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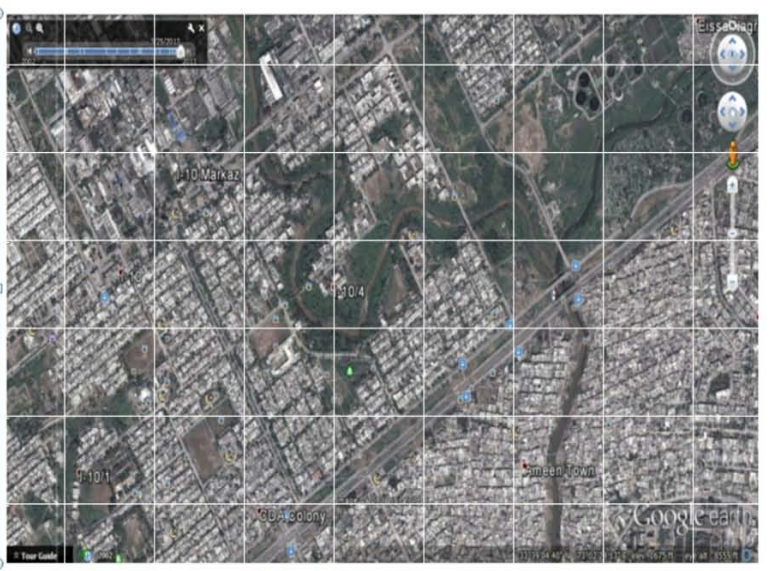
Climate Change Vulnerability Assessment of Islamabad



SUPARCO

Capital Administration and Development Division

Islamabad Capital Territory

Islamabad, Islamic Republic of Pakistan – Climate Change Vulnerability Assessment

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FOREWORD

Climate change is severely impacting many countries around the world and Pakistan is no exception to such changes and their impacts. Indeed, Pakistan with its largely arid geographical profile and resource scarcity is particularly vulnerable. In the last 75 year period (1929-2005) the return period of disasters has declined from 56 years from 1929 to 1982 to 5 years from 2001 to 2005. The country is susceptible to wide-ranging hazards from landslides to floods & droughts and cyclones. The Global Climate Change Vulnerability Index (CCVI) compiled by Maplecroft ranked Pakistan at 29th most vulnerable in 2009-2010 and at 16th in 2010-11.

The Federal Cabinet, headed by the Prime Minister of Pakistan, instructed the Climate Change Division (CCD) that an assessment of vulnerability to climate change factors should be undertaken. The decision required a pilot assessment for Islamabad to be conducted first, to then be replicated in other cities. With the support of UN-Habitat, the CCD set up a system to first assess the extent of vulnerability and then determine how new improved planning would support climate resilient development in Islamabad. UN-Habitat has vast experience through the Cities and Climate Change Initiative, which works in over 30 cities in 15 countries in Asia and the Pacific. The Initiative is developing, adapting and making available the methodologies necessary to equip city managers and practitioners with the knowledge they need to cope with climate change.

The CCD has established a Steering Committee that maintains oversight of this initiative, while a 6-member technical working group (TWG), consisting of officials from the Capital Development Authority (CDA), Islamabad Capital Territory (ICT) and Capital Administration Development Division (CADD) and three other knowledge-based agencies of SUPARCO, GCISC and PMD offers advice and guidance. We are grateful to the members of the Steering Committee and the TWG for providing excellent general and technical oversight to the development of the VA. We have separately acknowledged excellent work of the Steering Committee, the TWG and colleagues working on this initiative from CCD.

The Climate Change Vulnerability Assessment (CCVA) Study is in your hands. The next steps of mainstreaming the identified project as a result of the assessment are now being undertaken. We are grateful to the heads of CDA, ICT and CADD for supporting this initiative and which will help in climate-smart planning and in making the city climate resilient. We hope that the study would be equally useful for city managers, planners, academics and members of civil society in understanding the causes of climate change and its implications for coming generations in Islamabad with implications for other cities in Pakistan as well. We also hope that the city managers of CDA, ICT and CADDD would work with the continued zeal and dedication to address the issues of climate change in their planning and implementation.

Rukshana Saleem
Secretary to the Government of Pakistan
Climate Change Division
Islamabad

INTRODUCTION

The Government of Pakistan (GoP), through the Climate Change Division (CCD) has taken an excellent initiative to assess the extent of climate change vulnerability in Islamabad and Islamabad Capital Territory (ICT). The city authorities of Islamabad CDA, ICT and CADD have admirably supported the implementation of this new initiative. The analyses in this study are largely based on secondary data and information.

The work of SUPARCO, GCISC and PMD was paramount to the eventual success of this study and the support of these organisations through their focal persons is indeed commendable. The vulnerability assessment tools that were tested in Sorsogon in the Philippines but the same tools have been used in the context of Islamabad in producing this study. This coordinated effort of all the six participating Pakistani institutions and its combined outcome is a significant achievement for Pakistan.

The main findings of the assessment reveal a startling new picture of marked changes in the intensity, frequency and variability of temperature, precipitation and floods etc. The study makes a well thought 14 planning interventions to make Islamabad a climate resilient city. The study also makes recommendations of utilising the present institutional arrangements for a well coordinated effective implementation of suggested plans in Islamabad. We certainly hope that this analysis would provide sound basis for city authorities of CDA, ICT and CADD in conducting climate-smart planning and in creating a model of climate resilient Islamabad.

UN-Habitat sincerely appreciates the leadership support provided by the CCD, especially Mr Raja Hasan Abbas, Secretary, CCD in initiating the Climate Change Vulnerability Assessment (CCVA) in Islamabad and ICT. This study without recognising the effort of Mr. Jawed Ali Khan, CCCI Specialist, who spearheaded the effort from UN-Habitat Pakistan, is really appreciated.

It gives us great pride together with CCD to present this study to city planners and decisions makers. We also hope that this study would really help city authorities in Islamabad in setting an example of climate smart planning and creating a model of climate resilient Islamabad city. We further hope that city managers and planners from other climate vulnerable cities in Pakistan would find this a replicable model of assessment and adaptive planning.

Bella Evidente
Country Programme Manager a.i.
UN-Habitat Pakistan

Glossary

Exposure

Exposure relates to the degree of climate stress upon a particular unit of analysis. It may be represented as either long-term change in climate conditions, or by changes in climate variability, including the magnitude and frequency of extreme events. It considers both current and projected changes based on review of historic and current climate information (precipitation, temperature, extreme weather events) and projected climate scenarios. It also identifies primary impacts (increased precipitation, temperature, frequency and intensity of storms) and secondary impacts (flooding, ground water depletion, landslides and slope failures) including their current and future magnitude and frequency.

Sensitivity

The degree to which exposed people, places, institutions and sectors are impacted by climate change today and the degree to which they could be impacted in the future. As with exposure, impacts could be primary (change in city water supply due to climate change related decreases in precipitation) or secondary (slope failure and landslides due to more intense and longer precipitation events). Sensitivity refers to the degree to which a system is affected, either adversely or beneficially, by climate-related stimuli.

Adaptive Capacity

The degree to which, people, places, institutions and sectors are able to adapt and become more resilient to climate change impacts. It also identifies the extent to which the responsible institutions are capable of handling the emergency situation and the time do they take to respond to the disaster situation. As defined by the IPCC, adaptive capacity describes the ability of a system to adjust to actual or expected climate stresses, or to cope with the consequences.

Vulnerability

Refers to the degree to which people, places, institutions and sectors are susceptible to and unable to cope with, climate change impacts and hazards. vulnerability is generally understood as a function of a range of biophysical and socio-economic factors, commonly aggregated into three components that include an estimate of the above elements namely (adaptive) capacity, sensitivity, and exposure to climate variability and change.

Heat Waves

World Meteorological Organization defines Heat Wave as the temperature of more than five consecutive days when it exceeds the average maximum temperature by 5°C (9°F), the normal period being 1961–1990.

Smog

Smog is a phenomenon of deposition of suspended particulate matters in the air, intensified by smoke or other atmospheric pollutants. The pollutants are usually emitted from brick kilns, factories, transport, and power plants. Smog is produced through a complex set of photochemical reactions involving volatile organic compounds (VOCs) and Nitrogen oxides that result in production of ozone.

Urban heat island

An urban heat island is a phenomenon created in the metropolitan area which becomes significantly warmer than its surrounding rural areas due to human activities and climatic factors. As urban areas develop, changes occur in their landscape. Buildings, roads, and other infrastructure replace open land and vegetation. Surfaces that were once permeable and moist become impermeable and dry. These changes cause urban regions to become warmer than their rural surroundings, forming an "island" of higher temperatures in the landscape.

EXECUTIVE SUMMARY

The study on "Climate Change Vulnerability Assessment of Islamabad", reveals that the city of Islamabad and its surrounding Capital territory is exposed to a host of factors accelerating climate change impacts such as marked changes in the intensity, frequency and variability of temperature, precipitation, floods, draughts, cyclones etc. The extreme weather events recorded so far in Islamabad include a highest maximum temperature of 46.6° C on 24th June 2005 and lowest at – 4.3° C on 25th December 1984. In 2001 the heaviest day of rainfall was recorded with 621mm falling in just 10 hours.

As per the analysis of the past climate change trends carried out from the base year of 1961 and future projected changes for scenarios up to 2100 for temperature, wind profile and precipitation for Islamabad as well as the surrounding Capital Territory; the temperature in both the areas has become substantially warmer. Warming in the Central Islamabad area has been much higher than the surrounding Capital Territory. The mean annual temperature change in Capital Territory area from 1960 to 2010 was by 1ºC where as in the central area the temperature rise in the same period has been 3.5ºC. This temperature rise is double the global average.

Precipitation in the central and the Capital Territory area during the overall study period, from 1961-2010, has increased slightly. However, there was a marked rise in precipitation between 1961 and 1990, followed by a tailing off between 1990 and 2010. The total amount of rainfall is still higher than the surrounding Capital Territory area. The more alarming phenomenon revealed that the precipitation during the recent 20 years period after 1990 has further dropped. This trend is attributed to the tremendous increase invariability, leading to higher frequency of both droughts and floods, which is also re-enforced by the corresponding temperature increase during the same period. Projected temperatures also show increasing trends again with higher variability. This future scenario is also projected to encounter increased frequency and intensity of hydro-meteorological hazards.

Climate change impacts have been aggravated due to human induced actions which are the root cause of climate change and global warming. Islamabad presents an ideal case in this regard for triggering and intensifying climate change impacts due to a significant violation of the original Master Plan prepared by the Greek planning firm Doxiadis in 1960, which provided provisions to preserve and enhance the ecological conditions of Islamabad, particularly in zones III, IV and V but, through several revisions in the Master Plan, relaxation in the land use and zoning were allowed, building heights and floor area ratio regulations were also relaxed and the impact of these modifications is clearly evident from unprecedented urban sprawl caused from conversion of agricultural, barren, natural vegetation, rocky and rural settlement areas into urban land use. Such areas, measuring 61.01 square kilometres and 76.22 square kilometres and 53.98 square kilometres were converted into urban land in the year from 2000 to 2005, 2005 to 2010 and 2010 to 2013, respectively. This land conversion resulted not only in substantial encroachment on watersheds and aquifers but has also led to destabilization of the ecological balance and sustainability of the fragile eco-system. Further, due to urban sprawl, stress on basic urban infrastructure services such as water supply has gone down from 50ft to 300ft. On the other hand due to lack of proper planning and development of effective rain water drainage systems, urban flooding once occurs roughly once every three years as a result of the over flow of the Nullah Lai, that causes loss to human lives and significant damage properties downstream in Islamabad and Rawalpindi.

Moreover, the built-up area of Islamabad has become an Urban Heat Islands because of an increase in local atmospheric and surface temperatures compared to the surrounding rural areas. This has been caused by an increase in "residential bulk" from 60 per cent with Floor Area Ratio (FAR):1:0.5- to 170% with FAR 1:1.7. The other phenomenon contributing to climate change effects found were higher influx

of trace elements, excessive amounts of particulate matter and volatile organic compounds (VOC's), atmospheric aerosols, Ozone depleting substances in the atmosphere, emitted from industries, brick kilns, stone crushing and quarrying and automobiles. far exceeding the permissible limits prescribed under the National Environmental Quality Standards (NEQS) in the urban area.

The emissions from industries, brick kilns and automobiles are the main sources of smog. In 1998, the number of registered vehicles in Islamabad was 60,000, however, this grew more than 100 per cent 650,000 in 2013. It is estimated that about 45,000 vehicles are being registered annually in Islamabad. Carbon Dioxide (CO2) emissions from consumption of diesel/gasoline and compressed natural gas in the transport sector, has been estimated at 3 million tons per year. It was estimated that the emission of greenhouse gases from brick kilns, other industries, transport and land use change in Islamabad and Rawalpindi districts were about one billion tons per annum.

Health related climate change impacts in Islamabad and the Islamabad Capital Territory region are evident from increasing number of respiratory, skin and eye related diseases due to air pollution, high contents of PM-10, aerosols as well as water borne diseases such as acute diarrhoea, malaria and dengue fever. These are life-threatening diseases and highly climate-sensitive areas with weak health infrastructure, particularly in rural periphery of the Islamabad Capital Territory region and have the lowest adaptive capacity to cope with and respond to the climate related health impacts.

Since climate change impacts are a recent phenomenon and projections suggest that they are likely to become more severe in Islamabad and its surrounding area it is proposed that the Government may consider undertaking urgent review of the Master Plan, building by-Laws and town planning regulations to incorporate climate change concerns and adopt climate smart planning process. Further, the institutions responsible for planning, development and city management (Capital Development Authority, Islamabad Capital Territory and CADD), do not presently have sufficient capacity to address climate change challenges. It is necessary that these institutions establish a dedicated Climate Change Unit to adequately address emerging climate change challenges, adequately equip the concerned institutions with proper training and capacity building programmes.

Further, programs and projects focused on reduction of greenhouse gas emissions and increasing efficient use of energy, such as introduction of a Mass Transit System, Effective Waste Management, Bio-engineering for Recycle and Re-use of Grey Water for Enhancing Climate Change Resilience, Adaptation Project for Minimizing Effects of Urban Flash Flooding and Increasing Ground Water Recharge, Study of Carbon sequestration in Margalla Hills National Park, Recycling of Inorganic Solid Waste and Generation of Energy from Organic Solid Waste, Energy Conservation of Buildings may be initiated to reduce the impact of the climate change.

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Acronyms

BOD	Biological Oxygen Demand
CADD	Capital Administration and Development Division
CCCI	Cities and Climate Change Initiatives
CCD	Climate Change Division
CCI	Climate Change Institute
CCVA	Climate Change Vulnerability Assessment
CCVI	Global Climate Change Vulnerability Index
Cd	Cadmium
CDA	Capital Development Authority
CDMA	Capital Disaster Management Authority
CNG	Compressed Natural Gas
Co	Cobalt
CO_2	Carbon dioxide
COD	Chemical Oxygen Demand
Cr	Chromium
DCR	District Census Report
ECHAM	a Global Climate Model developed by the Max Planck Institute for Meteorology
ECMWF	European Centre for Medium Weather Forecasting
EEI	Ecological Evaluation Indices
FAO	Food and Agriculture Organization
FAR	Floor Area Ratio
Fe	Iron
GCISC	Global Change Impact Studies Centre
GCM	Global Climate Model
GDP	Gross Domestic Product
GTZ	Gesellschaft für Technische Zusammenarbeit, Germany Technical Cooperation
HCl	Hydrochloric Acid
HNO_3	Nitric Acid
ICT	Islamabad Capital Territory
ICTA	Islamabad Capital Territory Administration
IPCC	Intergovernmental Panel on Climate Change
IUCN	International Union for Conservation for Natural Resources
km	Kilo meter
LEAD-Pak	Leadership in Environment and Development -Pakistan
m	Meter
mg/l	Milligram per Litre
M&E	Monitoring and Evaluation
Mn	Manganese
NARC	National Agricultural Research Centre
NCEP	National Centres for Environmental Prediction
NDMA	National Disaster Management Authority
NEQS	National Environmental Quality Standards
NIRM	National Institute of Rehabilitative Medicine, Islamabad
NGO	Non-Governmental Organization
Ng/m^3	Nano gram per cubic meter
Ni	Nickel

NO_2	Nitrous Oxide
OXFAM	Oxford Committee for Famine Relief
Pak-EPA	Pakistan Environmental Protection Agency
Pak sat	Pakistan Satellite
Pb	Lead
PCRWR	Pakistan Council for Research in Water Resources
pH	Power of Hydrogen
PIMS	Pakistan Institute of Medical Sciences
PMD	Pakistan Meteorological Department
PM	Particulate Matter
PRECIS	Providing Regional Climates for Impacts Studies, Hadley Centre regional climate model
PSQCA	Pakistan Standard
PST	Pakistan Standard Time
RCM	Regional Climate Model
ROAP	Regional Office of Asia & Pacific
SDPI	Sustainable Development Policy Institute
SOP	Standard Operating Procedure
SO_2	Sulphur dioxide
SUPARCO	Pakistan Space and Upper Atmosphere Research Commission
TSS	Total Suspended Solids
TWG	Technical Working Group
$\mu g/m^3$	Microgram per cubic meter
UNEP	United Nations Environment Programme
UNDP	United Nations Development Programme
UN-Habitat	United Nations Human Settlements Programme
UNICEF	United Nations International Children Education Fund
UNISDR	United Nations International Strategy for Disaster Reduction
WHO	World Health Organization
WWF	World Wildlife Fund- Pakistan
V/V	Volume by volume
Zn	Zinc

Chapter 1: Introduction and Background of the study

The study on "Climate Change Vulnerability of Islamabad" was commissioned by the United Nations Human Settlements Programme (UN-Habitat) Pakistan office and its Regional office for Asia and the Pacific in collaboration with the Climate Change Division, Cabinet Secretariat, Government of Pakistan. The CCCI programme is being implemented in 50 cities in over 20 countries in Africa, Asia and the Pacific and Latin America. The objectives of the programme include promoting active climate change collaboration in order to achieve resilience and low carbon growth and enhancing policy dialogue to firmly establish urban dimensions of climate change on the local, national and international agenda. Furthermore, in the case of Pakistan, an additional objective was to commission this study to enable the Climate Change Division and other concerned institutions to help implement a Cabinet decision regarding preparation of a model climate resilient plan for Islamabad, taken by the Cabinet while according approval to the National Climate Change Policy.

Climate change is severely impacting many countries and Pakistan is no exception. Pakistan, because of its geographic location and unique topography, ranging from the third largest glacial mass accumulation beyond the polar region and the second highest mountain peak in the world, valley plains, deserts and large coastline is particularly vulnerable to climate change impacts. The Global Climate Change Vulnerability Index (CCVI) by Maplecroft ranked Pakistan at 29 in 2009-2010 and within a short span of only one year (2010-2011) that ranking dramatically fell to 16 while German Watch ranked Pakistan at number 1 on their global vulnerability measurement index.

The vulnerability of Pakistan to Hydro-meteorological hazards also has critical economic consequences and both leads to and results from rapid environmental degradation. The cost of adaptation to hazards from climate change in 2010 was estimated to be US$ 5.75 billion; 2 per cent of the country's GDP. At the same time, losses due to large scale flooding were much larger than the 5 per cent of GDP which is spent on flood prevention and adaptation measures annually. The National Climate Change Policy of Pakistan indicates that such disasters are likely to increase. It is estimated that the cost of adaptation to climate change would be more than 10 per cent of GDP over the next 40 years; ranging from US$13-14 per capita. With Pakistan ready to reach50 per cent urban population by 2030, cities, towns and urban regions are set to dominate the national agenda not only for promoting economic growth but more importantly managing adverse consequences of climate change.

In order to support the preparation of the vulnerability assessment and the development of a climate change action plan, the Climate Change Division has constituted a Multi Stakeholder Steering Committee and a Technical Working Group (TWG) to guide completion of this Task. The Vulnerability and Adaptive Capacity Assessment Workshop was held as a part of this process.

1.1. The Cities and Climate Change Initiative

Cities and local authorities have the potential to influence mitigation of the causes of climate change, and to understand how to protect themselves from the effects. The Cities and Climate Change Initiative promotes the mitigation of, and adaptation to, climate change in developing countries. More specifically, the Initiative supports the development of pro-poor innovative approaches to climate change policies and strategies. It builds on UN-Habitat's rich experience of sustainable urban development, through the Environmental Planning and Management approach of the Sustainable Cities and Agenda 21 Programmes as well as on internationally recognised capacity building tools. The Initiative develops, adapts and disseminates methodologies that put city managers and practitioners in a better position to support adaptation to climate

change. The Cities and Climate Change Initiative also promotes collaboration by local authorities and their associations in global, regional and national networks, with the triple rationale of: 1) enhancing policy dialogue so that climate change is firmly established on the agenda; 2) supporting local authorities' efforts to bring about these changes; and 3) enhancing awareness, education and capacity-building in support of climate change strategies. A major outcome of the initiative will be the development of a set of tools for mitigation and adaptation. The Cities and Climate Change Initiative now works in over 30 cities in 15 countries in the Asia-Pacific region.

In Pakistan, UN-Habitat is working with the Climate Change Division in addressing urban development challenges in the context of the challenges of climate change. The broader intention was to address the national challenges of climate change by conducting scoping analysis of vulnerability, advocacy and policy dialogue, sharing globally-tested adaptation and mitigation tools and programmes, piloting programme for adaptation and mitigation and knowledge management and dissemination.

The CCCI process model, shown in Figure 1, describes UN-Habitat's comprehensive approach on the city and country level. It encapsulates national and local plans and policies as well as climate change adaptation and mitigation. This study is based on UN-Habitat's tool "Planning for Climate Change" which focuses on Climate Change Adaptation on the city level. The planning for climate change process model is shown in Figure 2.

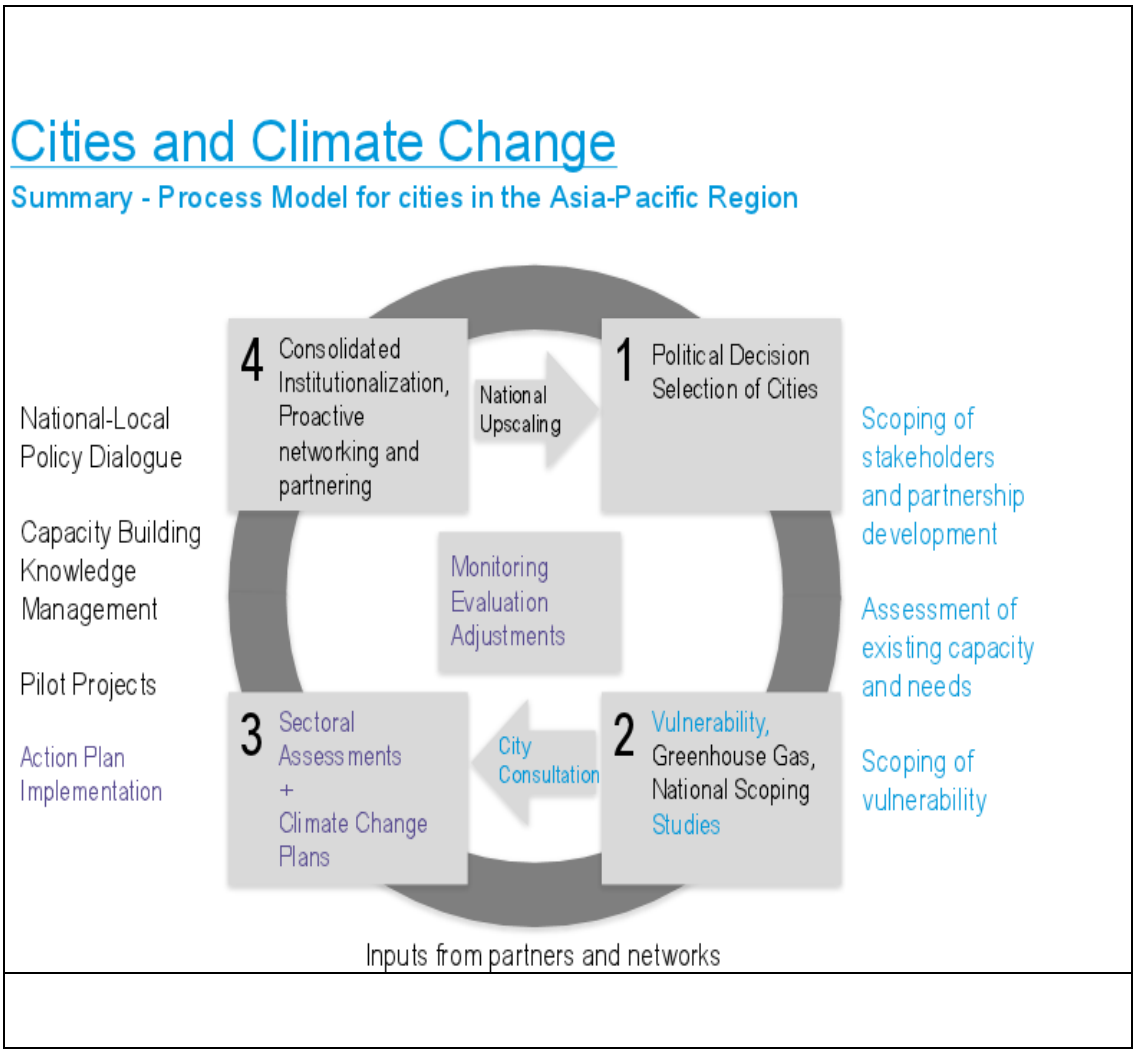


Figure 1 : Cities and Climate Change Overall Programme process Flow

Figure 2 : Planning for Climate Change Process Model at City Level

1.2. Purpose, Scope and Limitation of the Vulnerability Assessment

The purpose of this study is to commence the process of building climate resilient towns and cities in Pakistan and, where applicable, support initiatives for urban low emission development. For this purpose, UN-Habitat, under the auspices of the Cities and Climate Change Initiative has undertaken the vulnerability assessment. The vulnerability assessment complements the Resilient Cities Campaign, jointly conducted with United Nations International Strategy for Disaster Reduction (UNISDR), that focused on post crisis rehabilitation.31 cities have participated in this campaign and utilised the Local Government Self Assessment tool.

