote sensing tools, and the data collection and relay capacities of satellites can greatly reduce the cost of data collection and speed with which data can be both interpreted and synthesized.

Earth science information is useless, however, without effective communication and application, Earth, natural, and social scientists must work diligently to communicate with one another, with decision makers, and with the public for development of the area with less degradation of environments.

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### CONCLUSIONS

1. The Data from these maps would be helpful to urban planners, financial agencies for speedy development of Dera Ghazi Khan city with minimizing the environmental degradation.
2. Earth sciences information is useless unless its application is not properly communicated to the natural social scientist and decision makers.

### REFERENCES

Bennett, G. Gordon, 1978. Ground water, U.S. Geological Survey Year book, 2-10.  
Bajwa, M. S. & Akhtar, M., 1984. Geology of Dalana Area, D.G. District, Punjab Pakistan

I. R. No. 239.  
Donald R. Nichols, 1975. Earth Sciences and Urban Environment. U.S. Department of the Interior Geological Survey.  
John, E. C., 1981. Surficial Geology Building with the earth. Jhon Wiley Sons Inc. Newyork U.S.A., 145-176.  
Kamal, M. T., 1971. Geohydrology of the Dera Ghazi Khan District, West Pakistan, WASA, Bulletin No. 18. 37-46.  
Kazmi, A. H. & Rana, R.A., 1982. Tectonic Map of Pakistan.  
Sheikh M. I. & Khan M. A., 1992. Environmental Geology of Tounsa Area, Punjab Pakistan, Journal of Geology, 72. 80.  
Sheikh M. Iqbal, Muhammad A. Khan, Sarfraz Ahmed & Shafiq Ahmad, 1994. Urban geology of the Dera Ghazi Khan Area, Southern Punjab Pakistan, Geol. Bull. Univ. Punjab. 29, 35-41.  
Sheikh M.I. & Mahmoodul Hassan, 1994. Environmental Geology of Shadan Lund area, District D.G. Khan, Punjab Journal of Geology.  
Sheikh, M., Iqbal, Bajwa, M. Saleem, Reza, S. Q., Mahmoodul Hasan, Kaleem Akhtar Q, Shafiq Ahmed & Sarfraz Ahmed, 1995. Geology and Health Hazards of Dera Ghazi Khan Area Punjab Pakistan. Pakistan Journal of Mineral Sciences, Univ. Punjab.  
Syal, M. N. & Khan, S. H., 1984. Reconnaissance Soil Survey of Pakistan, Lahore, Report No.133.  
Valdiya, K. S., 1984. Environmental Geology. Tata Mcgraw Hill publishing Company Limited New Dehli, 91-117.