The Planning for Climate Change methodology is a nine step planning framework that comprises i) getting started, ii) stakeholders and participation, iii) vulnerability assessment, iv) issues and objectives, v) option identification, vi) option assessment, vii) implementation, viii) M&E and ix) adjust and modify. There are tools and approaches to run cities through these 9 planning steps. A manual has been developed by UN Habitat that helps understand and run the process.
The geographic scope of this report is primarily Islamabad. However, the report also focuses on the wider Islamabad Capital Territory Region and Rawalpindi, especially where trans-boundary issues, such as eco-system degradation or flooding in the Nullah Lai basin. This flexibility of geographic scope reflects the reality that climate change issues extend beyond administrative boundaries, and that urban systems that are affected by climate change are complex and interconnected

Chapter 2. Islamabad - the Capital city and Rawalpindi as Twin cities

2.1. City Profile

Islamabad was built on virgin land and it started functioning as the Capital of Pakistan in 1963. Over the past 53 years, Islamabad has emerged as a thriving cosmopolitan city. Islamabad is located in the northwest of the country on Potohar Plateau between the 33°26 73°02′E and 33.43°N 73.04°E.Thealtitude of Islamabad ranges from 457 to 610 metres above sea level. The area of Islamabad is 906.50 square kilometres. A further 3626 square kilometre area is known as the Specified Area, with the Margalla Hills in the north and northeast. Unlike other cities in Pakistan, Islamabad is a planned city. It is recognised as being a twin city with Rawalpindi, due to their proximity.

Rawalpindi is a city in the Potohar Plateau near Islamabad (Lat. 33º 36´ N, Long. 73º 02´ E). Its population is 1.4 million (Census 1998) and its area is 5286 km2. Its population density per km^2 is 1146 with annual growth rate of 2.7per cent. In Rawalpindi the annual lowest and highest temperature ranges between 2.6ºC and 45ºC respectively. There are about 2000 small and medium size industrial units in Rawalpindi. The major environmental concerns of the Rawalpindi are vehicular and industrial pollution along with brick kilns and solid waste incineration.

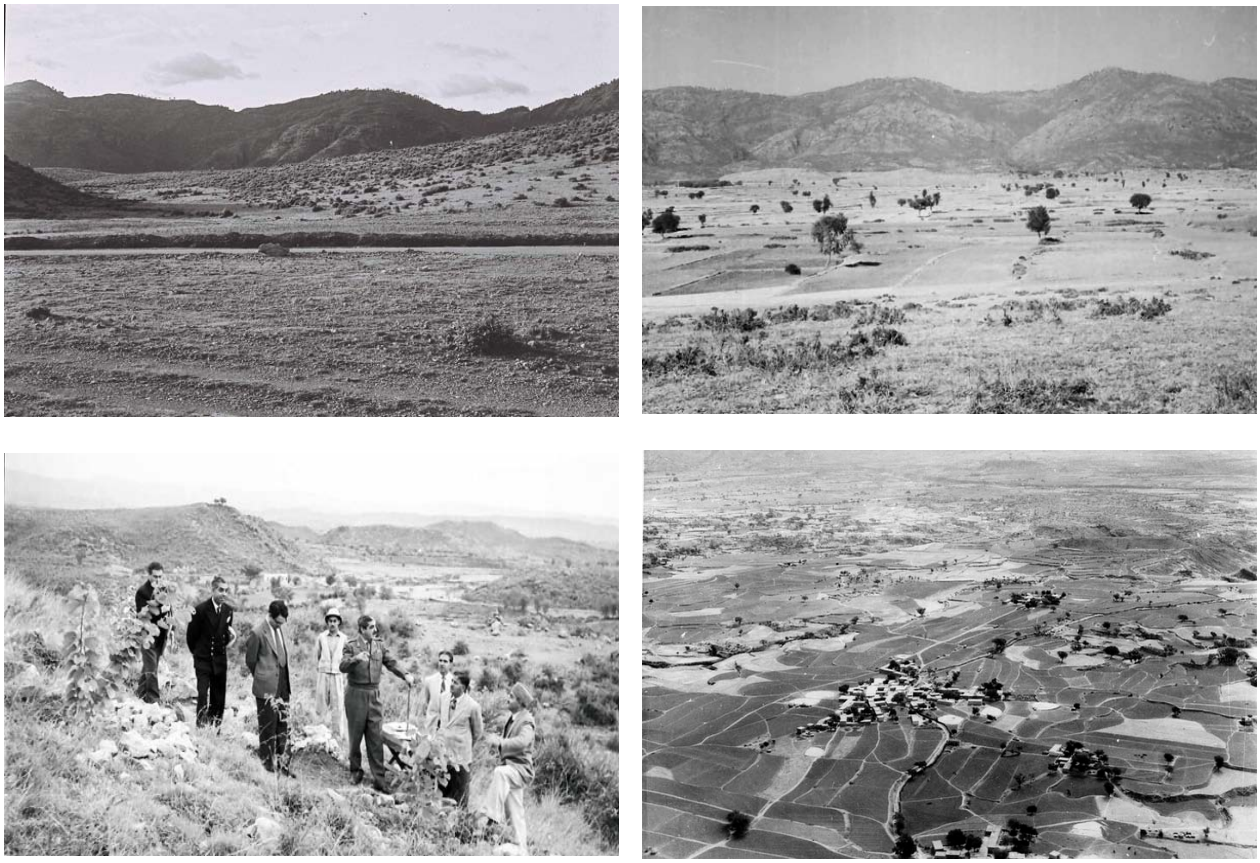


Figure 3 : A view of topography of Islamabad area before development of Capital[1]

[1]http://www.cda.gov.pk/

Table 1 : Islamabad District at a Glance[2]

Basic City Profile	
Population (1998 census)	805,235
Population (Projected for 2014)	1,400,000
Area	Total : 906 Sq. Km Urban : 505 Sq. Km Rural : 401 Sq. Km Cultivated : 119274 Acres Un-Cultivated : 85403 Acres Under Forest : 27149 Acres
Sex Ratio (males per 100 females)	117.0
Average Household Size	6.2
Literacy Rate	62.52 %
Male	75.09 %
Female	48.78 %
Average Annual Growth Rate (1981 - 98)	5.19 %
Total Housing Units	219,076
Administrative Units	
Tehsil	01
Capital Development Authority	01
Mauzas[3]	132
Union Councils	12
Villages	133
Rural Roads (Total Length)	593 Km
Rural Water Supply Schemes	65
Mini Dams	2
Small Community Centres	3
Rural Health Centres	3
Basic Health Units	14
No of Registered Vehicles	520,000

[2]http://en.wikipedia.org/wiki/Islamabad

[3] A Mauza is a local administrative unit for revenue purposes, wherein residents voluntarily make contributions to a government agency for redistribution to the poor

2.2 Climate

Islamabad has a variation of a sub-tropical climate, with hot, humid summers, followed by a monsoon season and severe winters. The weather varies greatly across seasons. Winter typically runs from December to March, and experiences some rainfall and cool temperatures– averaging around 4.5ºC in the coldest months; between December and February. Summer – from April to September experiences hot temperatures, averaging around 35ºC. Extremes of temperature, as high as 46ºC have been recorded in these months. Summers are accompanied by a monsoon season beginning in June or July and running through to September. Winds are predominantly from the southwest, except during the monsoon season when winds come from the southeast.

2.3 Rainfall and Humidity

The average rainfall is about 1150 millimetres per year with around 65 per cent of rain falling in the four months from June to September. Average yearly humidity is 55 per cent.

2.4 Demographic Characteristics

Main features of demography of Islamabad and Islamabad Capital Territory are as follows:

According to 1998 Census the total population of Islamabad was 805,235 comprised of 434,239 men and 370,996 women. The population in 2014 is estimated at 1.4 million. The average annual population growth rate from 1981-1989 was 5.19 per cent. The urban population of the city was 529,180 while the rural population was 276,055. People from throughout Pakistan have settled in the capital over the past 53 years. Islamabad is the most diverse metropolis in terms of the population makeup of the city, representing major ethnic groups of Pakistan.

- The majority of the population falls in the age group of 15 – 64 years, around 59.38 per cent. Only 2.73 per cent of the population is above 65 years of age. 37.90 per cent is below the age of 15 years.
- Islamabad has the highest literacy rate in Pakistan at 72.88 per cent. The labour force of Islamabad is 185,213 while the rate of un- employment at the household level is 11.7 per cent.[4]
- Islamabad population density per square kilometre is 889 with annual growth rate of 5.1 per cent.
- It has the largest expatriate and foreigner population in the country. Migrants are attracted to Islamabad due to its improved security situation, economic opportunities and good infrastructure.
- The city also serves as a transit point for tourists visiting the Northern Areas of the country for trekking, hiking, adventure sports and mountaineering
- The city is also growing as a business and commercial centre, it has attracted a large highly skilled workforce from other major cities including Karachi, Lahore and Quetta
- All of the country's diplomatic ties are maintained and exercised from Islamabad, as all major embassies, consulates and missions are operate from the city, as is the Foreign Office

[4]http://www.islamabadthecapital.com/islamabad/demographics/

Table 2 : Population of Islamabad through decades

Census	Population	Urban
1951	95,940	
1961	119,307	
1972	234,843	32.63%
1981	340,286	60.06%
1998	805,235	65.72%
2000	877,000	
2005	1,063,000	
2010	1,248,000	
2015	1,422,000	
2020	1,580,000	
2025	1,737,000	
2030	1,905,000	

Source: District. Census Report – Islamabad (1961, 1972, 1981, 1998) & NIPS, July 2005

2.5 Geology

Geologically the city of Rawalpindi and the Capital area belongs to tertiary age. As far as structure is concerned, the capital area forms a part of the northern limb of the Soan Geosynclines. A Geosyncline is a subsiding linear trough that was caused by the accumulation of sedimentary rock strata deposited in this basin and subsequently compressed, deformed, and uplifted into a mountain range. The rocks in the area are of sedimentary origin, mainly comprising sandstone, limestone and shale, limestone is very suitable for the construction for buildings, bridges and other structures. Limestone mining and stone crushing is contributing to a number of environmental issues, including ecosystem degradation in the Margalla Hills National Park and air pollution through Islamabad[5]. Sandstones represent deposits of levees, crevasse channels and splays, floodplain channels, and large sheet floods. Laminated mudstones represent floodplain and lacustrine deposits.

2.6 Soil Types

Soil in Islamabad and the surrounding Capital Territory is shallow with a clay composition, there is alluvial land and terraces which tend to have low agricultural productivity. Mostly, on the Southern and Western aspects of the Potohar plateau, the soil particles are thin and infertile. Streams and ravines cut the loose plain, affected by gully erosion and steep slopes. This land is unsuitable for cultivation. However, large patches of deep, fertile soil are found in the depressions and sheltered localities

[5] Programme& Plan Volume 2 of 2, Dox-PA 88 (30-9-60), 32

supporting quality small forests (rakh) and rain fed agriculture. Limestone and shale is characteristic of Margalla range.

2.7 Hydrology

There are two rivers, Kurang and Soan, but they don't run through Islamabad and Rawalpindi, the twin cities in the Islamabad Capital Territory region. The Kurang River, on which Rawal Dam is constructed, runs almost from north to south through the eastern suburbs of Islamabad and Rawalpindi and finally joins the Soan River, a river in the southern periphery of Rawalpindi. However, the Nullah Lai, a natural, rain fed stream system that passes through the jurisdiction area of Islamabad and Rawalpindi. The upper reaches of the Nullah have three tributaries; Saidpur Kas, Tenawali Kas and Bedarawali Kas, which originate in the Margalla Hills and join the Nullah while passing through Islamabad. Below Khattarian Bridge, it enters into Rawalpindi and passes through its centre, mainly from north to south and then finally joins the Soan River. Many tributaries also join the Nullah Lai while it passes through Rawalpindi. These tributaries in fact are drainage and sewage channels. It has at times encountered severe flooding due to heavy rains. The large scale flooding in July 2001 is an example, when Islamabad received 620mm of rainfall in just 10 hours.

Three artificial reservoirs; Rawal, Simli, and Khanpur Dam are responsible for regulating the micro-climate of the city[6]. The Khanpur Dam is about 40 kilometres away from Islamabad city and is located on the Haro River near the town of Khanpur, whereas, Simli Dam is located in the north of Islamabad in Zone III and is about 30 kilometres from central Islamabad.

The Rawal and Simli Dams are constructed to supply water for the urban area on Korang and Soan Rivers respectively. The quality and the quantity of water supply in the headwaters of the Korang and Soan Rivers have benefited from the growth of extensive forest reserves. Ground water extracted out of the Quaternary alluvial gravels (200m depth) is distributed through a network of private and municipal pipes across the geographic area of the city.

The Soan River is mostly polluted as a result of the effluents that are discharged through the Nullah Lai carrying the liquid waste from Rawalpindi. Moreover, poor management and disposal of the city's solid-waste is increasing the threat to the quality of ground-water reserves.

2.8 Planning Context

In 1959, Islamabad was selected as a new site for shifting the capital from Karachi. The government commissioned Doxiadis Associates, a Greek firm, to study and prepare the Master plan of the new capital which spreads over an area of 906 km^2. It forms the boundary of the Islamabad District while the hinterland of Islamabad further stretches far beyond this boundary and called the greater region and a specified area.

[6] *In the report by* Doxiadis Associates, it is mentioned at para 970 that the National Park is of the greatest value for Islamabad as an area which should be protected for micro-climatic reasons. However, in addition to the resorvoirs other factors like plantation, hills, valleys, and non-natural factors like pollution from transport, industries, power and building sector also effect micro-climate of the area

2.8.1 The greater region

The greater region is synonymous with the metropolitan area. In terms of coverage it extends over five districts, namely Islamabad, Rawalpindi, Attock, Haripur and Abottabad. The plan prescribed that this region be planned as it would be affected by urban development policies of both Islamabad and Rawalpindi.

2.8.2 Specified area

The new capital was conceived as a dynamic urban nucleus to serve as a new national centre. In the Master plan, it was mentioned that the capital site was to be built in harmony with the surrounding area. This region was defined under Capital Development Authority (CDA) Ordinance 1960 which also tasks Capital Development Authority to plan the capital site and its neighbouring city Rawalpindi and cantonment. The proposed Master Plan covers the whole metropolitan area. Constituents of the metropolitan area are as follows:

- The whole of Islamabad (Zone 1)
- Islamabad National Park area (Zone 2)
- Rawalpindi city and its surrounding cantonments.

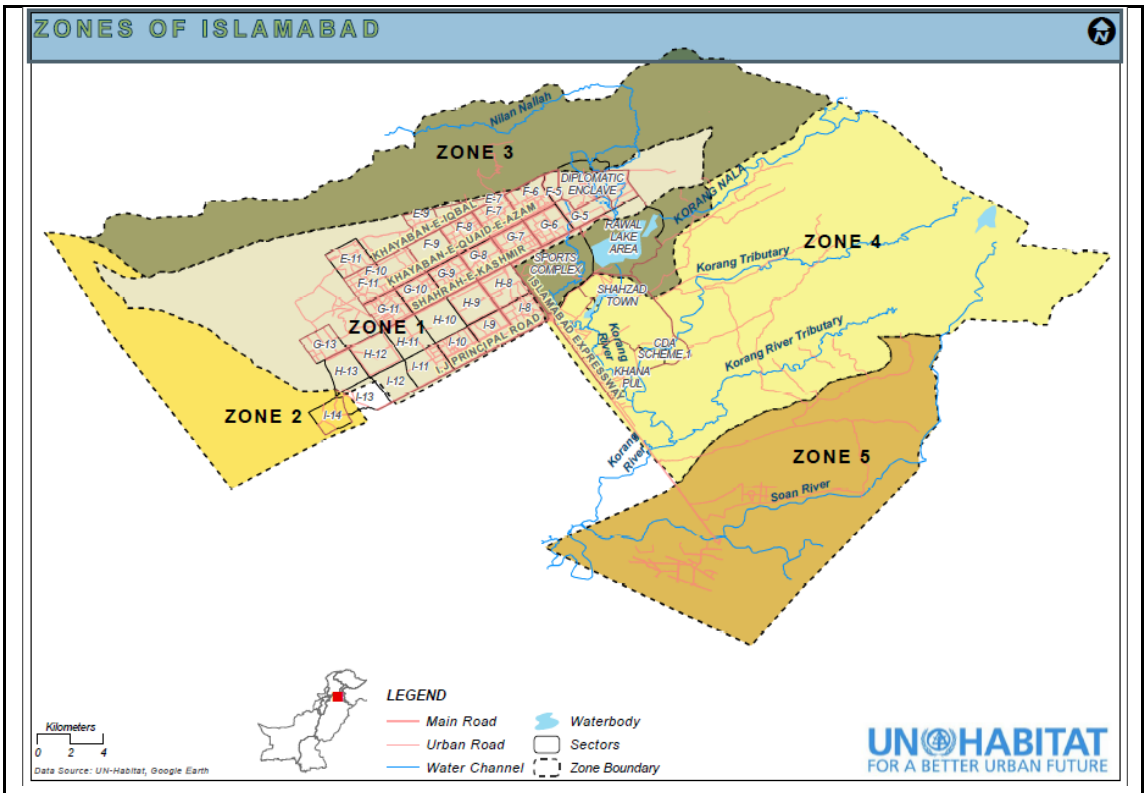
Islamabad was planned to be limited to the north by the Margalla hills where it cannot and should not expand, since these hills have to remain a national Park.

2.9 Main features of Islamabad Master Plan

Islamabad was designed as a linear dynamic city[7] with a grid-like arrangement of sectors with straight, intersecting roads. The sectors have been conceived as “human communities” provided with self-sufficient utilities and amenities at the neighbourhood level. The layout plan also provides a network of service centres with decentralized activities at neighbourhood and sector levels. The Master Plan also provides for open spaces for leisure, recreational farming and model villages. In addition Margalla Hills National Park area reserved for preservation and conservation of the diverse existing flora and fauna.

Islamabad city is divided into five major zones: Zone I, Zone II, Zone III, Zone IV, & Zone V. The Zone IV is the largest in area while Zone I is the largest developed residential area. Each residential sector is identified by a letter of the alphabet and a number, and covers an area of approximately a grid measuring 4 square kilometres.

[7] Linear dynamic city means that the city was planned for various functions that can be expanded following a linear pattern running southwest, in the main direction of future growth. The residential and light industrial zones were invisioned to spread out in the same direction



Map of Islamabad Capital Territory limits (Islamabad Capital Territory Administration)

Figure 4 : Zones of Islamabad, Map of Islamabad Capital Territory

Zone I covers222.4 square kilometres, consisting of all the highly developed residential sectors. While Zone II, covering an area of 39.7square kilometres consists of the under-developed residential sectors, Zone III constitutes about 203.9square kilometres, Zone IV constitutes 282.5square kilometres, and zone V covers about 157.9square kilometres of the total land area of Islamabad.

Table 3 : Location of zones in Islamabad

	Zone	Location	Comments
Urban	I	Sectors up to G.T. Road	Capital Development Authority exclusively responsible for Development
Rural	II	Residential Sectors - Beyond G.T. Road	Private Housing Schemes
	III	Margalla Hills and 2 Kms around Rawal lake.	Notified as National park for preservation and conservation.
	IV	South of Rawal lake and areas around Lehtrar Road	Predominantly green Zone for Agro Farms, Sports, Recreation, Large Institutions. No Private Housing Schemes permitted.
	V	Area around Soan river up to G.T. Road	Private Housing Schemes.

2.10 Urban Sprawl

Islamabad is the most rapidly urbanizing city in Pakistan. Extensive urban sprawl around Islamabad has occurred, particularly since 2000. In the year 2000, the urban land of Islamabad was 346.2 square kilometres which increased to 407.2 square kilometres, 483.4 square kilometres and 537.4 square kilometres in the years 2005, 2010 and 2013, respectively. Agricultural, barren, natural vegetation, rocky and rural settlement areas have been converted into urban land use. This means that land areas measuring 61 square kilometres, 76.2 square kilometres and 53.9 square kilometres were converted into urban land in the year from 2000 to 2005, 2005 to 2010 and 2010 to 2013, respectively. From 2000 to 2010, the extension of urban land was mostly in Zones I, II and V of the city. From 2010 to 2013, the extension was mostly in Zones IV and V of the city. Other minor classes which were converted into urban area are agricultural land, barren land and natural vegetation as shown in Table 3.1. During the period 2005 to 2010, an area of 76.2 square kilometres was urbanized. From 2010-2013 an additional area of 53.98 km^2 has been urbanized. As compared to 2000 to 2005 more area was urbanized during 2005 to 2010 and the rate of urbanization during the past three years is showing much rapid pace of conversion of peripheral land in to urban land use. The major classes that were converted in to urban land use include agricultural land, barren land, natural vegetation and rocky area. The area of different classes is shown in table 4.

In spatial terms, Karachi is the largest city in Pakistan measuring 966.32 square kilometres extent in the year 2010. Lahore is the second largest, measuring 516.14 square kilometres in the year 2010 while Islamabad / Rawalpindi is the third largest, measuring483.40 square kilometres.

Table 4 : Statistical Analysis of Islamabad Land use Classes 2000, 2005, 2010, 2013 (SUPARCO)

Sr. No	Land use Classes	Urban Land 2000	Urban Land 2005	Urban Land 2010	Urban Land 2013	Converted other land into Urban from 2000 to 2005	Converted other land into Urban from 2005 to 2010	Converted other land into Urban from 2010 to 2013
		Area km^2						
1	Urban Land	346.17	407.18	483.4	537.38	-	-	-
2	Barren Land	-	-	-	-	6.98948	13.58786	1.142186
3	Agricultural Land	-	-	-	-	9.94144	17.54646	6.45154
4	Natural Vegetation	-	-	-	-	5.92114	9.127138	1.11425
5	Water Body	-	-	-	-	-	0.073464	0.032557
6	Rocky Area	-	-	-	-	21.6034	26.48601	16.3551
7	Other Settlements	-	-	-	-	16.5563	9.398311	28.88628
	Total	-	-	-	-	61.01	76.22	53.98191

Islamabad was rapidly urbanized during the years 2000 to 2013; a total area of 191.21 square kilometres of Islamabad was converted into urban land. Land cover map of Islamabad showing urban sprawl during up to year 2000, 2005, 2010 and 2013 and aggregated impact of urban sprawl during these periods are at Annex II.The built up area of the city has seen considerable expansion between 2000 and 2013 increasing from 346.2 to 537.38 square kilometres. The expansion has involved considerable land use change with declines in agricultural and forest areas.

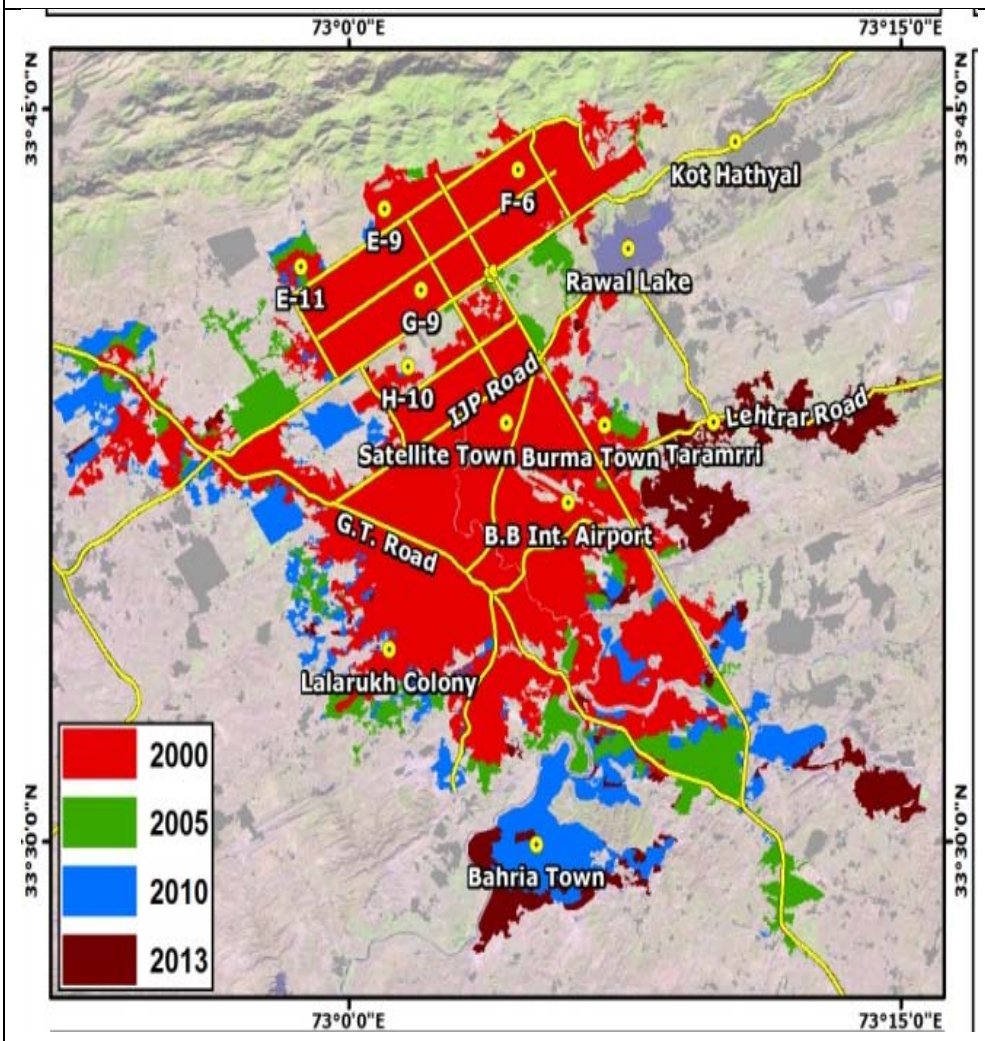


Figure 5 : Islamabad City Expansion, Year 2000-13

2.11 Administration of Islamabad - Governance - institutions

2.11.1 Capital Development Authority

The Capital Development Authority was established under the Capital Development Authority Ordinance 1960 which provided adequate powers to implement the Master Plan and perform all functions required to this effect. The Capital Development Authority works under the Cabinet Division.

Allocation of Functions

1. Land acquisition in the specified area under Capital Development Authority Ordinance 1960
2. Development of schemes
3. Studies , surveys and research
4. Municipal functions under Municipal Ordinance 1960
5. Execution of schemes through Local Bodies and Agencies
6. Building Control and Land – use Zoning.

Assessment of Performance

The Capital Development Authority having the requisite legal jurisdiction over all aspects of development and municipal services within the Islamabad Urban Area , with the exception of the maintenance of law and order that vests with Islamabad Capital Territory; has gradually eroded over the years . The primary reason for such deterioration is the result of many contradictions and jurisdictional overlaps and legal complications created by the present system since the creation of a separate administration; the Islamabad Capital Territory in January 1981, backed by the Islamabad Capital Territory (Administration) Order, 1980. This created difficulties in connection with the functions in the rural areas of the territory, which were previously performed by the Capital Development Authority but thereafter, Islamabad Capital Territory Administration. Further, Zoning Regulation, 1992 empowered the Islamabad Capital Territory Administration through its Union Councils to exercise the powers of development control within non-urban, non-municipal or "rural" areas of the Islamabad Capital Territories outside municipal or urban areas in Zone I and II .

As a result, policy implementation and zoning enforcement deteriorated rapidly and illegal encroachments and incompatible uses proliferated. It has resulted into unplanned urbanization and failure to preserve the Islamabad Park Area and Specified Area in zones III and IV and V.

2.11.2 Islamabad Capital Territory Administration

Islamabad Capital Territory Administration is the main administering body of the city. Capital Development Authority helps the Islamabad Capital Territory administration in the overall development, planning, construction, and administration of the city. For efficient administration, Islamabad Capital Territory is divided into eight main zones. Those zones include the Administrative Zone, Diplomatic Enclave, Educational Sector, Industrial Sector, Green Area, Residential Areas, Commercial District, and the Rural Areas.

The Chief Commissioner of Islamabad is head of local government and under Presidential Order No. 18 (Islamabad Capital Territory (Administration) Order 1980, the powers and duties conferred on the Provincial Government.

Mandate & Roles

- Regulate Law & Order in the Federal Capital Territory.
- Administer the matters pertaining to the Land & Revenue, Auqaf[8], Food, Civil Defence, Co-Operatives, Transportation, Population & Women Development, in the specified spheres of operation.
- Implementation of Labour Laws & Social Security Institution.

[8]Auqaf is a department under Islamabad Capital Territory Administration; it deals with Voluntary charity contributions of people collected by the Government Department for distribution to the poor.

- Registration of vehicles, Housing Societies, NGOs & Firms.
- Development of infrastructure in the rural areas, comprising exploration of Potable Water & harnessing the resources for irrigation, construction of rural as well as farm to market roads, provision of human healthcare as well as agricultural extension services.
- Prospection and mining of minerals and natural resources
- Municipal functions in the rural areas

Disaster Risk Reduction: Organizational Responses and Mechanisms

The Capital Disaster Management Authority (CDMA)has been constituted under capital administration and respond in cases of emergency under the supervision and direction of an 'Incident Spot Commander' who will be the assistant commissioner of the area where the disaster or incident takes place. Under CDMA all operational departments would be put under a centralized command and control structure to cope with emergencies and natural calamities. All the departments concerned, including city administration, police, paramilitary forces, Pak Army, Capital Development Authority, Rescue 1122, state-run hospitals, health emergency response units, city's fire brigade and the NDMA will make Standard Operating Procedure (SOP) for the CDMA. Pakistan Meteorological Department (PMD) provides early warning information to all concerned organizations working in disaster risk reduction. It also shares the information to the general public through its website, toll free telephone number, print and electronic media.

2.11.3 Capital Administration and Development Division

A new Division named Capital Administration and development Division (CA&DD), Islamabad was created in March 2011, after the 18th Constitutional amendment. The Division was vested with the mandate to execute, within the jurisdiction of the Federal Capital Area, all such functions handled by the abolished Ministries and Divisions and such other functions as allocated to it from time to time. As such, the CA&DD, Islamabad was conceived to be the sole administrative agency for service delivery in Education, Health and Special Education Sectors within Islamabad Capital territory modelled along the lines of a provincial setup comprising of the Federal Directorate of Education, Private Educational Institutions Regulatory Authority, Department of Libraries, Federal College of Education/Technical Panel Teachers Education, National Institute of Science & Technical Education, F.G. Polytechnic Institute for Women, F.G. College of Home Economics & Management Sciences, Pakistan Institute of Medical Sciences (PIMS), Federal Government Services Hospital, National Institute of Rehabilitation Medicines, Federal Government Polyclinic, Human Organs plant Authority (HOTA), Directorate General of Social Welfare and Special Education, Directorate General of Social Welfare and Special Education, Directorate of Workers Education, Department of Tourist Services, District Population Welfare Office, Islamabad, Regional Training Institute, Islamabad, Islamabad Club and Gun & Country Club, National Council for Social Welfare, National Trust for Disabled along with Three Centres.

Chapter 3 Climate Change Vulnerability Assessment

According to Intergovernmental Panel for Climate Change (IPCC) any change in climate over time, whether due to natural variability or as a result of human activity can be referred to as climate change. According to the UN Framework Convention on Climate Change, it is a change of climate that is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and that is in addition to natural climate variability observed over comparable time periods. The methodology and steps required to assess vulnerability are described below:

3.1. Methodology

The assessment used a participatory process looking into the city's exposure, sensitivity, and adaptive capacity of the area vis-à-vis projected climate scenario, previous climate related disaster events and trends, and community accounts of the past events and observations. The methodology includes the following steps:

- Collecting primary level data through a questionnaire and interviews
- Collecting secondary data
- Focus group discussions
- Two consultative workshops
- Taking guidance from Multi Stakeholder Steering Committee & Technical Working Group (TWG)

A questionnaire (Annex-I) was developed, and circulated among the participants of a multi-stakeholder workshop which was participated in by a diverse group of stakeholders from public as well as civil society organizations, academia and agencies responsible for management of Islamabad and the surrounding Capital Territory. It included men and women and different age groups. The context specific factors that have an effect on the different vulnerability components (exposure, sensitivity, adaptive capacity), are identified in this module.

A set of proforma questionnaires concerning vulnerability assessment, capacity assessment, institutional structure and capacity gaps of city authorities (Annex-I) was designed and circulated among the participants of the consultative workshop. The participants were asked to fill the requisite proformas. The same was analysed and is reflected in this document.

A Multi Stakeholder Steering Committee was headed by the Secretary, Climate Change Division and members comprised of representatives from Government, Academia, Research Organizations, UN organizations, national and international NGOs. The Steering Committee performed the role of coordination, oversight and guidance.

A Technical Working Group was chaired by Director General, Climate Change Division and included members from Capital Administration Development Division (CADD), Capital Development Authority (CDA) and Islamabad Capital Territory Administration (ICTA), Global Change Impact Studies Centre (GCISC), Pakistan Space and Upper Atmospheric Research Commission (SUPARCO) & Pakistan Meteorological Department (PMD). The Group provided technical inputs and guidance on regular basis and facilitated in data collection, analysis and modelling of various climate change parameters/scenarios.

A Description of terminology used in the module is as follows:

Assessment Framework adopted for the study

The vulnerability assessment process for Islamabad city considered the framework of the Intergovernmental Panel on Climate Change (IPCC) Third and Fourth Assessment Reports, which is also utilised by the UNDP-Adaptation Planning Framework, World Bank's Climate Resilient Cities Primer, the UNEP Handbook on Methods for Climate Change Impact Assessment and Adaptation Strategies, and most especially UN-Habitat's Vulnerability Assessment Methodology and Planning for Climate Change.

The key terms in this assessment are:

Exposure

Exposure relates to the degree of climate stress upon a particular unit of analysis. It may be represented as either long-term change in climate conditions, or by changes in climate variability, including the magnitude and frequency of extreme events. It considers both current and projected changes based on review of historic and current climate information (precipitation, temperature, extreme weather events) and projected climate scenarios. It also identifies primary impacts (increased precipitation, temperature, frequency and intensity of storms) and secondary impacts (flooding, ground water depletion, landslides and slope failures) including their current and future magnitude and frequency.

Sensitivity

The degree to which exposed people, places, institutions and sectors are impacted by climate change today and the degree to which they could be impacted in the future. As with exposure, impacts could be primary (change in city water supply due to climate change related decreases in precipitation) or secondary (slope failure and landslides due to more intense and longer precipitation events). Sensitivity refers to the degree to which a system is affected, either adversely or beneficially, by climate-related stimuli.

Adaptive Capacity

The degree to which, people, places, institutions and sectors are able to adapt and become more resilient to climate change impacts. It also identifies the extent to which the responsible institutions are capable of handling the emergency situation and the time do they take to respond to the disaster situation. As defined by the IPCC, adaptive capacity describes the ability of a system to adjust to actual or expected climate stresses, or to cope with the consequences.

Vulnerability

Refers to the degree to which people, places, institutions and sectors are susceptible to and unable to cope with, climate change impacts and hazards. vulnerability is generally understood as a function of a range of biophysical and socio-economic factors, commonly aggregated into three components that include an estimate of the above elements namely (adaptive) capacity, sensitivity, and exposure to climate variability and change.

Figure 6 : Vulnerability Assessment Framework

3.2. Steps taken for Assessment of Vulnerability

To ensure strong support from the technical staff of the city government, research organizations and academia for the vulnerability assessment process, initial preparatory activities were conducted. These activities centred on establishing the process of the vulnerability assessment and represent Step 2 in the Planning for Climate Change Process:

- A meeting was held under the chairmanship of the Secretary of the Climate Change Division and was attended by senior representatives of the key stakeholder organisations

- To follow up to this meeting, conducted key informant interviews and Focus Group Discussions were conducted with key stakeholders (senior official of Global Change Impact Studies Centre(GCISC), Pakistan Meteorological Department(PMD), Pakistan Space and Upper Atmosphere Research Commission(SUPARCO), Capital Administration and Development Division(CADD) and Capital Development Authority(CDA) to identify the other stakeholders as a part of scoping exercise

- A Technical Working Group was formed representing key stakeholders including government agencies (Climate Change Division, Capital Development Authority, Islamabad Capital Territory Administration (ICTA) & CADD) and Research Organizations (SUPARCO, GCISC & PMD). The group held three meetings to discuss and deliberate on the climate change challenges and to identify the need to collect relevant information to plan the vulnerability assessment of Islamabad and Islamabad Capital Territory.

- Conducted multi-stakeholder Consultative workshops and Technical Working Group meetings of key stakeholders in Islamabad for data sharing and seeking their input on the draft report on Climate Change Vulnerability in Islamabad. Vulnerability assessment was conducted from the data collected through secondary sources, workshop inputs, analysis of the available data carried out by collaborating institutions such as GCISC, PMD and SUPARCO and results of research work done for the study by GCISE and SUPARCO. This further led to identification of issues and objectives, identification of options and their assessment. Based on the assessment viable projects in relevant areas of concern in climate change mitigation and adaptation have been proposed. It is expected that the concerned agencies will pick up these projects for implementation.

3.3. Mapping/Scoping of institutes working for Climate Change in Islamabad

The key institutes working on climate change issues in Islamabad are as follows:

1 Climate Change Division, Government of Pakistan, Islamabad
2 UN Agencies (UNHABITAT, UNDP, UNICEF, FAO etc.)
3 GIZ
4 Global Change Impact Study centre (GCISC), Islamabad
5 Pakistan Meteorological Department (PMD)
6 SUPARCO
7 Centre for Climate Research and Development (CCRD)[9]
8 Sustainable Development Policy Institute
9 LEAD (Pakistan)
10 World Wildlife Fund, Pakistan
11 IUCN, Pakistan
12 Oxfam, Pakistan
13 Centre for Climate Change, Pakistan Institute of Development Economics, Islamabad
14 National Agricultural Research Centre, Islamabad

3.4. Factors of Climate Change Vulnerability: City Climate Change Exposure, Sensitivity and Adaptive capacity:

In addition, participating research organizations; Global Change Impact Studies Centre (GCISC), Pakistan Space and Upper Atmosphere Research Commission (SUPARCO) and Pakistan Meteorological Department carried out climate change research modelling and an analytical assessment to ascertain observed climate change trends and projections, Urban Sprawl, Urban Heat Island and carbon sequestration in Margalla Hills National Park. Based on this exercise as well as feedback from working groups constituted in the Consultative workshops the following factors of climate change vulnerability including 'Exposure, Sensitivity, and Adaptive capacity were identified:

[9] CCRD is a public university specializing in science and technology based in Islamabad

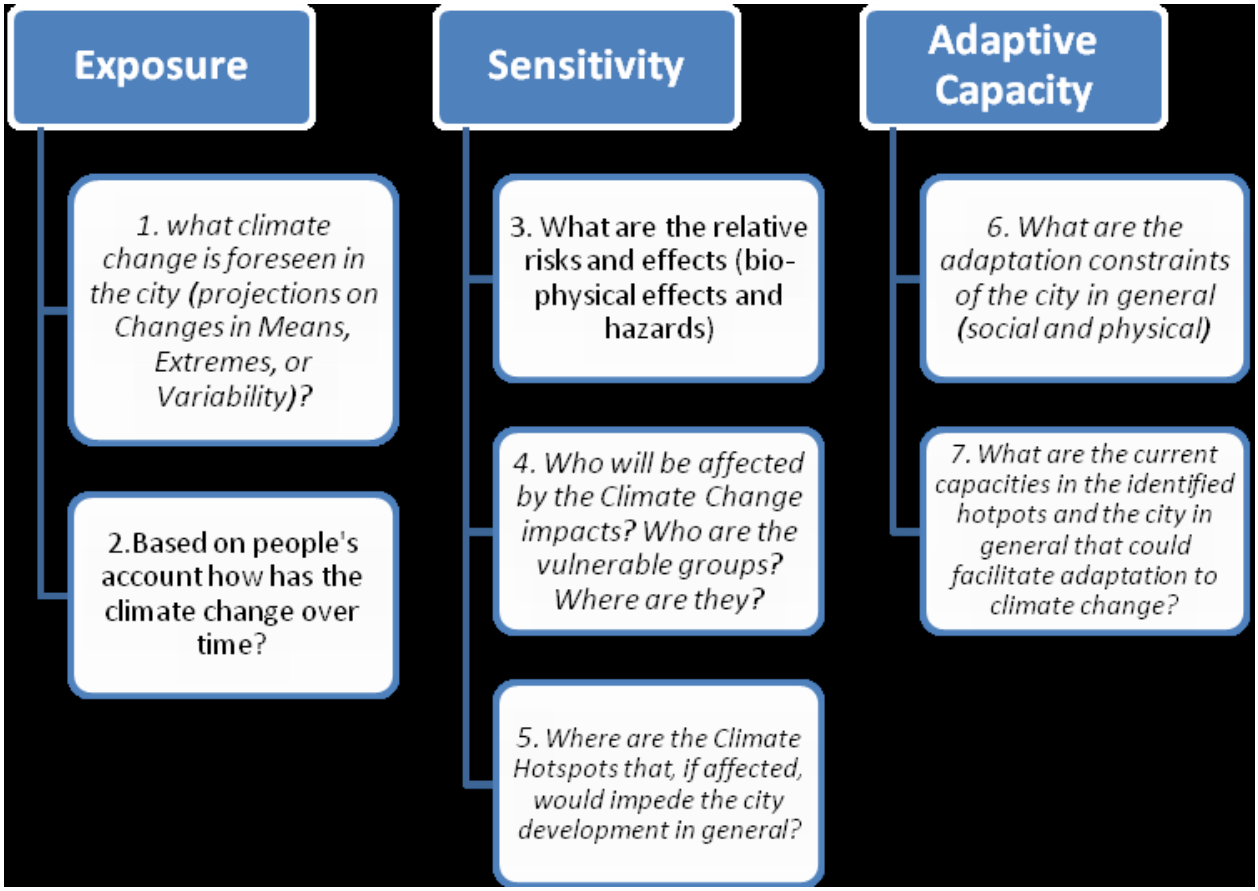


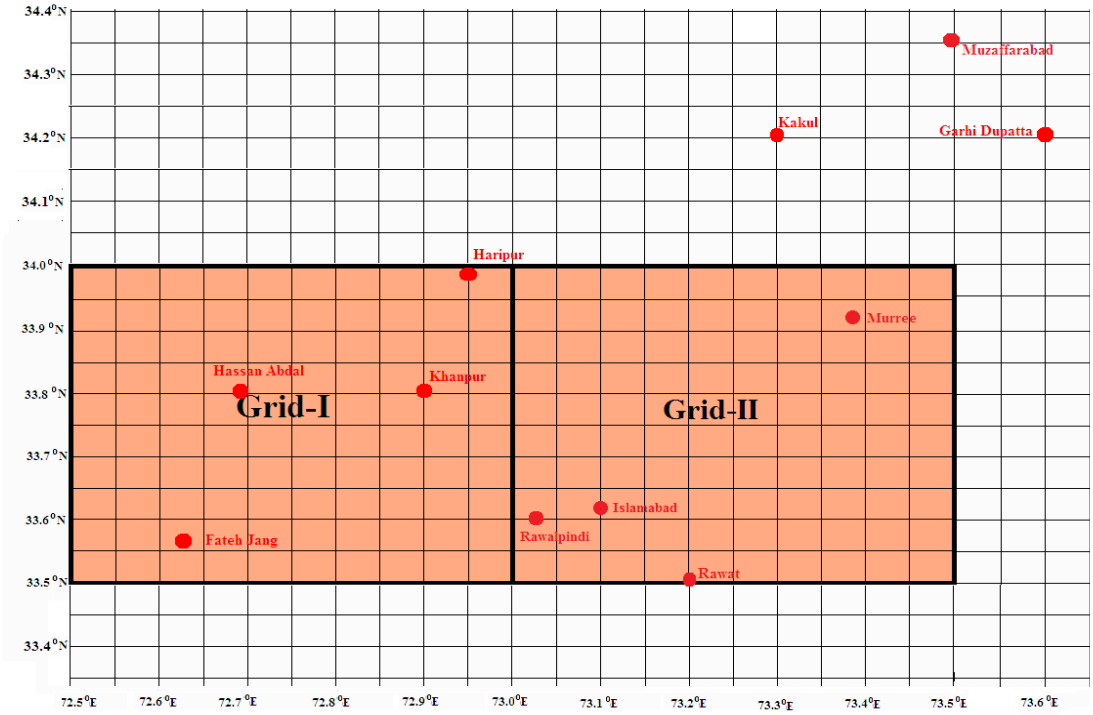
Figure 7 : Factors of Climate Change Vulnerability (UN-Habitat)

3.4.1. Exposure

The climate of Islamabad has a typical version of humid subtropical climate, with four seasons: Winter from December to March, summer, which includes the monsoon period, from May to September, and Autumn/Post monsoon from September to October. The hottest month is June, where average highs routinely exceed 38 °C (100.4 °F). The wettest months are July and August, with heavy rainfall and evening thunderstorms with the possibility of cloudburst. The coolest month is January, with temperatures variable by location. In Islamabad, temperatures vary from cold to mild, routinely dropping below zero. In the hills there is sparse snowfall. The weather ranges from a minimum of −3.9 °C (25.0 °F) in January to a maximum of 46.1 °C (115.0 °F) in June. The average low is 2 °C (35.6 °F) in January, while the average high is 38.1 °C (100.6 °F) in June.

3.4.1.1 Climate Change: Past Trends[10]

The results of the climate change modelling exercise undertaken by the Global Change Impact Studies Centre – an autonomous Climate Change research institute attached to the Climate Change Division, reveals that the temperature of the Islamabad and Islamabad Capital Territory from base period (1961-1990) to the 1991 – 2010 recorded a rise double the global average when compared with the neighbouring cities in the same latitude represented in 50 kmX50km grid. Warming in the Region II (containing Islamabad Capital Territory region) is seen higher compared to its surroundings, though more grids around the Islamabad Capital Territory grid are required to ascertain this finding. While precipitation, compared to the base period of 1961-1990 showed increasing trends for both Islamabad Capital Territory (Grid II) and its surrounding Grid I, has decreased thereafter but with higher variability reflecting increase in the frequency and intensity of hydro-meteorological disasters such as floods, droughts etc.



Projected temperatures also show increasing trends again with higher variability. Future thus is also projected to encounter increased frequency and intensity of hydro-meteorological disasters. For the study carried out for this exercise, Grid-I was represented by Lat: 33.5 – 34.0°N; Lon: 72.5 – 73.0°Eand Grid-II was represented by Lat: 33.5 – 34.0°N; Lon: 73.0 – 73.5°E. Coordinates of cities located within or closely outside the above two grids are as follows to identify their locations.

[10]Rizvi, Dr.Hussain Haider, SUPARCO 2014, "Field survey for carbon sequestration in Margalla Hills National Park", unpublished.

Figure 8 : Exposure Analysis Grids

Climate Profile of Islamabad and Islamabad Capital Territory, Trends[11]

The Climate profile of Islamabad Capital Territory in the context of temperature and precipitation parameters as based on the data of Islamabad for the period 1961-1990 & 1961 - 2010[12]are shown as base line parameters:

Table 5 : Islamabad and Islamabad Capital Territory, Mean Temperature & Precipitation[7]

Season	Months	Temperature (Mean °C)		Precipitation (Total millimetres)	
		1961 – 1990	**1961 – 2010**	**1961 – 1990**	**1961 – 2010**
Annual		21.3	21.6	1142.1	1176.3
Monsoon	JJAS	29.1	29.1	737.3	781.8
Post-monsoon	ON	19.4	19.6	47.1	45.8
Winter	DJFM	12.7	13	251.9	253.6
Summer	AM	25	25.4	101.1	95.2

Wind Profile

West and north westerly winds prevail during the period from November to April, variable winds during May, the transitional pre-monsoon month and south and south easterly during the months June to September with variable winds again during September and October, the post-monsoon season. Wind speed ranges from around 18.5 kilometres per hour to74 kilometres per hour. Wind speeds are at their lowest during the months of November and December, highest during April, May and June, and moderate during the remaining months.

Recorded Extreme Weather Parameters

Highest Maximum Temperature	*46°C (24th June 2005)*
Lowest Minimum Temperature	-4.3°C (25th Dec. 1984)
Heaviest Rainfall in 24 hours	181.3 mm (10 August, 1982)
Heaviest Rainfall in 10 hours	621.0 mm (23 July, 2001)

Past Climate Changes

a) Temperature

The Islamabad Capital Territory region (Grid II) compared to the base period 1961-90 has become substantially warmer 1990-2010. Warming in Grid II is higher compared the base period 1961-90 but the warming in Grid II (Islamabad Capital Territory) is much higher than the warming over Grid I. Islamabad Capital Territory, in fact, has become a heat island among its surroundings. More grids around Grid II, and

[11]Sheikh, Muhammad Munir, Shahbaz Mehmood and Naeem Manzoor, "Islamabad Capital Territory (ICT) in the context of climate change: past and projected. Un-published (Table 7,8,9)

[12]Reference: Muhammad Munir Sheikh, Shahbaz Mehmood and Naeem Manzoor; Islamabad Capital Territory (ICT) in the context of Climate Change: Past and Projected. Unpublished; 2014.

additional analysis are, however, required to ascertain this finding. Tables and graphs for period 1961 – 1990 and 1961 to 2010 are shown below:

Table 6 : Past Temperature Trend Changes (°C) for the two grids

Grid-I (Lat: 33.5-34.0; Lon: 72.5-73.0) Period (1961-1990)					Grid-II (Lat: 33.5-34.0; Lon: 73.0-73.5) Period (1961-1990)				
Annual Mean	**Annual Mean Monsoon (JJAS)**	**Annual Mean Winter (DJFM)**	**Annual Mean (AM)**	**Annual Mean (ON)**	**Annual Mean**	**Annual Mean Monsoon (JJAS)**	**Annual Mean Winter (DJFM)**	**Annual Mean (AM)**	Annual Mean (ON)
- 1.6	- 3.1	- 1.0	- 0.1	- 1.2	0.9	- 0.01	1.1	1.9	**1.3**
Period (1961-2010)					Period (1961-2010)				
1.0	**0.1**	**1.3**	**2.4**	**1.0**	**3.5**	**3.4**	**3.1**	**4.5**	**3.4**

The graphs of the annual mean temperature trends (°C) of Grid I and II for the year 1961-1990 and 1961-2010 are at Annex VIII.

Not only is the warming substantially higher in Grid II compared to Grid I, it is also very noticeable that the warming in both grids has accelerated substantially since 1990. In order to understand change over time, in the respective time periods, the assessment team analysed the 1961-2010 dataset. The change in annual average temperature was analysed first.

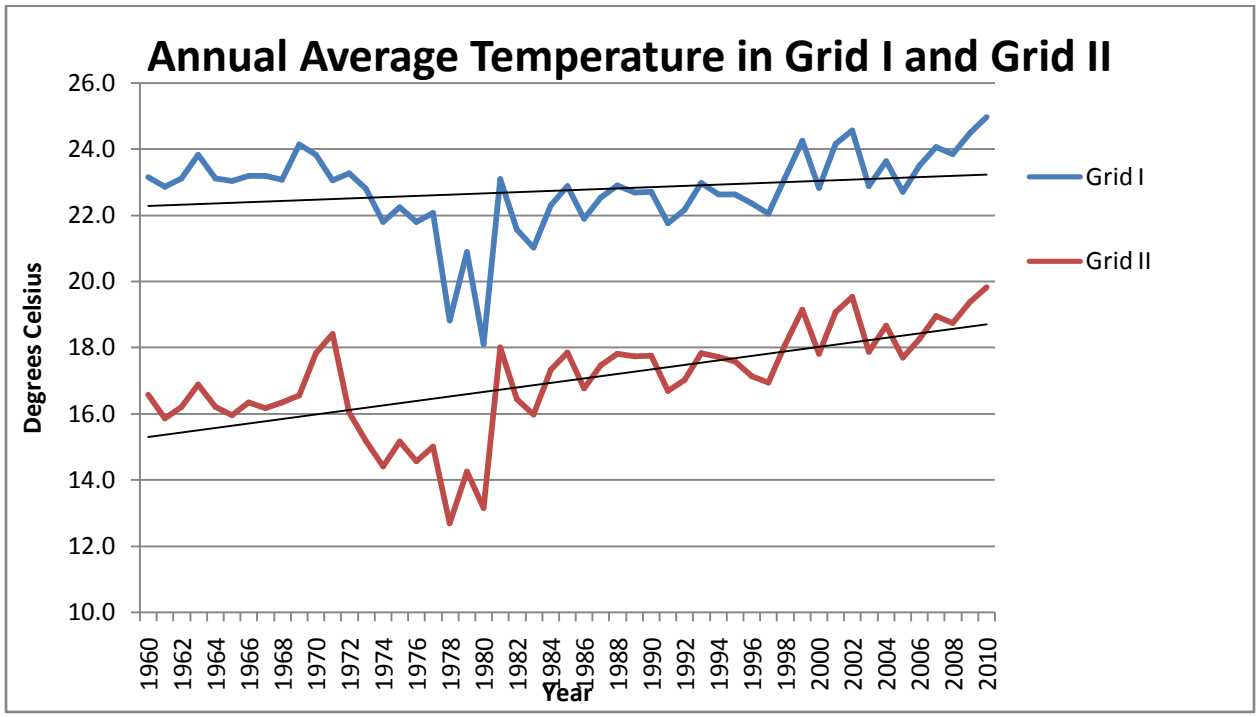


Figure 9 : Change in Annual Average Temperature in Islamabad, 1961-2010

Figure 10 shows that there has been an increase of about 1°C in average over the period of the data set in Grid I, while Grid II has shown an even more significant rise of over 3°C. The average temperature actually showed a notable decline of 1.6°C between 1990 in Grid I and an even more marked decline in Grid II, followed by a significant rise between 1990 and 2010, which represents an alarmingly rapid

warming rate over a twenty year period in both Grids. In order to provide further analysis, the team then broke the analysis into four sections, analysing change in temperatures in January-March, April-June, July-September and October-December. This analysis is presented below.

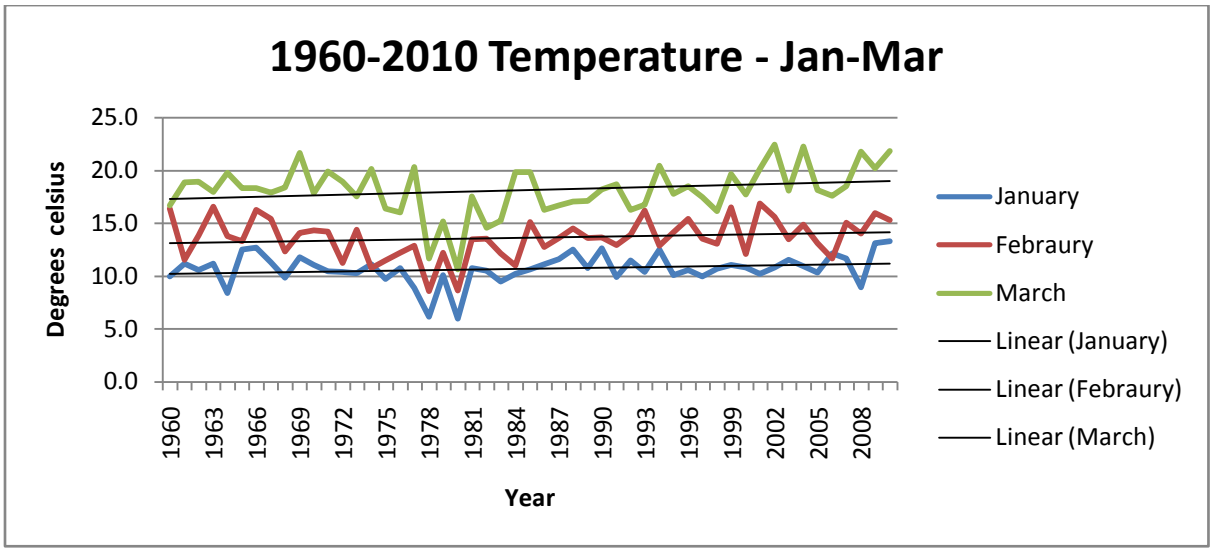


Figure 10 : Change in Average Temperature for the Months of January, February and March

The dataset for January, February and March generally mirrors the overall annual situation over the same time period, with an initial decline in temperatures over the first thirty years of the data set and a substantial rise over the last 20. March shows the most rapid increase in temperature, with January and February also showing increases. All months in the dataset show the slight decline in temperatures followed by a rapid increase

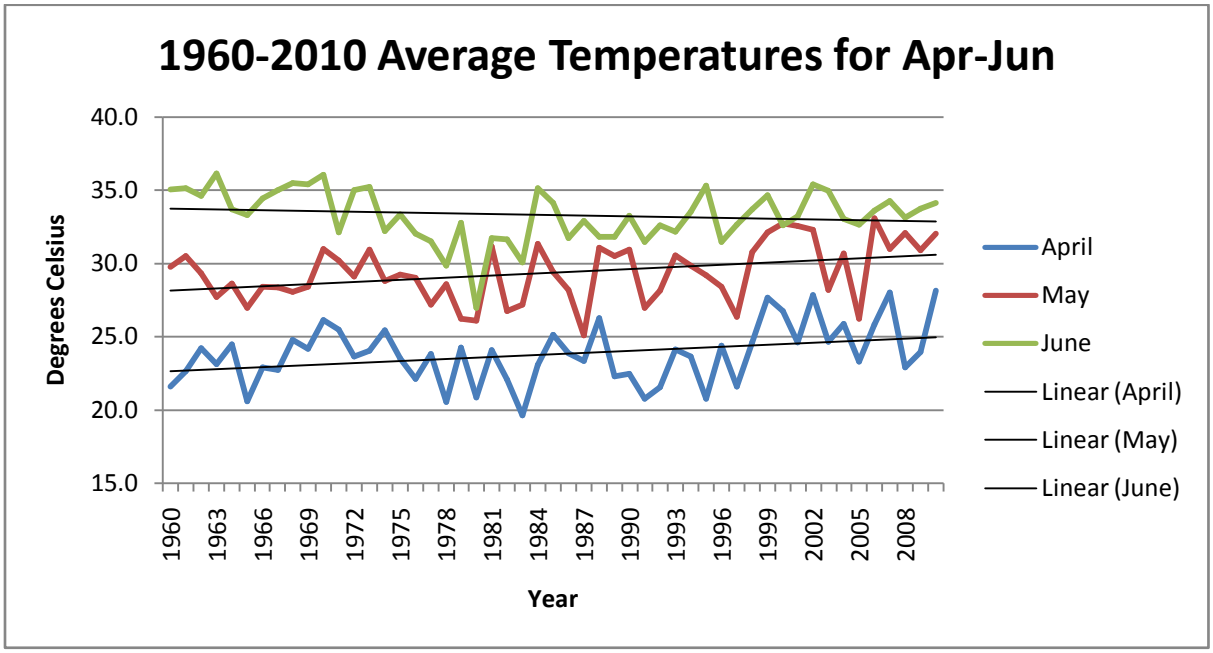


Figure 11 : Change in Average Temperature for the Months of April, May and June

April and May also reflect the trend of the annual average, in that they show a slight decline over the first thirty years of the dataset with a marked increase over the last 20 years. The overall increase is especially acute in April, where there has been an overall temperature increase of 2.5°C across the dataset

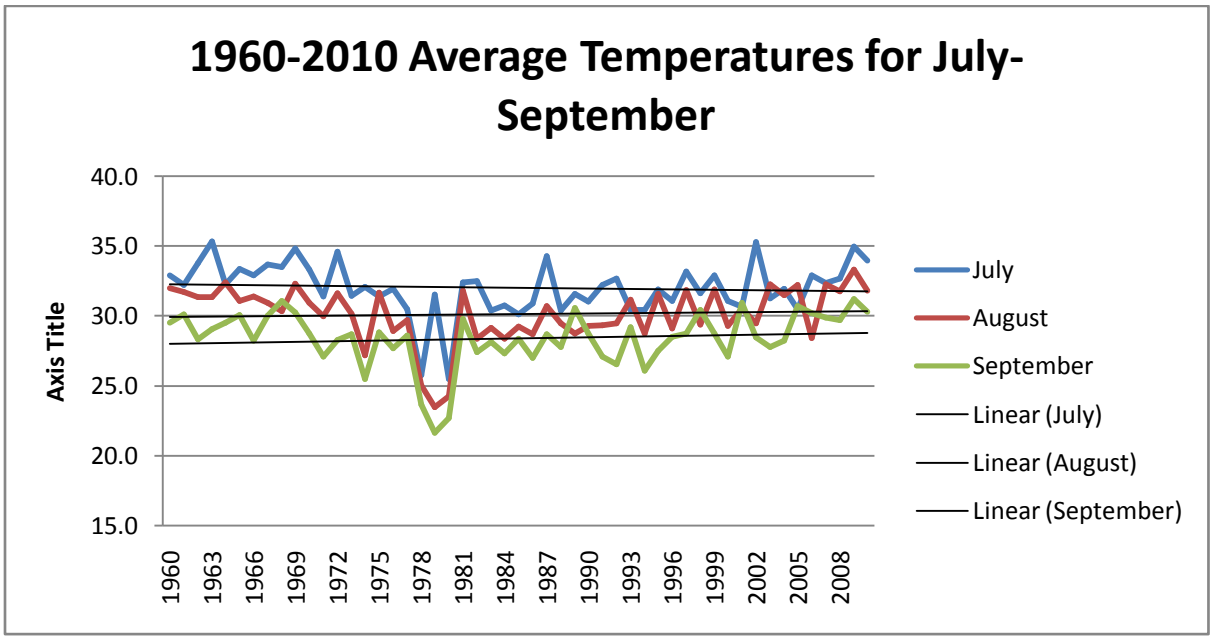


Figure 12 : Change in Average Temperature for the Months of July, August and September

Temperatures in the July, August and September period have been much more consistent, showing little or no change in temperatures. As with the annual trend, however, there was a decline in temperature over the first thirty years and an increase over the last 20. The data is also skewed by an exceptionally cold year in 1979.

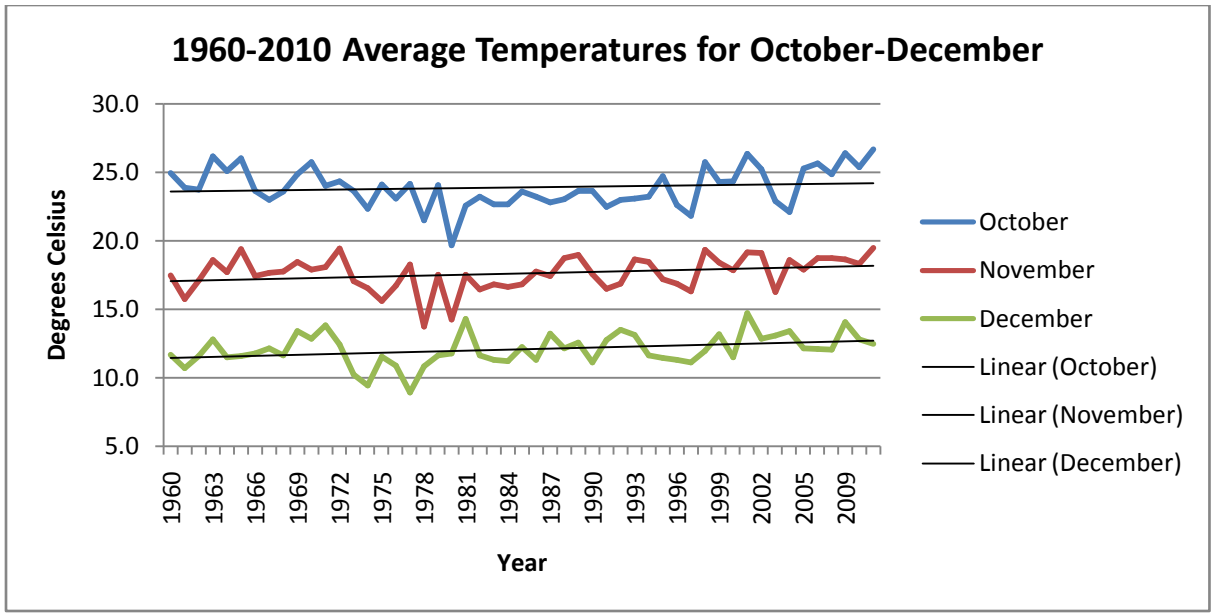


Figure: 13 Change in Average Temperature for the Months of October, November and December

The analysis of temperature change in October, November and December also shows significant increases in temperature, especially over the last twenty years of the data set. It is also noticeable that in for all months, the highest recorded monthly averages have been within the last ten years and in many cases, 2010 was the hottest year on the record

b) Precipitation

Precipitation has shown a slight increase over the whole study period of 1961-2010. However, in the base period, from 1961-1990, there was a marked rise in precipitation – both in terms of annual average and across almost all seasons in both grids (with the exception of summer in Grid I). However, in the period from 1990 to 2010 there was a tailing off of the increase and in some cases a slight decrease in the amount of precipitation. So, while the overall pattern has been for a moderate increase in rain, the recent trend has been towards decreasing rain. In addition to this, and as shown below in Figures 15-18, variability has increased significantly in recent years. This means that within the context of a slight overall increase in precipitation there can be both extended dry spells, leading to droughts and more intense rain periods. This is summarised in Table 7, below.

Table 7 : Past Precipitation Trend Changes (mm) for the two grids

Grid-I (Lat: 33.5-34.0; Lon: 72.5-73.0) Period (1961-1990)					Grid-II (Lat: 33.5-34.0; Lon: 73.0-73.5) Period (1961-1990)				
Annual	**Annual Monsoon (JJAS)**	**Annual Winter (DJFM)**	**Annual Summer (AM)**	**Annual Post-monsoon (ON)**	**Annual**	**Annual Monsoon (JJAS)**	**Annual Winter (DJFM)**	**Annual Summer (AM)**	Annual Post-monsoon (ON)
169.3	**124.4**	**67.0**	**- 57.6**	**5.8**	**234.0**	**147.2**	**101.2**	**61.5**	8.2
Period (1961-2010)					Period (1961-2010)				
99.1	114.3	36.4	- 46.2	- 4.3	58.6	73.3	48.2	48.9	- 48.9

The graphs of the annual precipitation trends (mm) of Grid I and II for the year 1961-1990 and 1961-2010 are at Annex viii.

The total annual precipitation shows an increase of around 99 millimetres in Grid 1 and 58.6 millimetres in Grid II throughout the overall study period. The increase is more marked in the early period of the dataset – levelling off over the later part (though still showing an increase. There is also significant deviance around the mean, the highest recorded precipitation was 1557 millimetres in 1976, and the lowest was 582 millimetres in 2009, giving a standard deviation of around 18.5 per cent around the mean, a high and statistically significant deviation. In short, this means that the level of rainfall is highly unpredictable, and can vary greatly from one year to the next, which, as we will see, if challenging for agriculture and can lead to flooding and droughts. The trend for Grid I mirrors that of Grid II.

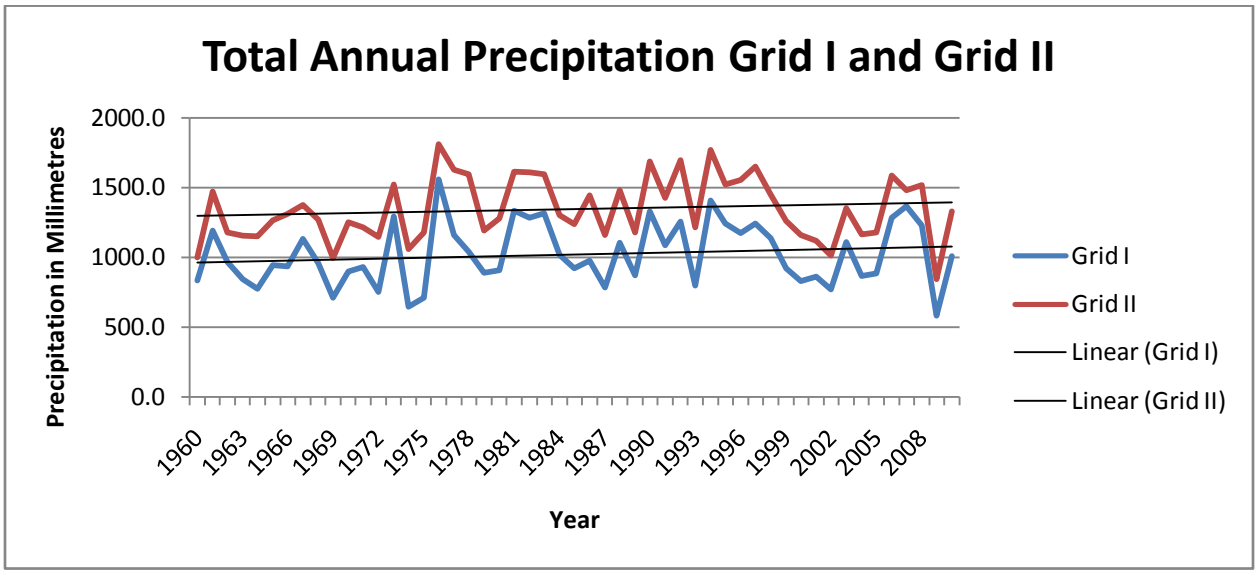


Figure 14 : Average Annual Precipitation

As with the analysis of temperature changes, in order to analyse trends in precipitation, months were grouped together in January to March, April to June, July to September and October to December. The analysis showed that there was significant variation in the amount of precipitation in each month. For example, the month of February has experienced as little as zero rainfall or as much as 260 millimetres, while July has experienced less than 100 millimetres of rain or over 500 millimetres across the dataset.

The months of February, June, and July showed significant increases in rainfall, the months of January, and April showed a slight increase, while the months of August, September, October, November and December showed no significant increase or decrease, while finally March and May show notable declines in the amount of precipitation received over the period of the dataset. A selection of this data is presented below. The trends for February and July, shown in Figures (14 and 15)show both the significant increase in precipitation on average and the vast year to year differences that have been recorded

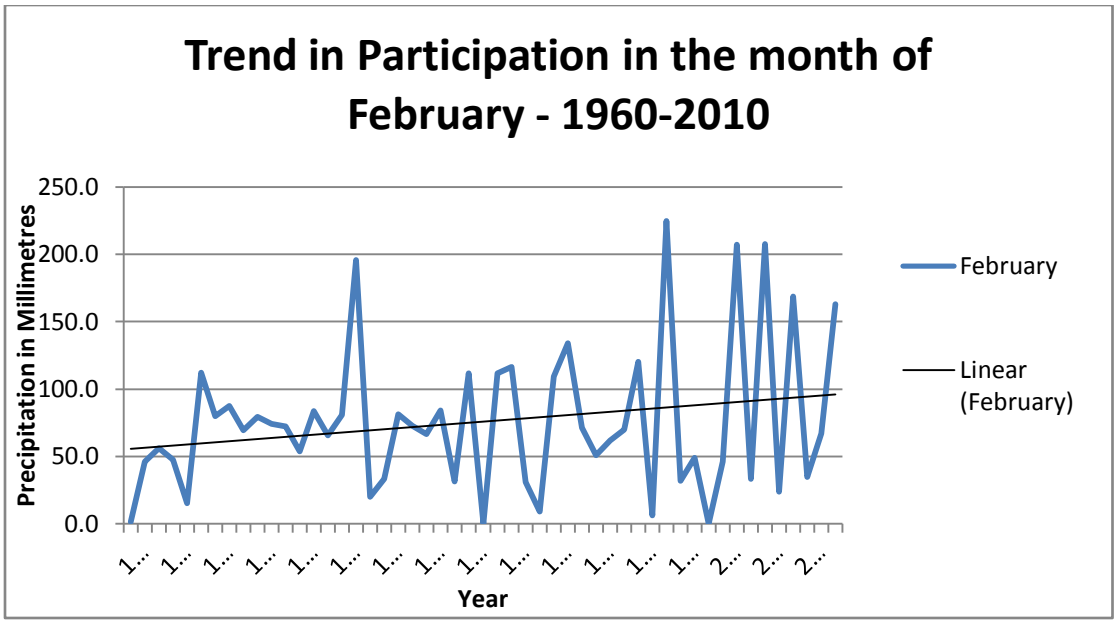


Figure 15 : Trend in Precipitation for the Month of February - 1960 - 2010

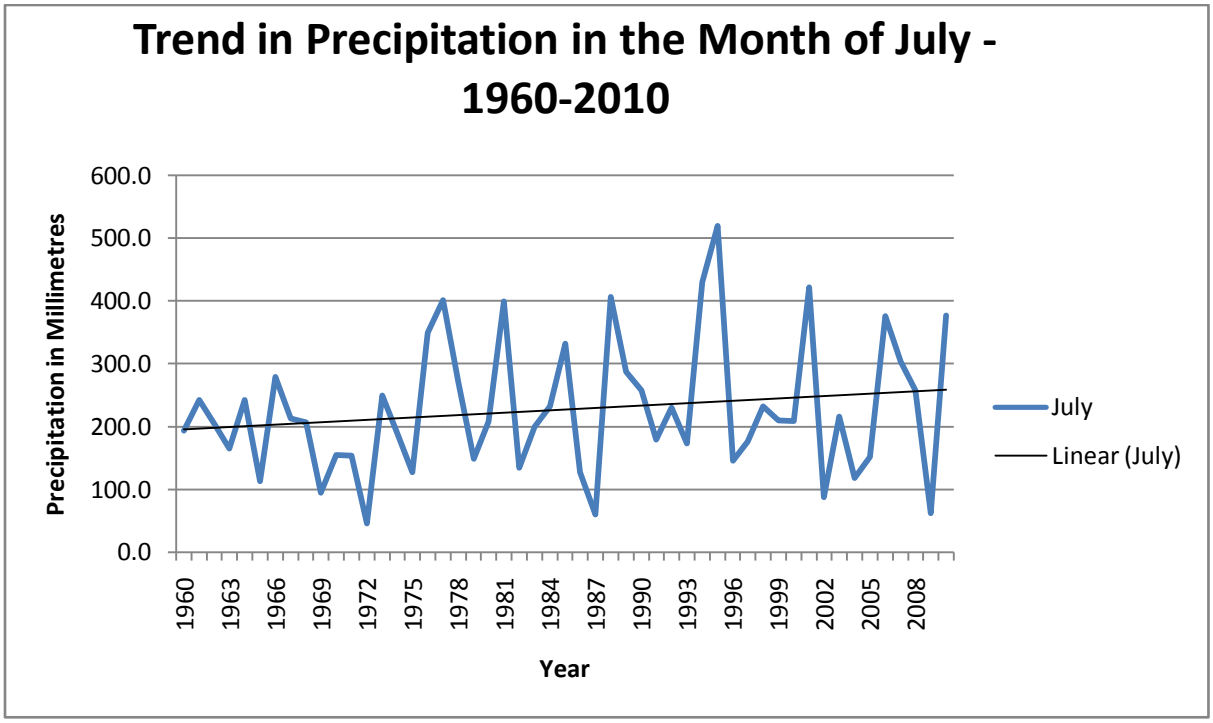


Figure 16: Trend in Participation in the Month of July 1960 – 2010

We can see then, that in terms of temperature and precipitation, the climate has already changed markedly in Islamabad. Rainfall has increased, while continuing to be erratic and unpredictable, while temperatures have increased significantly – especially over the last twenty years. Given this, the report now turns to temperature and precipitation projections

Projected Climate Change (Temperature)

Projected temperature changes compared to the average temperature for the base period of 1961-1990 for both the grids have been worked out using the output of ECHAM4 GCM dynamically downscaled with PRECIS RCM at a horizontal resolution of 50km. Both the grids show similar warming trends in future as shown in the Tables and Figures below:

Table 8 : Projected Temperature Trend Changes in degree centigrade (°C) for 2020s, 2050s & 2080s using A2 Scenario for the two grids

Grid-I (Lat: 33.5-34.0; Lon: 72.5-73.0)				Grid-II (Lat: 33.5-34.0; Lon: 73.0-73.5)		
A2 Scenario	**2020s (2010-2039)**	**2050s (2040-2069)**	**2080s (2070-2099)**	**2020s (2010-2039)**	**2050s (2040-2069)**	2080s (2070-2099)
Annual Mean Temperature Trend	**0.7**	**2.2**	**1.8**	**0.7**	**2.2**	**1.7**

As both grids show almost identical projected change over both the short and long term, only Grid I is presented here. Over the short term (to 2039), the 0.7ºC change is clearly identifiable, with continued substantial deviation around the mean.

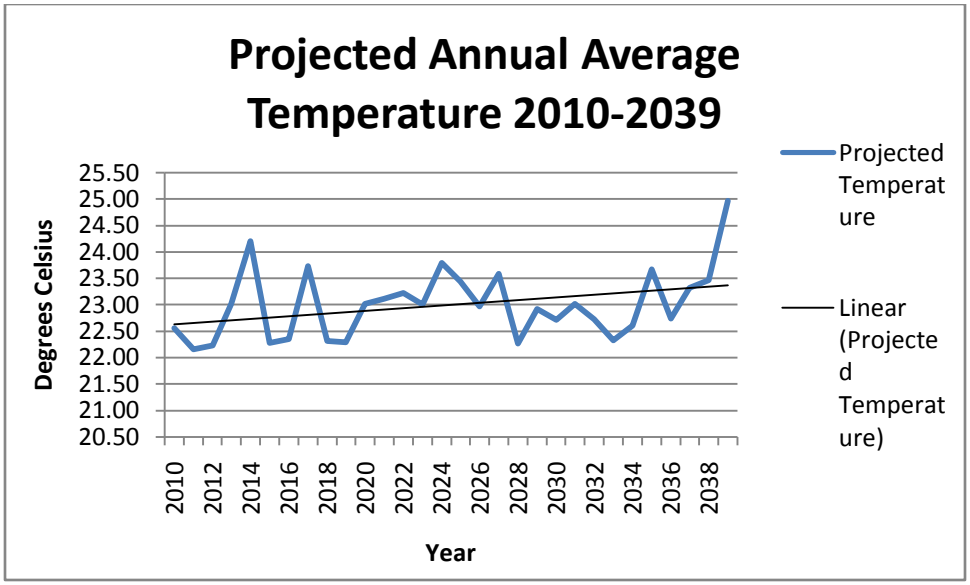


Figure 17 : Projected Temperature Change

Over the longer term – to 2069 – the temperature change is significantly greater; around 2.2ºC higher than the baseline year. This is beyond the 2ºC global 'limit' identified by the IPCC and therefore is the point at which, human health, agriculture and ecological systems could become severely affected.

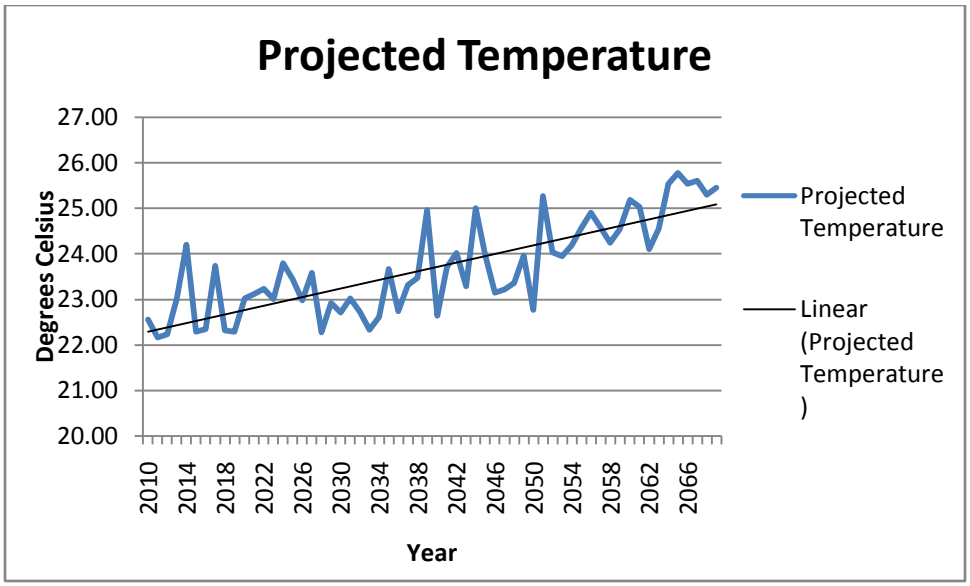


Figure 18 : Projected Temperature

Rainfall Projections

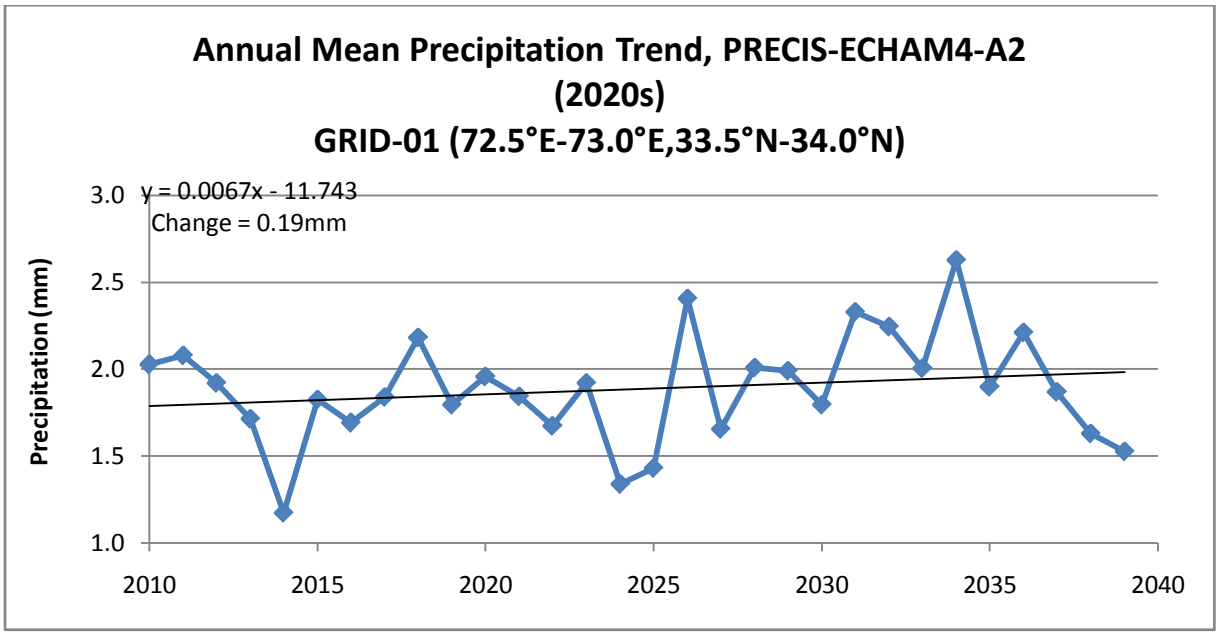


Figure 19 : Projected Change in Rainfall in Grid 1

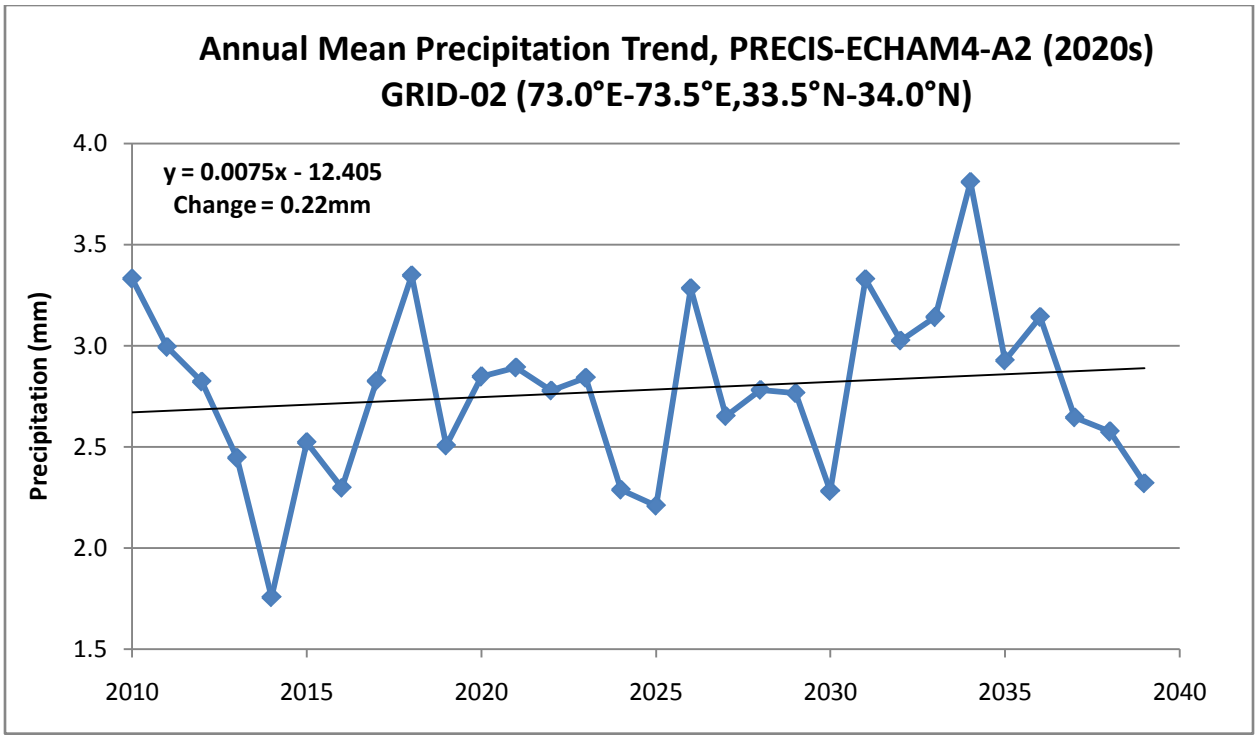


Figure 20: Projected Rainfall Change in Grid 2

Projections of rainfall in both grids show only slight annual increases in the period from now to 2040. However, the projections do show an increasing trend towards variability of rainfall. The projections to 2100 show a levelling off and possibly a slight decline in rainfall, relative to 2040 levels. All projections are based on an A2 emissions scenario – which emphasises a economic, regional and heterogeneous global development pattern. Such increases – both in projections for rainfall (however minimal) and increased variability, when combined with patterns of urban growth mean that urban flooding, such as that analysed below, is likely to become an increasingly severe problem.

3.4.1.2. Temperature, Sunshine, Rainfall, changes in means, extremes or variability

The highest temperature recorded was 46.5 °C (115.7 °F) in June, while the lowest temperature was −4 °C (24.8 °F) in January. On 23 July 2001, Islamabad received a record breaking 620 millimetres (24 in) of rain fell in 10 hours. It was the heaviest rainfall in 24 hours in Islamabad and at any locality in Pakistan during the past 100 years. According to the data of Pakistan Meteorological Department (PMD), Government of Pakistan from 2001 to 2012, the rainfall of 100 mm or more during a day is as follows:

Table 9 : Rainfall of 100 mm or more during a day in Islamabad[13]

Date	Rainfall (mm)
24 July 2001	620
04 Sept. 2003	168.7
03 Sept. 2012	161.0
13 July 2006	138.0

[13]Pakistan Meteorological Department; Dr. Muhammad Afzaal, Deputy Director, Muhammad Aleemul Hassan, Deputy Director, February 2014 (Un-published)

07 Aug. 2004	135.0
06 July 2008	128.0
05 Aug. 2006	123.0
18 Feb. 2003	105.1

The maximum ten rainfall months occurred from 2001 to 2012 are as follows:

Table 10 : Maximum ten rainfall months from 2001 to 2012 in Islamabad[14]

Month	Rainfall (mm)	Month	Rainfall (mm)
July 2001	1038.7	Aug. 2007	382.2
July 2008	531.2	Aug. 2002	360.3
July 2006	510.0	Sept. 2012	355.2
Aug. 2006	416.0	Aug. 2004	313.0
July 2003	407.3	July 2007	295.2

From 1961-1990, the highest temperature during a day recorded was 46 °C while it was 46.6°C on June 2005. Days when temperature was more than 44°C from data of Highest temperature recorded by PMD from 1993-2012 are as follows:

Table 11 : Twelve days when Temperature was >44 °C in Islamabad

Rank	Date	Temperature (°C)
1.	*24-Jun-05*	*46.6*
2.	*17-Jun-07*	*46.1*
3.	12-May-01	45.7
4.	16-Jun-07	45.3
5.	*9-Jun-02*	*45.0*
6.	22-Jun-05	45.0
7.	28-Jun-09	44.6
8.	23-Jun-05	44.5
9.	22-Jun-12	44.5
10.	07-May-05	44.4
11.	21-Jun-10	44.2

The average monsoon rainfall of Islamabad is 790.8 millimetres (31.13 in). Monsoon season starts by the end of June and prevails till the end of September. In 2009, Islamabad saw below normal monsoon rainfalls due to the presence of El-Nino over Pakistan. It just recorded 354 millimetres (13.9 in) of rain during the Monsoon season in 2009.The highest rainfall of 620 millimetres (24 in) was recorded in Islamabad during 24 hours on 23 July 2001. The record breaking rain fell in just 10 hours. It was the heaviest rainfall in Islamabad in the past 100 years. The following is the Monsoon rainfall in Islamabad since 2006 based on the data from Pakistan Meteorological Department.

- In 2006, a total of 975millimetres (38.4 in)

[14]Pakistan Meteorological Department; February 2014 (Un-published)

- In 2007, a total of 909.4millimetres (35.8 in)
- In 2008, a total of 807.7millimetres (31.8 in)
- In 2009, a total of 267millimetres (10.5 in)
- In 2010, a total of 689millimetres (27.1 in)
- In 2011, a total of 646.8millimetres (25.5 in)
- In 2012, a total of 800.7millimetres (31.5 in)
- In 2013, a total of 1,072.3millimetres (42.2 in)

3.4.1.3 Urban Flooding

Due to extreme weather events and change in the intensity and frequency of rainfall recorded in the past sixty years in Islamabad and Islamabad Capital Territory region there have been 19 urban flooding events since 1944; approximately one flood event every three year. Major floods occurred in 1966, 1970, 1972, 1976, 1977, 1978, 1981, 1982, 1985, 1988, 1990,1994, 1995, 1996, 1997, 2001,2002, 2010, 2011 and 2012. The major cause of flooding is rooted in the frequent over spill of NullahLai. The Nullah Lai has a catchment area of 234.8 square kilometres. Of this area; 69 per cent falls in Islamabad Capital Territory and the 31 per cent is in Rawalpindi and its suburbs. The Nullah Lai is fed by four tributaries called Saidpur Kas, Tenawali Kas, Bedaranwali Kas and Jodh Kas all these tributaries originate from the Margallah Hills. A map showing the catchment basin of Nullah Lai is shown below:

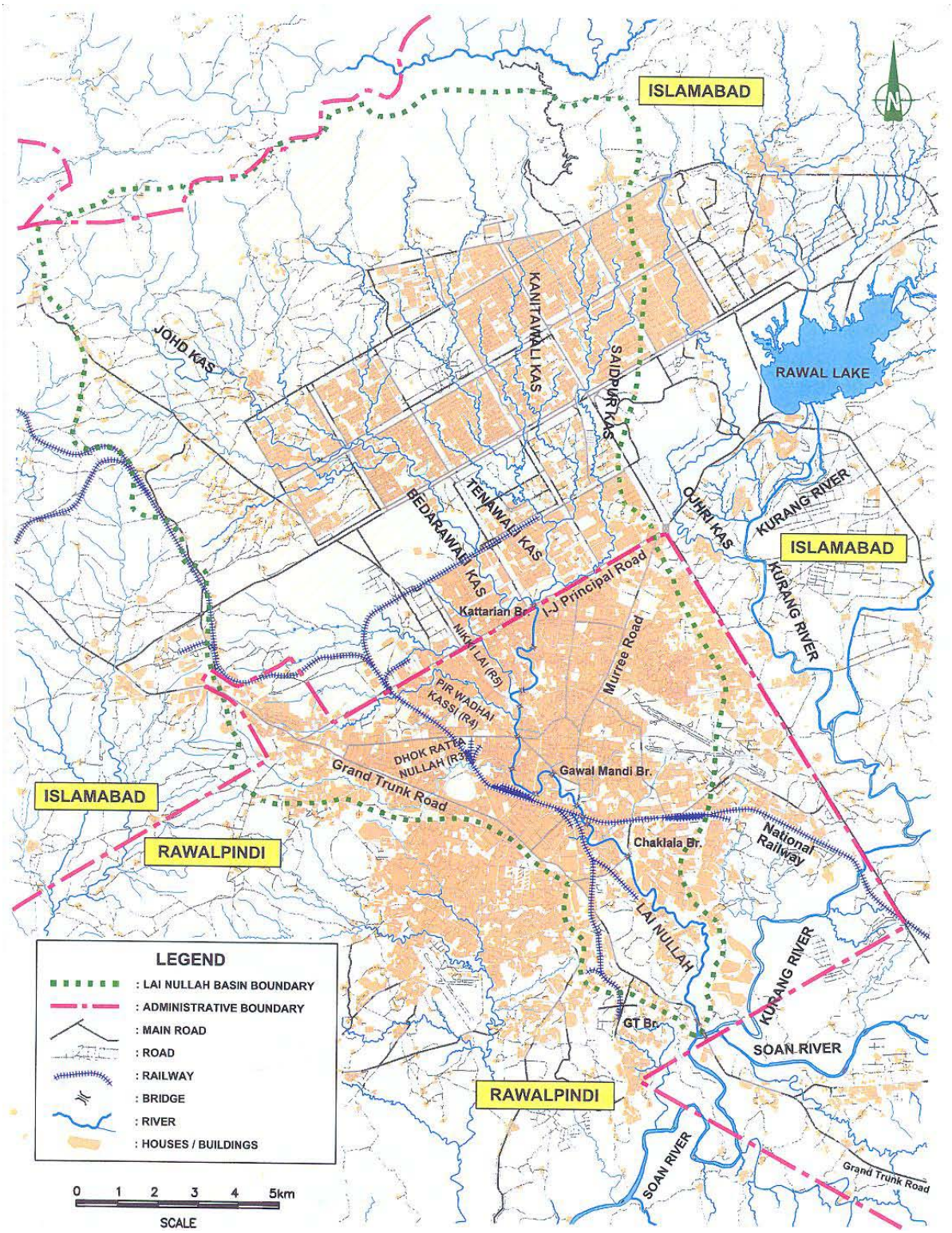


Figure 21 : Catchment area of the Nullah Lai

The maximum levels of water discharge from the Nullah Lai recorded in flood years are as follows.

Table 12[15] : Observed Maximum Water Levels and Discharges in the Nullah Lai at Gawal Mandi Bridge

Year	Max. water level heights in river (feet)	Max. water level/Peak (m)	Flow/Discharge(m^3/s)
1966	25	494.02	450
1970	30	495.54	700
1972	26	494.32	500
1976	25	494.02	450
1977	30	495.54	700
1978	25	494.02	450
1981	29	495.24	560
1982	32	496.15	850
1994	31	495.85	770
1995	26	494.32	500
1996	20	492.50	270
2001	41	498.90	2870
2002	22	493.10	320

The most severe example of flash flooding from the Nullah Lai was in July 2001 when 620 millimetres of rain fell in a ten-hour period in Islamabad and 335 millimetres fell in Rawalpindi. The recorded water flow was 2870 cubic metres per second, resulting in 74 deaths, damage to around 3000 homes and an estimated total economic damage of 28 billion Pakistan Rupees (280 Million US$) to property and infrastructure.

The impacts were mainly felt on the low lying and densely populated areas and katch abadies along the Saidpur Kas and Tenawali Kas. In Rawalpindi approximately 400,000 people were affected, primarily along the banks of the Nullah Lai where homes and business are situated close to the banks.

[15]Source: JICA Final Report on Nullah Lai Basin 2003

Figure 22 : Nullah Lai

3.4.1.4. Urban Heat Island Phenomenon

The Urban Heat Island Effect describes increased local atmospheric and surface temperatures in Urban Areas compared to the surrounding rural areas. The Ecological situation of the city has been changed during the period 2000 to 2013. The ecological situation in 2000 was normal overall but bad to some extent along built up areas according to Ecological Evaluation Indices[16] (EEI). On the Contrary, the ecological situation of built up areas during 2010 and 2013 seems worst in various locations whereas undeveloped areas are possessing excellent EEI. This implies that the extent of built-up area and their corresponding anthropogenic activities of Islamabad have been increasing.

Islamabad's 'residential bulk' was 0.6 or 60% with Floor Area Ratio (FAR):1:0.5-06 in 1960, but has increased to about 170% with FAR 1:1.7 in 2013. This indicates addition of bulk in the form of brick and concrete three fold without corresponding increase in open or green space. These factors have contributed largely towards increase in temperature resulting into urban heat island phenomenon. Moreover, in commercial and civic areas the covered area FAR and height has been increased manifold without caring for the impact on available voids, road width, circulation of vehicles and parking areas. This has also resulted into heat island, air pollution, noise pollution and visual pollution.

[16]Ecological Evaluation Indices are biotic indices for implementation of the Water Framework Directive of the European Union. The concept of the EEI is to recognise that "anthropogenic disturbances, such as pollution-eutrophication, shifts the ecosystem from pristine to degraded state, where opportunistic species are dominated" are the main drivers of the loss and damage of ecosystems.

3.4.1.5. Ambient Air Quality

Islamabad

The concentrations of fine particulate matter ($PM_{2.5}$), coarse particulate matter (PM_{10}), sulphur dioxide (SO_2), ozone (O_3) and nitrogen dioxide (NO_2) at Site 1 (Quaid-e-Azam University-Zone III), Site 2 (PAKSAT Office near Peshawar Morr-Zone I) and Site 3 (Industrial Estate I-9/3-Zone I) observed in 2011 are as follows:

Table 13: Concentrations of $PM_{2.5}$, PM_{10}, SO_2, O_3 and NO_2in Islamabad[17]

Values in micro-gram per cubic meter (µg/m^3)

Table 13 : Atmospheric Pollutants

Sample Sites	PM2.5			PM10			SO_2			O_3			NO_2		
	24 hrs. av.	**Hourly Max**	**Hourly Min**	**24 hrs. av.**	**Max**	**Min**	**24 hrs. av.**	**Max**	**Min**	**24 hrs. av.**	**Max**	**Min**	**24 hrs. av.**	**Max**	**Min**
Site 1 Residential	25.7	61	6.5	51.5	73.9	32.3	36.1	42	26.2	60.8	80	24.6	43.1	69.4	14.9
Site 2 Commercial	43.5	79.5	13.5	133.3	180.7	62.5	39.1	45.6	34.2	54.8	97.9	6.3	59.7	84.8	21
Site 3 Industrial	45.1	89.5	20	155.1	250.9	93.1	42.2	51.8	39.5	55.4	107.2	5.2	81.3	127.9	36.2

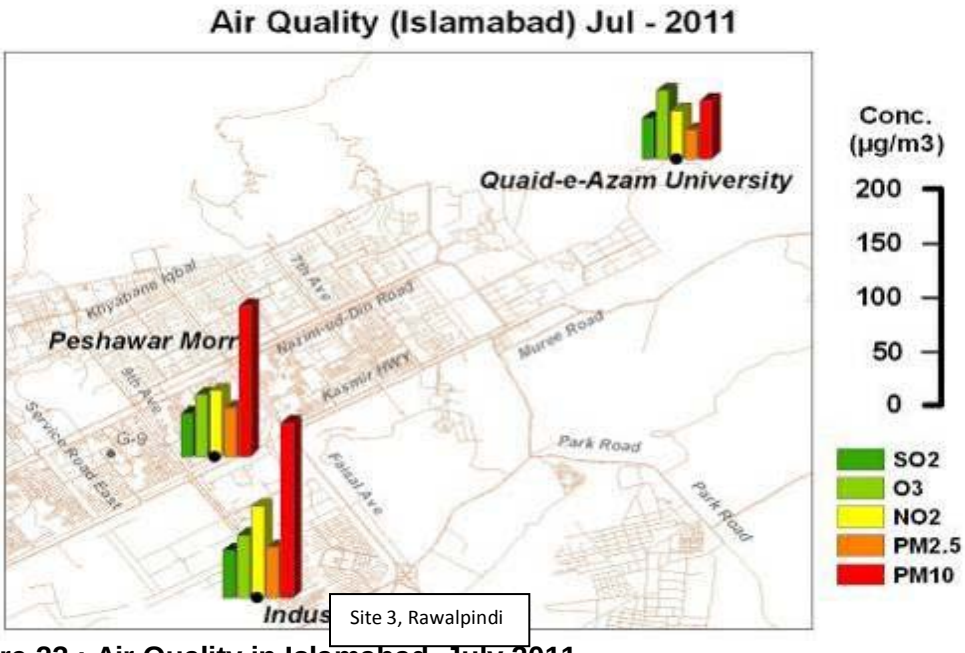


Figure 23 : Air Quality in Islamabad, July 2011

[17]National Environmental Information Management System, Final Report 2013 by SUPARCO & Ministry of Climate Change

The Site 1, Site 2 and Site 3 were selected as the residential, commercial and industrial sites respectively in Islamabad. The average concentrations (24 h) of fine Particulate Matter ($PM_{2.5}$) at Site 2 and Site 3 slightly exceeded the standard limit (40µg/m^3) while it remained within the limit at Site 1. The average concentration (in a 24 hour period) of coarse Particulate Matter (PM_{10}) was within the Pakistan Environmental Protection Agency (Pak-EPA) standard limit (250µg/m^3) at all the three sites. The average concentrations of SO_2 and O_3 were found within the Pak-EPA standard limits [120µg/m^3 for SO_2 and 180µg/m^3 (1h) for O_3] at all the three monitoring sites of Islamabad. The average concentrations of NO_2 were within the standard limit (80µg/m^3) at Site 1 and Site 2 while somewhat exceeded at Site3.

Rawalpindi

The concentrations of $PM_{2.5}$, PM_{10}, SO_2, O_3 and NO_2 at Site 1 (Kohinoor Mill), Site 2 (Attock Refinery Limited), Site 3 (Faizabad, Murree Road), Site 4 (Raja Bazaar) and Site5 (Radio Pakistan) observed in 2011 are as follows:

Table 14 : Atmospheric Pollutants in Rawalpindi[18]

Sample Sites	$PM_{2.5}$			PM			SO_2			O_3			NO_2		
	24 hrs. av.	**Hourly Max**	**Hourly Min**	**24 hrs. av.**	**Max**	**Min**	**24 hrs. av.**	**Max**	**Min**	**24 hrs. av.**	**Max**	**Min**	**24 hrs. av.**	**Max**	**Min**
Site 1 business & industrial	49.7	167	10	180.9	347.5	89	43	54.6	37.3	64.9	107.9	16	62.6	131.9	19.8
Site 2 business & industrial	44.2	64	20	163.7	201.3	100.3	42.7	53.9	37.9	87.2	124.6	11.6	84.1	137.6	35.4
Site 3 residential & commercial	35.8	71.5	8	163.1	257.8	111	41.5	50	37.3	59.1	97.5	10.6	69.4	117.6	27.3
Site 4 residential &commercial	32.7	67	9.5	162.2	211.8	97	52.3	81.5	37.1	44.5	52.8	26	60.8	116	22.6
Site 5 residential &commercial	36.5	62	19.5	189.1	307.5	132.8	49.6	75.1	32.5	69.3	122.5	16.6	69.1	121.8	24.8

The averages (24 hour period) of fine particulate matter ($PM_{2.5}$) at Site 1 and Site 2 slightly exceeded the standard limit (40µg/m^3) while it remained within the limit at Site 3, Site 4 and Site 5. The average concentrations of coarse particulate matter (PM_{10}) were within the Pak-EPA standard limit (250µg/m^3) at all the five sites. The average concentrations of SO_2 and O_3 were found within the Pak-EPA standard limits

[18]National Environmental Information Management System, Final Report 2013 by SUPARCO & Ministry of Climate Change

[120µg/m^3 for SO_2 and 180µg/m^3 (1h) for O_3] at all the sites, while the average concentrations of NO_2 were slightly higher than the standard limits i.e. 80µg/m^{3}at Site 2 while it was within limits at other four sites.

3.4.1.6 Smog

Smog is made up of a combination of air pollutants consisting mainly ozone, sulphur dioxide and fine particulate matter. The impact of smog in Islamabad has become more pronounced in recent years. Smog is produced due to increases in air pollution through a complex set of photochemical reactions involving volatile organic compounds and nitrogen oxide that results in the production of ozone. Emissions from industries, brick kilns, motor vehicles etc. are the main source of smog formation. In 1998, the number of registered vehicles in Islamabad was just 60,000, whereas it was360,000 in2011[19]. It is estimated that about 45,000 vehicles are being registered annually in Islamabad. The number of vehicles on the roads of Islamabad is estimated to be about 650,000 in 2013. Carbon Dioxide (CO_2) emissions from consumption of diesel/gasoline and compressed natural gas in the transport sector, has been estimated to be over 3 million tons per year[20]. It was estimated that the emission of greenhouse gases from brick kilns, other industries, transport and other sectors in Islamabad and Rawalpindi districts were about one billion tonnes of all greenhouse gasses combined per annum.

3.4.1.7 Atmospheric Aerosols in Islamabad:

Atmospheric aerosols refer to the suspended solid and liquid particles consisting of in the troposphere. Aerosols have significant impact on Earth's energy budget through absorption and scattering of solar radiation. Aerosols also alter the climate through modification of chemical, microphysical and optical properties of clouds and their extent. In this way, atmospheric aerosols lead to change in precipitation pattern as well[21].

A study[22] was undertaken to assess the distribution of aerosols in Islamabad and 74 samples were collected from residential and urban areas of Islamabad. The sampling was conducted on 8-12 hours day time basis. The results revealed that zinc has highest mean concentration of 844 ng/m^3, followed by iron, at 642 ng/m^3, and lead at 253ng/m^3 which are emitted from industrial and automobile emissions respectively. While, iron in the atmosphere is from windblown soil dust. The remaining metals manganese, chronium and cobalt showed their mean levels as 69,26 and 15 ng/m^3 respectively. These levels could be attributed to industrial emissions in the area. Average level of nickel and cadmium were estimated to be 10 and 5 ng/m^3, respectively. Their relative contributions are shown in Figure below.

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[19]The News, 2011, *New System for Registration of Vehicles Launched in Capital*, Published on January 01, 2011, http://www.thenews.com.pk/Todays-News-6-23300-New-system-for-registration-of-vehicles-launched-in-capital (March 31, 2014)

[20]http://webcache.googleusercontent.com/search?q=cache:t1y9_EjtrnYJ:www.automark.pk/articles/item/201-first-motor-vehicle-fitness-certification-centre-islamabad.html%3Ftmpl%3Dcomponent%26amp+&cd=1&hl=en&ct=clnk&gl=pk

[21]CCSP, 2009.*Atmospheric Aerosol Properties and Climate Impacts,* A Report by the U.S. Climate Change ScienceProgram and the Subcommittee on Global Change Research. [Mian Chin, Ralph A. Kahn, and Stephen E. Schwartz(eds.)]. National Aeronautics and Space Administration, Washington, D.C., USA, 128 pp.

[22] Shah, MunirHussain and Shaheen, Nazia,"Study of Particle size and trace metal distribution in atmospheric aerosol of Islamabad. (2009)

Table 15 : Statistical Distribution of Parameters for Trace Metal Levels (ng/m3)

	Zn	Fe	Pb	Mn	Cr	Co	Ni	Cd
Minimum	27	37	16	23	4	3	4	2
Maximum	2350	2950	2013	314	94	59	65	17
Mean	844	642	253	69	26	15	10	5
Median	793	536	133	60	9	8	8	4
Standard Deviation	578	450	396	43	23	17	14	2
Standard Error	67	52	46	5.0	2.7	2.0	1.6	0.2
Kurtosis	-0.7	9.1	9.6	14.5	-0.1	0.4	7.2	8.4
Skewness	0.3	2.4	3.1	3.0	0.7	1.4	2.9	4.7

The data on particulate size fractionate are given in the above table which lists the volume percentage fractions of particles found in the aerosol samples. Particle size fractioning was obtained for four size categories.

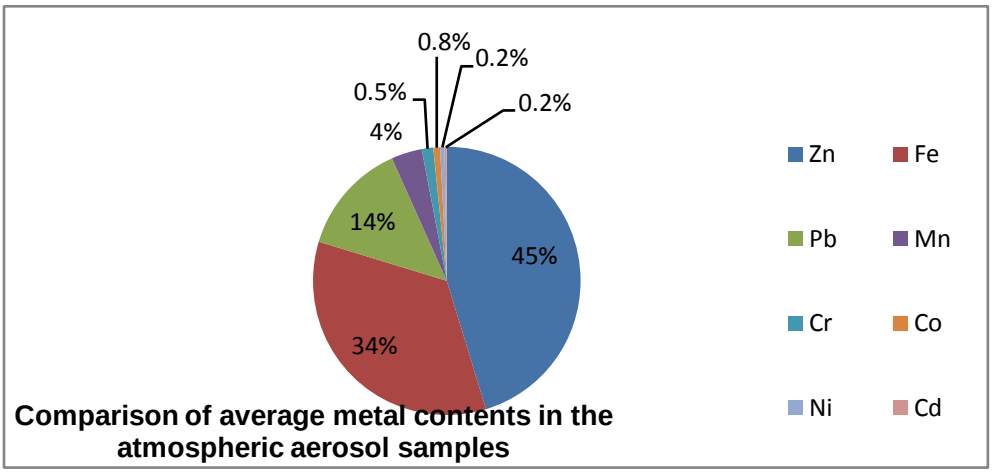

Figure 24 : Comparison of average metal contents in the atmospheric aerosol samples

The study brings out marked difference between levels of trace metals in the local urban atmosphere. Relatively higher levels of trace elements in Islamabad are indicative of the fact that the local atmosphere is undergoing some significant anthropogenic translocations, possibly through the process of colloidal particulate transport and/or preferential flow of air masses. During the period of present study, the meteorological data indicates that Monsoon winds mostly carried the anthropogenic particulate burden towards central locations in Islamabad, a fact that supports higher influx of trace elements in the urban area.

On the whole, the major particulate contributors are Zn, Fe and Pb, while the minor contributors come from Mn,Cr, Co, Ni and Cd. The trace metals are mostly contributed by automobile and industrial emissions along with some contribution from natural sources. Most of the metals reveal positive correlation with smaller size particles ($PM_{<2.5}$ and $PM_{2.5-10}$) which are detrimental to human health.

Experimental methodology

The sampling was conducted on 8-12 hours' time day time basis. An axial air sampler was also periodically as a parallel check for the same sampling duration. In all, 74 aerosol samples were collected at Sector H-8, representing the typical residential/urban area and stored in a desiccators at constant humidity. Each filter containing aerosol particulates was cut into two halves, one was digested in concentrated HNO_3/HCL (1:3 v/v) for atomic absorption spectrometric based quantification of the 8 trace elements and the other for particulate size determination using a master sizer.

3.4.1.8 Views of Local residents about climate change effects over time

Scientific projections for Climate change Vulnerability assessment are very useful but due to limitation of well documented data, it was considered to interview the local residents living in Islamabad for more than 20 years to supplement the scientific findings and bridging the gap of unavailability of scientific projections. The observations noted are as follows:

- Intensity of coldness has decreased over time and the winter season has shortened;
- Duration of summer season has increased; initially after 2-5 hot days, there was a rain, now there are a number of hot weeks and then hardly rainfall occurs. This has caused depletion of groundwater recharge
- Maximum temperature and number of hot days has increased;
- Need of use of Air-conditioners has caused increased energy requirements;
- Duration of spring season has decreased; causing reduced greeneries in plants and increased occurrence of plant diseases and pests.
- Occurrence of storms due to wind or rainfall has increased in intensity and frequency; affecting economic activities; Snowfall in Islamabad and Rawalpindi city area was seen up to 2008.
- Increased smog and aerosol effects are causing reduction in visibility and affecting communication and economic activities;
- Incidence of pollen allergy and skin, respiratory and eye diseases due to climate effects has increased.

3.4.2. Islamabad CC Sensitivity: Biophysical effects and its bearing on socio-economic conditions

Climate change sensitivity due to bio-physical and natural environment such as change in frequency & intensity of temperature and rainfall, increased wind storms, smog and aerosol effects, change in duration and intensity of seasons etc. is affecting the socioeconomic conditions of the people.

3.4.2.1. Groundwater Depletion and ecosystems

According to a study in Islamabad by Pakistan Council for Research on Water Resources (PCRWR), "Only 10 years ago in some locations water could be found 50 to 100 feet deep. Today people have to bore 250 to 300 feet down for drinking water". It may be attributed to unsustainable use of water and increasing groundwater extraction and reduced water percolation in soil due to urban expansion and increase in population.

According to another study carried out in Rawalpindi[23], a trend of continuous drop in groundwater level of Rawalpindi was observed. On average, the aquifer is depleting at the rate of 1.7 metres per year. A maximum

[23]Spatio-temporal analysis of groundwater regime within Rawalpindi Municipal Jurisdiction, Pakistan by Iftikhar Abbas, H.M. Rafique, Muhammad A. Sohl, Attia Falak, Shahid Mahmood d, Muhammad Imran d, Yousef Al-Zaghayer, Adul Rehman Al-Awadi & Asif Mahmood

of 20metre drop in water level was noticed in Gulshanabad Mohallah, in the study area. It has also been observed that drop in water level is more where wells are densely distributed.

The aquifer consists of varying proportions of gravel, boulders and sand deposits with layers of clay and silt. The physical properties of the aquifer are favourable for the development of groundwater with moderate values of transmissibility and specific yield.

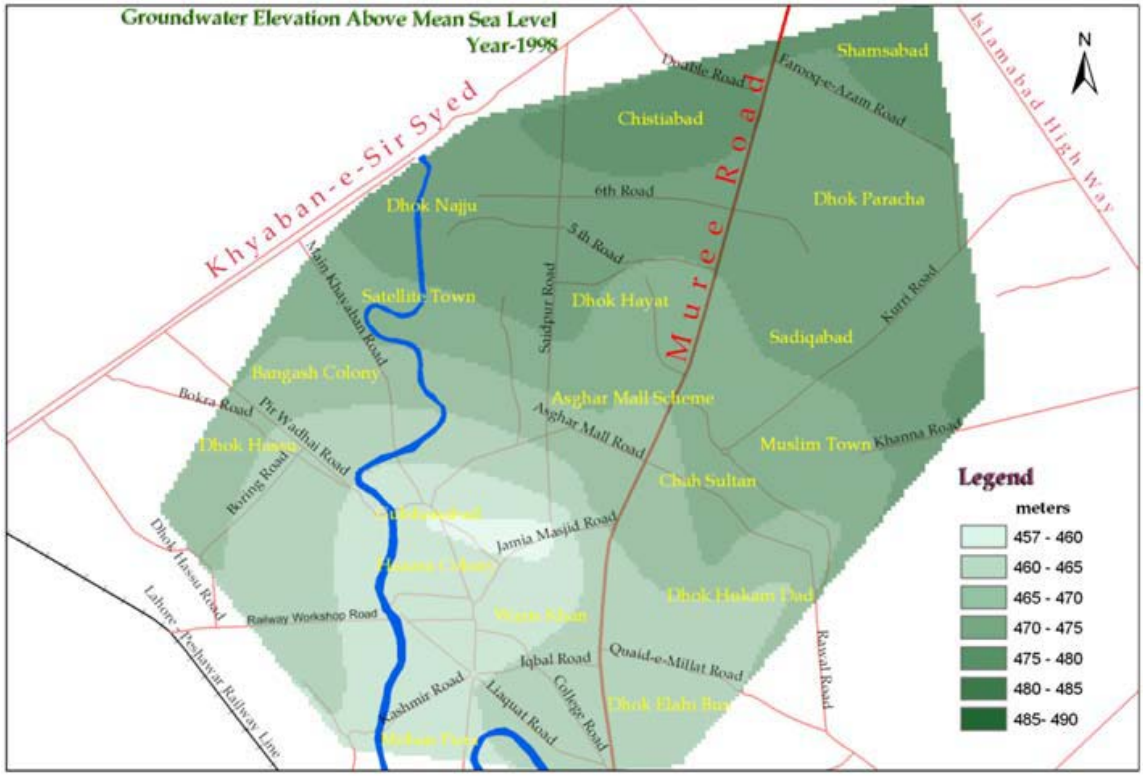

Figure 25 : - Groundwater elevation above Mean Sea level in Rawalpindi Year 1998

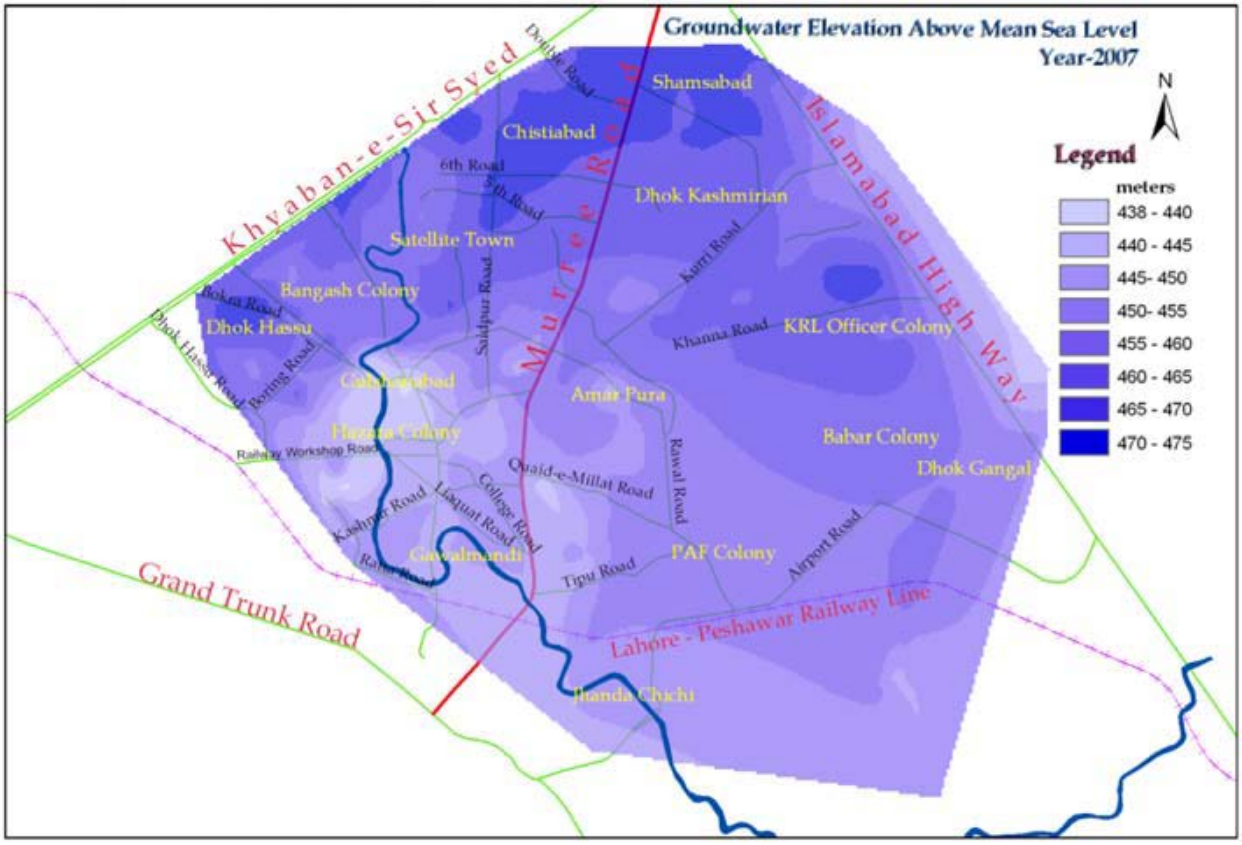

Figure 26 : Groundwater elevation above Mean Sea level in Rawalpindi Year 2007

Ecosystems

Climate change has the potential to impact ecosystems, and exacerbates existing ecosystem degradation caused by rapid urbanisation, conversion of green space into urban land use. As noted above, there has been a decline in ground water availability, or, more specifically, an increase in the depth of ground water. This not only makes the water harder to extract but also decreases the ability of ecosystems in and around Islamabad and the Capital Territory to utilise ground water for their survival. Meanwhile, an extended dry season, especially coupled with increasingly rapid extraction (and thus greater depth) of ground water means that ecosystems will struggle to survive because they receive insufficient water.

Ecosystems have a strong inter relationship with food production and other livelihoods. The shortening of the spring season – which is a crucial time for growing fruit, flowers and some vegetable species such as peas – is likely to impact the growth and health of these species and ecosystems, and consequently will result in a decline in food production. Moreover, as urban land expands and land use of ecosystems and agriculture decreases, so the ability of land to absorb water also decreases. Even without climate change, this means that there is greater flood risk. If climate change results in heavier rainfall over shorter periods – as projected – this is very likely to further heighten the impact of local and river flooding.

Lack of political will for protection of the natural environment, non-implementation of land use regulation, defiance and divergence from Master Plan is causing rapid deterioration of environment and ecology of

Islamabad and Islamabad Capital Territory region. Encroachment of natural environment by vested groups and violators are further triggering the deterioration of the environment. Compromises out of political expediencies are the root cause of deviation from the Master Plan. Industrial pollution; vehicular emissions; biomass burning; lack of control of particulate matters and encroachment of alien botanical species (paper mulberry) causing pulmonary diseases are the main causes of deteriorating environment in the region. Brick kilns, stone crushing and other industrial units in Islamabad are causing environmental problems.

The incidence of **pollen allergy** has increased in twin cities of Rawalpindi and Islamabad due to climate effects and excessive plantation and wild growth of exotic trees like mulberry. There is a need to plant indigenous species of trees only and stop import of alien species of plants, animals and micro-organisms. Spread of Alien species of plants, animals and micro-organisms are posing serious threats to biodiversity and eco-systems. Particularly, The wild spread of exotic species of trees is also threatening the indigenous tree species. The alien species are also adversely affecting growth of various local plant species including wild olive (Kahu), Phulai plants, wild pomegranate (daruna), soapberry (reetha), katha, bamboo (baans), and banyan tree (bohar). According to various reports, about 45.5 percent of allergy patients in Islamabad and Rawalpindi are allergic to pollen from mulberry plant. Pollen counts as high as 50,000 per cubic meter were recorded in Islamabad during 2013 turning the city into the so called "Allergy Capital" of the world. Other allergy culprits in Islamabad include bottle brush, *callistemon conocarpus*, and various grasses that release pollens particularly in the spring season.

3.4.2.2 Economic Systems and Livelihoods

The Benazir Income Support Programme of the Government of Pakistan collected data and analysed it to establish a poverty scorecard in different cities of Pakistan. Based on the analysis for Islamabad and its peripheral areas, the findings revealed that the socio-economic profile of the urban poor in Islamabad is as follows:

- The people living in marginal areas and slums such as French colony, settlements along nullahs/natural drains in sectors like F-6, F-7, Bari Imam, Saidpur village;
- Temporary abadies and transit camps formed due to migration of internally displaced population and refugees; Altogether 81,000 individuals live in slums, informal settlement areas and seven transit camps in Islamabad, out of these 10,900 individuals live in transit camps, .
- In rural areas impact of poverty is relatively lesser in Islamabad as compared to other rural areas of Pakistan;
- The Level of poverty was more pronounced in areas without proper drinking water and sanitation facilities.

Impacts of climate change such as extreme weather conditions, cold winds from Mangalla Hills are more severe on the poor people because of substandard housing conditions and non-availability of basic support infra-structure services. The daily wage labourers and vendors have lesser working hours during extreme weather events. The female population is not able to collect fuel-wood and water for daily use during extreme weather conditions.

Multiple climate change hazards affect agricultural production, which has numerous impacts on wealth and livelihoods. About 50 per cent of the rural population of Islamabad Capital Territory earn their livelihood from livestock and dairy farming. Other sources of livelihood include services including white collar jobs, daily wage earners and real estate business. Since agro-farming in Islamabad is dependent on rains, and there is absence of a proper irrigation network so there is only subsistence farming practiced by rural population. These people will be most severely and immediately impacted by floods, droughts, heat stress and declining air quality as all these hazards prevent crops from growing and can kill existing crops and animals. Such impacts on agricultural production have a secondary impact on food prices in the urban area, as decreased supply and/or availability of food results in higher prices, thus impacting the poor, women and daily wage earners most significantly. Referring back to Figures 26 and 27, we can see, for example, there has been a

marked change in the depth of ground water. Changes in ground water depth can be influenced by both climate and non-climate factors, including, inter alia, declines in rainfall, overuse due to increased population pressures and urban expansion.

Cottage industries around Islamabad include honeybee keeping, clay potteries, value added products from sccharum (Kana), embroidery, and marble are affected by the breakdown of electricity supply for long hours that affects the working hours of labourers and their output as a whole and consequently increasing the poverty. Benazir Income Support Programme and Zakat system at the government and private levels are contributing towards social safety nets on short term basis. Education and health facilities are being affected due to extreme climate events.

3.4.2.3 Infrastructure and Urban Basic Services – Drinking Water Quality, Drainage, and Transport

Drinking Water Quality

There are serious drinking water quality concerns for Islamabad, which include contamination with effluent from industry and hospital waste. Three sites were selected to study water quality in Islamabad which included residential, commercial and industrial areas. The 1st cycle for monitoring of water quality was carried out by Pakistan Council for Research on Water Resources (PCRWR) during 2001 and the 2nd cycle of water quality monitoring was also carried out by PCRWR during 2005-2006 while 3rd cycle was carried out by SUPARCO from July 2011, to September, 2011.

Islamabad

The analysis of water samples from Rawal Dam, Rumliwala near Bari Imam, G6/4 Abpara and Abpara revealed following results:

- The hardness level was much **higher** in all the four sites than the limit of 20 mg/l (Maximum acceptable concentration) set by Pakistan Standards and Quality Control Authority (PSQCA).
- At the Rawal dam site, the hardness level of the water was still lower than the results obtained in 2001 and 2005 by PCRWR which remained at the levels of 260 mg/l and 310 mg/l.
- The result of Fluoride (F-1) levels was 2.5 mg/l, which exceeded the WHO permissible maximum limit of 1.5 mg/l. The Fluoride at this site was also higher than that examined during 2001 and 2005 by PCRWR 0.36 mg/l and 0.3 mg/l respectively. The level of Fluoride in other sites was within the limits.
- The results of Coli (total Coliform bacteria) and E.Coli at Rawal dam and Rumliwala near Bari Imam were observed as over and above the WHO permissible limit of zero (0) / 100 ml in water while E.Coli was within the limits in other two sites.
- The results of other parameters like Conductivity, pH, Odour, Taste, Turbidity, Calcium, Magnesium, Chloride, Sodium, Potassium, Sulphate, Nitrate, Total Dissolve Solids, Iron, Chromium and Arsenic remained within the limits set by WHO.
    - The graphical presentation of the results is at Annex-VIII.

Rawalpindi

Water sample analysis was conducted at Moti Masjid, Pakistan Air Force Base Minhas Campus and Banni Thana in Rawalpindi. The results of the study are as follows:

- The hardness value at all the three sites was found to be much **higher** than the 20 mg/l (Maximum acceptable concentration). limit set by PSQCA
- The Hardness result of Moti Masjid, PAF Base Minhas Campus was also found **higher** than the results determined by PCRWR during 2001 and 2005, while it was found lower at Banni Thannathan the results determined by PCRWR during 2001 and 2005.

- The analytical result for Iron (Fe) exceeded the World Health Organisation's maximum permissible limit of. 0.30 mg/l at all the three sites. The result of Iron at this site was also found to be **higher** than the results obtained by PCRWR which were determined as 0.05 mg/l and 0.12 mg/l during 2001 and 2005 respectively.
- Arsenic (As) at Pakistan Air Force (PAF) Base Minhas Campus was 0.039 mg/l exceeded the World Health Organisation's maximum permissible limit (0.01 mg/l). The Arsenic result of this site was found to be higher than the results obtained by PCRWR which amounted to 0.0 mg/l and 0.00034 mg/l during 2001 and 2005 respectively. Arsenic levels at other two sites were within permissible limits.
- The results of Coli (total Coliform bacteria) and E.Coli were **higher** at all the three sites than WHO's permissible limit of zero (0) / 100 ml of sample.
- The results of other parameters were within the World Health Organisation limits.

The graphical presentation of the results is at Annex-IX.

Wastewater

Rawal Dam Site

The analysis of wastewater samples collected from the site of Rawal Dam determined the level of Chemical Oxygen Demand (COD) to 365 mg/l which was noted as higher than the NEQS maximum limit of 150 mg/l. The results of other parameters such as pH, Total Suspended Solids (TSS), Biological Oxygen Demand, Ammonia, Arsenic, Barium, Boron, Cyanide, Chloride, Chlorine, Chromium, Cadmium, Copper, Fluoride, Lead, Iron, Mercury, Manganese, Nickel, Sulphate, Sulfide, Selenium, Zinc, Phenolic Compounds and Oil and Grease were within the NEQS limits.

Rumliwala Near Bari Imam Site

The analysis of wastewater samples collected from the site of Rumliwala near Bari Imam determined the Total Suspended Solids (TSS) amounting to 209 mg/l which were higher than the NEQS maximum limit set as 150 mg/l. The Chemical Oxygen Demand (COD) was evaluated to 175 mg/l which was also higher than the NEQS maximum limit set as 150 mg/l. The quantity of Arsenic (As) was found to be 1.016 mg/l which exceeded the NEQS maximum limit of1.0 mg/l. The amount of other parameters such as pH, Biological Oxygen Demand (BOD), Ammonia, Barium, Boron, Cyanide, Chloride, Chlorine, Chromium, Cadmium, Copper, Fluoride, Lead, Iron, Mercury, Manganese, Nickel, Sulphate, Sulfide, Selenium, Zinc, Phenolic Compounds and Oil and Grease was found within the NEQS limits.

G 6/4 Abpara Site

The analysis of wastewater samples acquired from the site of G 6/4 Abpara revealed the level of Biological Oxygen Demand (BOD) being 83 mg/l which was higher than the NEQS maximum limit defined as 80 mg/l. The amount of Phenolic Compounds was found to be 0.141 mg/l which exceeded the NEQS maximum limit of 0.1 mg/l. The quantity of Chromium (Cr) was noted to be 1.015 mg/l which was slightly higher than the NEQS maximum limit of 1.0 mg/l. The results of other parameters such as pH, Total Suspended Solids (TSS), Chemical Oxygen Demand (COD), Ammonia, Arsenic, Barium, Boron, Cyanide, Chloride, Chlorine, Cadmium, Copper, Fluoride, Lead, Iron, Mercury, Manganese, Nickel, Sulphate, Sulfide, Selenium, Zinc and Oil and Grease were within the NEQS limits.

Abpara Site

The analysis of wastewater samples collected from the site of Abpara determined the level of Chemical Oxygen Demand (COD) amounting to 192 mg/l which was higher than the NEQS maximum limit set as 150 mg/l. The amount of Oil and Grease was observed as 12 mg/l which exceeded its NEQS maximum limit that set as10 mg/l. The results of other parameters such as pH, Total Suspended Solids (TSS), Biological Oxygen Demand (BOD), Ammonia, Arsenic, Barium, Boron, Cyanide, Chloride, Chlorine, Cadmium, Chromium, Copper, Fluoride, Lead, Iron, Mercury, Manganese, Nickel, Sulphate, Sulfide, Selenium, Zinc and Phenolic Compounds were within the NEQS limits.

Drainage

Flooding in Rawalpindi is mainly due to the Nullah Lai and its five tributaries that originate from Islamabad and pass through dense urban settlements downstream of Islamabad and Rawalpindi. Over the years, there has been increased catchment area encroachment throughout the Nullah Lai. As a result, the right of way of natural drainage has been reduced. Erratic and extreme rainfall and cloud bursts cause flash floods, approximately once in every three years – a situation that it likely to become more frequent – while drainage is reduced in the catchment area of the Nullah Lai due to encroachment of residential and commercial buildings.

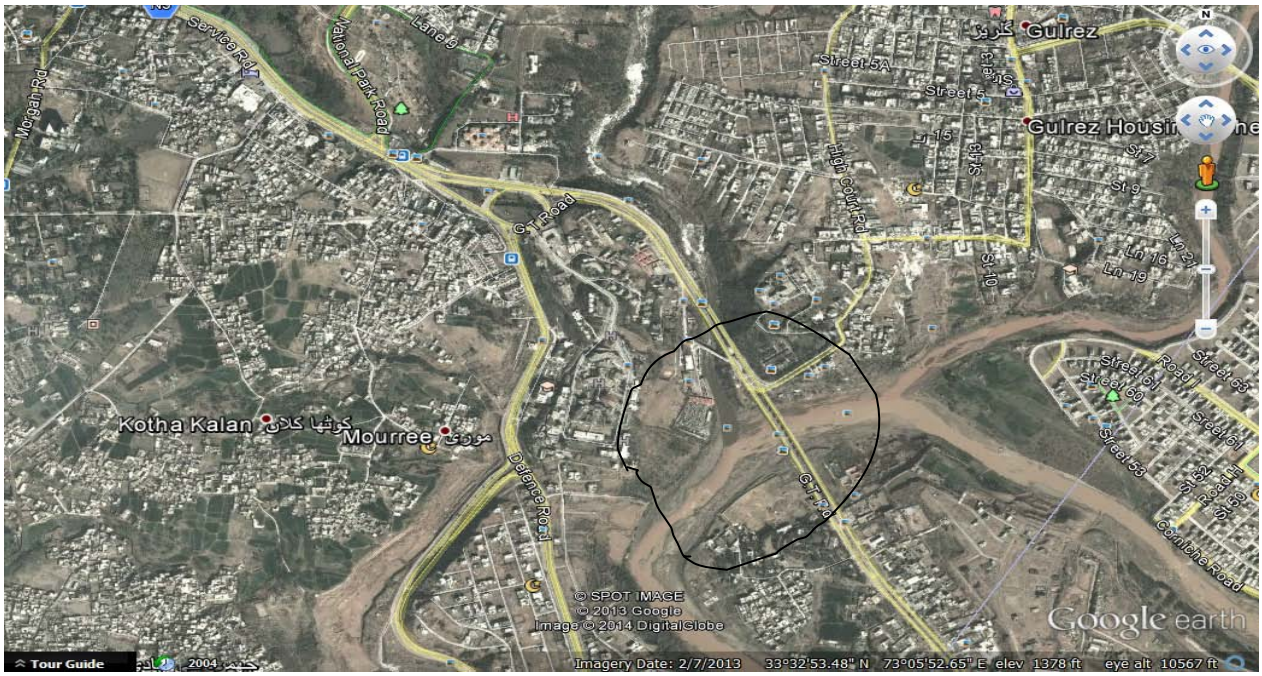

Figure 27 : Discharge of Nullah Lai in River Swan in 2013

The Lai Nullah Basin has a catchment area of 234.8 km^2, extending to the twin cities of Islamabad and Rawalpindi.

JICA has done a study to formulate a comprehensive flood mitigation and environmental improvement plan of Nullah Lai. The principle measures suggested by the study include: (i) Community rainwater harvesting pond with a catchment area of about 26.5 km^2; (ii) Flood Diversion Channels to divert the flood discharge from upper reaches of Lai Nullah to the adjacent Korang River; (iii) River bed improvement and (iv) Slide slope protection. Major recommendations of a workshop of stakeholders held on 31st December 2013 are as follows:

- Building of Retarding ponds in F-9 park
- Natural Depressions at appropriate locations in the green belts for retention / absorption of water
- Inverted wells (mesh) and surface ponds
- Every plot of over 500 ft^2must has a rainwater harvest system developed within the vicinity of the structure. Present in Capital Development Authority by-laws and this requires enforcement.

Encroachment around natural drains

The discharge of Nullah Lai falls in River Soan. At this point Nullah Lai discharges untreated municipal sewer water that has a foul smell and is the major source of pollution of the Soan. The Soan's water is used downstream for drinking purposes and irrigation of agricultural fields.

To monitor flooding situation in the Nullah Lai catchment area, local communities form groups to monitor the water level in the Nullah Lai. As the water rises above a certain threshold level, sirens are used by public institutions, beating drums and other methods to inform the people are used by local community. People take their belongings to the upper stories of the building. They transfer their livestock to some safer places. In addition, the Pakistan Meteorological Department has flood forecasting and early warning system. It helps in providing advance information through print and electronic media. Moreover, the Pakistan Meteorological Department has a toll free telephone number to get the information of rain and flood forecasting. The NGOs like National Rural Support Program through their Urban Poverty Alleviation Programme have established community based organizations/groups. In Rawalpindi they have about 16,000 groups of 62,000 local residents. During disaster these organizations help in informing the local community, their shifting to safer places, providing preventive/curative health care measures, assessment of damage and provision of relief goods.

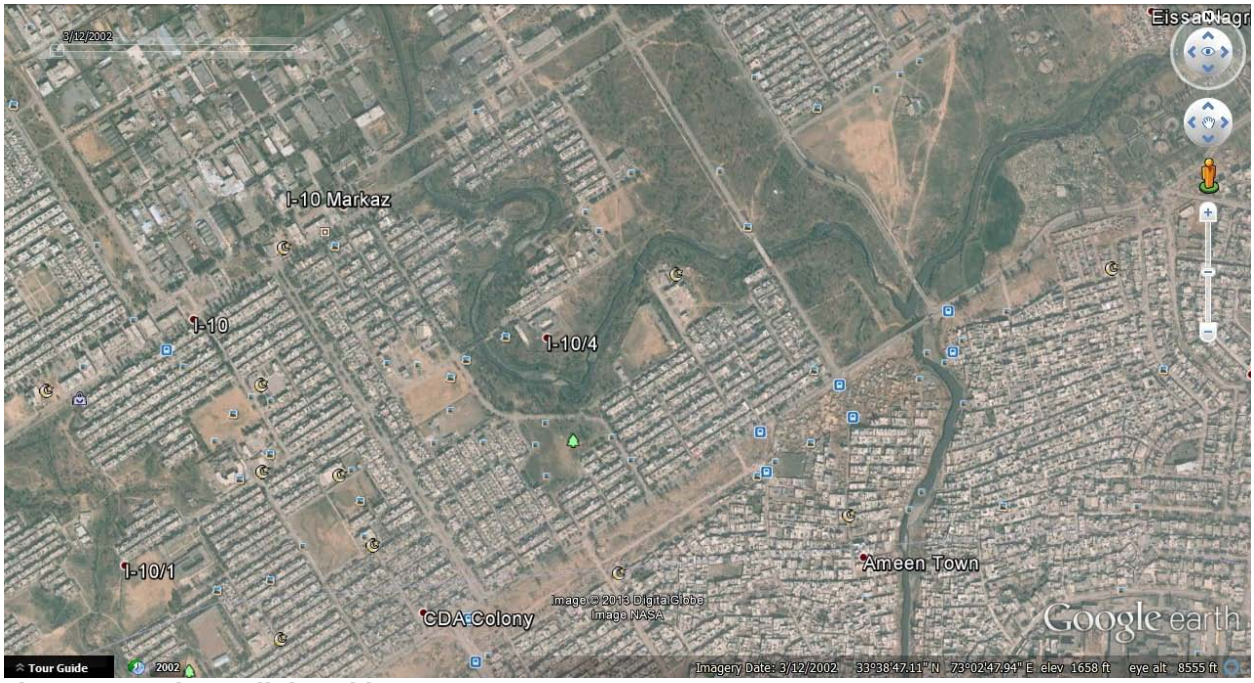

Figure 28 : The Nullah Lai in 2002

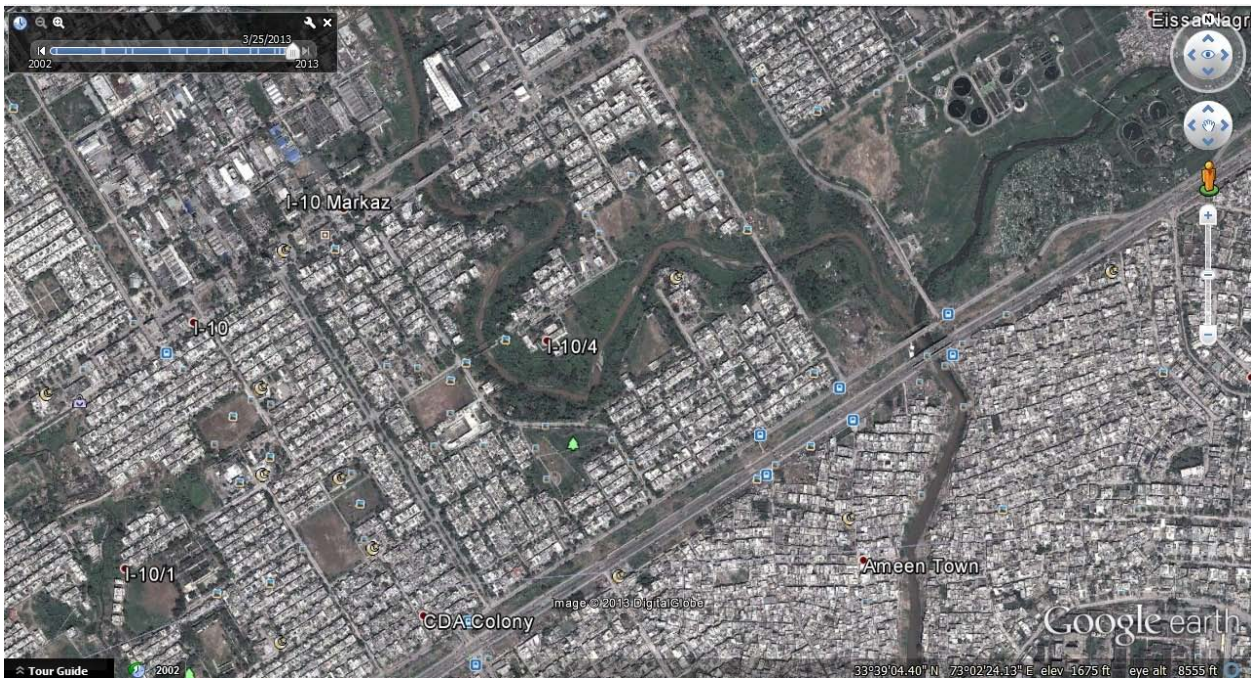

Figure 29 : The Nullah Lai at the junction of Islamabad and Rawalpindi in 2013

Figure 30 : The Nullah Lai in Rawalpindi in 2013

Sanitation and waste collection:
The sanitation condition in Islamabad urban areas is relatively better than the condition in rural areas. However, the sanitation condition in the slums, katchi abadies and transit camps located in Zone I and II comprising of urban areas is poor and becomes worst during rainy season and urban flooding. More than 80 per cent municipal waste is collected by the Capital Development Authority. Major part of the waste collected by the authority is sold to cement industry for use as fuel. The Pakistan Environmental Protection Agency, keeping in view the high demand of municipal waste has developed the guidelines for Refuse Derived Fuels (RDF) for protection of environment around the industry using RDF for fuel. In addition, due to energy crisis,

Public Transportation
The Government of Pakistan has recently launched construction of Metro Bus Service route. The portion of Metro Bus Service in Rawalpindi from Flashman's Hotel to Faizabad having distance of 8.6 kilometres would be on elevated track, while from Faizabad to Pak Secretariat via IJP Road and 9thAvenue up to the destination having distance of 14.6 kilometres, the project will be on ground road. A total of 24 modern stations for passengers would be built on the whole track out of which 10 will be on Murree Road and the remaining 14 will be in Islamabad area. Initially, 60 buses would be plied on Metro Bus track from Rawalpindi to Islamabad and more than 150, 000 passengers would be benefitted with this project. This initiative will reduce GHG emissions from the transport sector.

The land allocated for central transport terminal including rail and road transportation and warehousing in Sector I-8 has been consumed for residential purposes. This has deprived the city of an essential component of transportation facility. Resultantly, the city lacks mass transit system and is totally dependent on individually owned vehicles, taxies and mini- vans. This phenomenon has also contributed towards warming of micro-climate of Islamabad city and its suburbs.

Extreme weather events like fog, smog, high and low temperature, extreme rainfall etc. cause disruptions in smooth functioning of transport and communication networks, which affects the daily life of the people. The people especially women cannot go to their work places due to damaged or impassable roads. Severe flooding, both localised flooding through heavy rainfall and flooding due to excess ground water and/or water in the Nullah Lai and its associated river systems can also damage railway infrastructure, including both vital commuter and inter-city rail lines. Damage to critical infrastructure has direct economic costs. Repair of roads and railways is costly to the city and strains local budgets, while impassability of roads means that local people cannot access market places to trade or earn sources of livelihood. Consequently, the poor and daily wage earners are the most seriously affected by the economic knock-on effects of flood related damage to roads and other transport infrastructure.

Housing

The impact of 2001 flood in Islamabad was mainly in low lying and densely populated areas along Saidpur Kas and Tenawali Kas and katchi abadies, while in Rawalpindi 400,000 people were affected living along Nullah Lai and its lower basin, where the houses and shops were built encroaching the bed of the Nullah Lai.

The expansion of Islamabad and Rawalpindi beyond its original plan heightens the likelihood that those living in unplanned areas will be seriously impacted – especially by flooding. In many cases, the poorest tend to be driven to areas that are most likely to flood. However, in severe floods, such as that in 2001, even people in the planned urban area, within and outside the Nullah Lai’s immediate lower basin, were also affected

3.4.2.4 Social Systems and Health Related Impacts

Health related climate change impacts in Islamabad and the Capital Territory region are evident from increasing number of respiratory, skin and eye related diseases due to air pollution, high contents of particulate matter, aerosols as well as water borne diseases such as diarrheal diseases, malaria and dengue. These diseases are potentially life threatening and highly climate-sensitive Areas with weak health infrastructure particularly in rural periphery of Islamabad are often the most seriously affected and are the least able to cope to prepare and respond to the diseases due to climate change effects.

Extremes of temperature are increasing the number of heat-related illnesses like heat stroke and dehydration which are one of the reasons of the increasing number of deaths. Increases in the frequency and severity of extreme weather events such as storms increase the risk of dangerous flooding, mostly in Nullah Lai and its basin areas downstream up to Rawalpindi; high winds are threats to people and property. Warmer temperatures increase the concentrations of unhealthy air and water pollutants. Changes in temperature, precipitation patterns, and extreme events could enhance the spread of Dengue fever, respiratory and skin diseases, for example.

The impacts of climate change on health depend on many factors. These include the effectiveness of a community's public health and safety programs, the behaviour, age, gender, and economic status of individuals affected the sensitivity of populations, the extent and length of exposure to climate change impacts, and society's ability to adapt to change.

As shown in the exposure section, urban areas are in Islamabad and the Capital Territory are becoming warmer than their rural surroundings due to the urban heat island effects. As per climate change projections, it is likely to further increase the demand for electricity in the summer to run air conditioning, which in turn would increase air pollution and greenhouse gas emissions as electricity is primarily generated through fossil fuelled power plants in Pakistan. Extreme weather events are causing injuries and, in some cases, deaths. As with heat waves, the people most at risk include young children, older adults, people with medical conditions, and the poor. Furthermore, extreme events are leading to reduction in the availability of fresh food and water; interrupt communication, utility, and health care services; contribute to poisoning due to carbon monoxide and other harmful gases from portable diesel generators used during and after floods.

Inhaling fine particles (smaller than 2.5 micrometers) also leads to a broad range of adverse health effects, including premature death, aggravation of cardiovascular and respiratory diseases, development of chronic lung disease, exacerbation of asthma, allergy and decreased lung function growth in children. Sources of fine particle pollution include gasoline and diesel engines, wood combustion, high-temperature industrial processes such as re-rolling mills, and forest fires. Climate change is also increasing surface-level ozone concentrations in areas where pollution levels are already high. Disease-causing agents, called pathogens, are being transmitted through food, water, and animals such as mosquito, birds, mice, pets and insects. Climate change is affecting all of these transmitters.

Higher air temperature is increasing cases of salmonella and other bacteria-related food poisoning because bacteria grow more rapidly in warm environments. These diseases cause gastrointestinal distress and, in severe cases, death. Flooding and heavy rainfall causes overflows from sewage into fresh water sources. For example, severe flooding between December 1993 and March 1994 in sectors G-9, G-10 and H-11 caused more than 1300 cases of acute viral hepatitis. .

Heavy rainfall events cause storm-water runoff that may contaminate water bodies used for recreation (such as lakes) and drinking water sources with other bacteria. Mosquitoes favour warm, wet climates and spreads diseases such as Dengue and Malaria. The spread of climate-sensitive diseases depend on both climate and non-climate factors. Changes in temperature and precipitation, as well as droughts and floods, also affect agricultural yields and production.

Mining of stone quarries and establishment of stone crushing businesses is further contributing to air pollution (Particulate Matter – PM10), which is causing increase in lungs and respiratory diseases) and reducing the availability of land based resources for development and plantation.

Smog affects people, livestock and crop production in various ways, such as respiratory ailments and asthma. The mucus membranes in the eyes and nose become irritated by smog leading to soreness, especially among children, women and elderly people. Its impacts are also caused on pets and farm animals as well as crops like wheat, maize, and peas.

3.4.2.5 Education

Schools in Katchi abadies, slums and poor settlements are without building and proper infrastructure and in case of extreme weather conditions, it is not possible to teach the students causing disruption in teaching and the children are not able to complete the curriculum and courses in time. As a result of this disruption, education attainment is likely to decline, especially in the poorest and most flood-prone areas. This is due to a number of factors – access to school and scheduled classes being the most immediate, but also increased rates of disease, poorer nutrition and lower family livelihoods also affect educational attainment

3.4.2.6 Summarising Exposure and Sensitivity

The table below summarises the exposure and sensitivity analysed so far in this report, and introduces the critically affected 'hotspot' areas where impacts are at their most severe.

Table 16 : Sensitivity Summary Table

Climate Driven Phenomena	Biophysical/Risk Effects (evidences from previous events)	Sensitivity	Critical Places/Hot spots	Critical Impact Areas/Sector	Level of Impact on Vulnerable Population
A. Changes in extreme climatic conditions					
Increase in frequency & intensity of temperature	- Heat stress caused by urban heat island effect - The weather affects air pollution concentration & distribution, seasonality & production of Aero-allergens)	- Heat stroke and other heat related sickness - Increased energy demand for air conditioning - Deaths from cardio-respiratory diseases& Long term physiological problems - Air pollution related mortality. - Reduction in livelihoods &urban economy - Loss of bio-diversity	Down town & dense settlement areas. Watershed zones, Dam command areas with lesser vegetation and water.	- Increased business of air-conditioners and room coolers. - Shortening of working hours of labourers and farmers exposed to open atmosphere. - Land & forest degradation	High
Increase in intensity of rainfall / Cloud burst	- Flashflood events - Areas identified as erosion prone - Occurrence of rainfall at the time of crop harvest	- Loss of human and animal lives and damage of property - Reduced production of crops. - Reduction in livelihoods &urban economy - Injuries& Long term physiological morbidities - More favourable breeding grounds for pathogens - The spread of epidemic diseases, mosquito-borne diseases like dengue fever, food and	Near Nullah Lai and in its basin area, Dam command areas experiencing flooding.	- Damage to physical infra-structure systems (Roads, railways, Street, bridges, power lines, sewage lines, school & hospital buildings etc.) - Trading reduced due to breakdown of communication network & means of transportation - Restriction in mobility of service oriented people including women Damage to crops	- High

		water-borne diseases			
Decrease in frequency of rainfall	- Depletion of groundwater recharge	- Shortage of drinking water - Drought & drought like phenomenon - Loss of bio-diversity	Down town & dense settlement areas. Watershed zones with lesser vegetation and water.	- Decrease in crop production. Increase in water delivery service business.	- High
Increased wind storms	- Creation of low pressure pockets, surge of high speed winds.	- Increased forest fires - Falling of trees - Damage of property	Sub-urban dry areas with lesser number of trees, dominated by shrubs, bushes & rocky areas	- Lesser trading - Reduced mobility of labourers, farmers, workers, women and children. Disturbance to livelihoods & city economy	- Medium
Increased smog and aerosol effects	- Produced through photochemical reactions of volatile organic compounds and Nitrogen oxide found in smoke from industries and transport sectors	- More particulate matters (PM-10) causing respiratory and cardiac diseases in human - Damage to crops and long-term health problems for pets and other animals	Down town & dense settlement areas	- Lesser trading - Reduced mobility of labourers, farmers, workers, women and children. Disturbance to livelihoods & city economy	- Medium
Changes in Means					
Increase in duration of summer season	- Prolongation of drought like situation.	- Reduced crop production - Increased livestock & human diseases	Watershed zones having lesser vegetation.	- Increased business of air-conditioners and room coolers. - Reduced production of rabi crops. - Load-shedding increasing business of emergency lights & candles. Increased expanses of	- High

				utility bills	
Decrease in intensity of coldness	- Reduced duration of winter season causing delay in sowing of rabi crops like wheat, mustard.	- Decreased production of fruits requiring specific chilling season. - Increased livestock and human diseases - Loss of bio-diversity	Orchards.	- Decreased business of heaters and geysers.	- Low
Decrease in duration of spring season	- Reduced spring season duration due to prolonged summer season	- Effecting production of crops like flowers and pea - Loss of bio-diversity	Gardens.	- Decreased tourism. - Bad effects on agri. sector (Ornamental & medicinal crops). Bad effects on household flowering plants	- Medium

3.4.2.6 Analysis of local impacts and key critical thresholds

The report has so far shown that the most severe impacts of climate change are located along the Nullah Lai. The hydro-meteorogical hazards to which Islamabad is exposed combine with high sensitivity high density, urban poor settlements, with poor drainage, sanitation and a lack of basic services to heighten the impact level on settlement areas that surround and encroach on the Nullah Lai. The most visible impacts have been those that have occurred as a result of extreme events, such as the cloud burst in 2001. In this case, 620mm of rain caused 74 deaths, 3,000 homes to be affected and more than US$200 million of damage. We can conclude that this event was well over the critical threshold of impact that Islamabad is able to withstand in terms of heavy rain events. In fact, as the exposure section shows, there have been at least 10 heavy rain events of over 300 millimetres during the study period that have caused damage to homes and infrastructure. We can also make the assumption that, as areas around the Nullah Lai continue to urbanise, with no corresponding improvements in drainage capacity or other protective infrastructure or ecosystems, the critical threshold at which impacts occur will decrease.

All people, places and institutions have a critical threshold regarding climate change. The impact and critical threshold describes the level or amount of a particular hazard – or change in a particular hazard – that is required to cause disruption (impact) and the level beyond which, people places and systems are not able to cope (critical threshold). In Figure 32, below, the team has plotted the 2001 cloudburst, where over 600 millimetres of rain fell in 10 hours. As the report has shown, this even caused significant loss of life and economic damage. It was beyond the critical threshold of cloud burst rainfall that Islamabad can withstand – both in terms of time and volume of water. The city may have been able to withstand 600milimetres spread over one month, or 100 millimetres in one day, but it could not withstand such a volume in such a short time period.

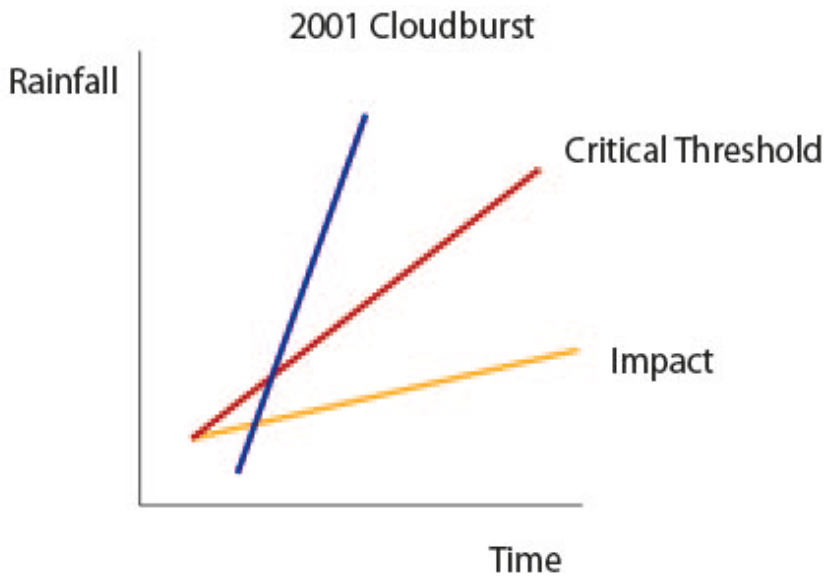

Figure 31 : Impact and Critical Thresholds against 2001 Cloudburst

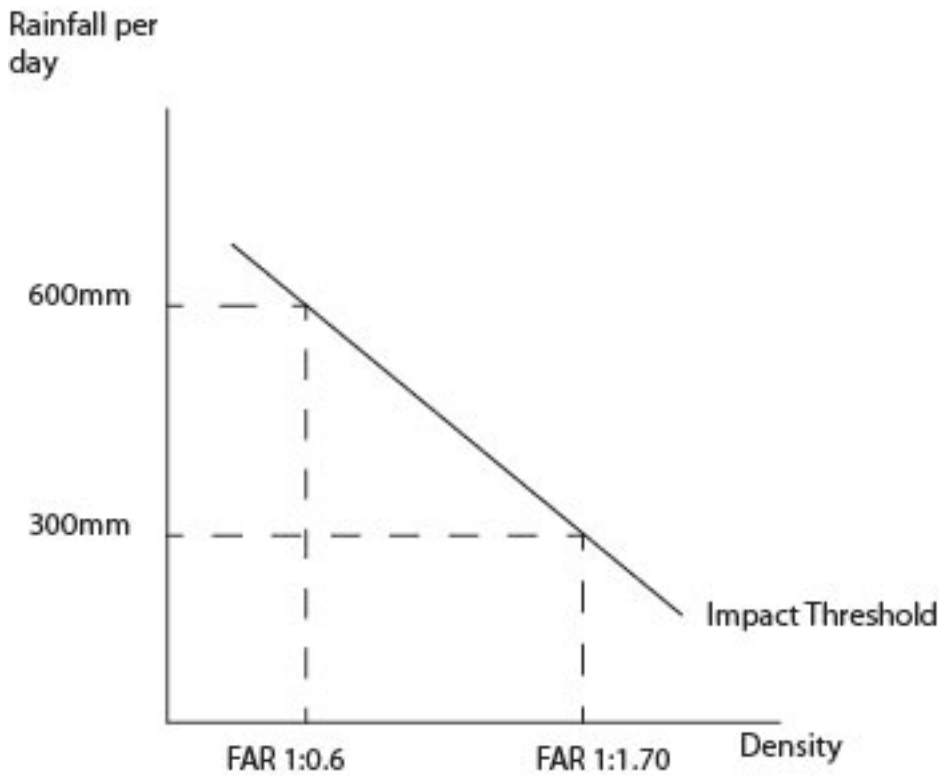

Figure 32 : Impact Threshold and urban Density

Figure 33 shows how, in the case of urban flooding that occurs as a result of cloudburst conditions, an increase in urban density, with no corresponding adaptation measures to improve drainage or to protect against floods, results in a declining impact and critical threshold. In other words, as density increases (measured here by floor area ratio), the level of rainfall required to cause flooding under cloud burst conditions decreases. The is a concern because Islamabad has been going through a rapid increase in urban density and urban expansion in recent years, which when combined with the possible impacts of climate change – cloudburst conditions becoming more frequent and more severe, creates a lower impact threshold and increases the urgency with which adaptation actions are required.

3.4.3 Adaptive Capacity

There are significant capacity gaps in undertaking climate change adaptation actions, yet both the people of Islamabad and Rawalpindi and government agencies have undertaken some adaptation measures to protect themselves from adverse effects of extreme events of climate change.

3.4.3.1 Effect of modifications to the 1960 Master Plan on adaptive capacity of the city

Over the years, there were a number of modifications have taken place in the Master plan due to policy changes. A few of such modifications area listed below, which are relevant to the adaptive capacity of the city:

1. Relocation of the site Quid-i-Azam University at the foot of Margalla hills in 1964
2. An Industrial estate for medium scale industry was created at the rural periphery at Kahuta road in 1968.

3. Fecto cement plant was allowed inside the Margalla hills National Park area in 1985, creating waste and pollution.
4. Zoo cum botanical garden was developed at a site reserved for Quaid-e-Azam University.
5. Sector I-8 earmarked for development of transportation hub was converted into residential sector in 1988. This deprived the city with the strategic site reserved for the establishment of circular railway station and bus terminals.
6. Convention Centre and five star hotels were allowed to be developed in the National Park area in 1995, degrading ecosystems.
7. Increase in Building heights in blue area was allowed. Centaurs and other high rise building were allowed along the blue area putting a heavy burden on the utility and infrastructure services beyond the bearing capacity of the area.
8. Allowing land sub-divisions for residential housing schemes in the National Park area.
9. Allowing development of roads, building and land-fill sites within the area reserved for greenbelts in the Master plan.
10. Massive land use changes and mushroom growth of encroachments in the form of katchi abadies/unplanned settlements have taken place, which are triggering clogging of natural drainage system, landslides and land erosion.

3.4.3.2 Adaptive Capacity at the Institutional Level

I. Capital Administration Development Division

The Capital Administration Development Division (CADD) being a newly established institution has very limited capacity to tackle climate change effects and impacts. There is a need to enhance their capacity by imparting training to the existing staff to inform them about the issue of climate change, its effects and impacts, possible adaptation and mitigation measures to minimize the climate change impacts. In addition, a dedicated unit may be established in the CADD to effectively address climate change issues.

They may develop curriculum for introducing Climate Change as a subject to create awareness among the children and youth about the factors causing climate change. As the major cause of climate change is predominantly anthropogenic factors i.e. human induced activities. Hence it is extremely important to bring behavioural change among the children and youth so that they grow up as a responsible citizens with positive mindset contributing towards reduction of climate change effects. In this connection, it is also necessary to facilitate CADD to train teachers as well as hold training of trainers workshops on climate change mitigation and adaptation measures.

In the health sector, CADD may launch aggressive preventive health care programmes for awareness raising of Physicians, para-medical staff as well as general public to inform about the climate change triggered health impacts and its preventive and curative measures.

II. Capital Development Authority

Capital Development Authority (CDA) was established to implement the Master Plan of Islamabad and undertake development activities in accordance with the Master plan and carryout functions mandated under the Capital Development Ordinance 1960. They do not have any section dealing with climate change effects and impacts. However, Emergency and Disaster Management Directorate was established in 2008 in the aftermath of 2005 earthquake and Marriot fire incident realizing the increasing importance of a fully equipped, pro-active and fast disaster mitigation and response unit of trained and motivated men and women. The Capital Development Authority has recently launched the operational command of the highly-sophisticated and well-equipped Urban Search and Rescue (USAR) team. Salient features of the team are high-tech search and rescue, canine component (search dogs), operational self-sustainability and local and international deployment capability.

The staff of Capital Development Authority has not been properly trained for addressing climate change issues, its adaptation and mitigation measures for Islamabad. There is a need to conduct such trainings, particularly training on climate smart planning so as to undertake effective climate change adaptation measures while designing the layout plans for land sub-division and designs for development activities and projects. There is a need to review and revise the building By-Laws and Town Planning Regulations in the light of the climate change challenges and impacts being experienced in Islamabad and Islamabad Capital Territory region in the recent decades and projected scenarios.

III. Islamabad Capital Territory

Islamabad Capital Territory (ICT) is the main administrative body which derives the powers of the President of Pakistan and the functions vested with this body are that of a provincial government. However, there is no technical wing in the Islamabad Capital Territory dealing with climate change issues and other environmental matters. Their mandate also includes provision of physical infrastructure services, social services in addition to administrative matters. The major challenges faced by the Islamabad Capital Territory include: mushroom growth of illegal settlements and land sub-divisions, lack of technical capacity to develop and enforce building control and town planning regulations, lack of technical capacities to deal with climate change and environmental challenges, Security Issues , Law & Order Sensitivity , Growth in Population , Expansion in Trade & Business , Public Expectation for Better Service Delivery , Extreme Pressure on Rural land bank , Religious & Sectarian polarization , Media Explosion and Overburdened Administration.

The staff of Islamabad Capital Territory may be trained in environmental and climate change challenges and measures to address such challenges. There is a need to conduct awareness raising programmes for the Islamabad Capital Territory. They may have a separate wing dealing with climate change issues.

IV. Metropolitan Corporation of Islamabad Capital Territory

A Bill has been introduced in the National Assembly to rationalize and reorganize the local government system in the Federal capital to promote good governance, effective delivery of services and transparent decision making through institutionalized participation of the people at local level; and to deal with ancillary matters. Under this Bill, Metropolitan Corporation of Islamabad Capital Territory will be constituted to perform municipal functions, approve development schemes for beatification of urban areas of Islamabad, execute development plans and works, maintain a comprehensive database and information system and provide public access.

V. Union Councils for Islamabad Capital Territory

The Government may after passage of the Bill, declare any area in Islamabad Capital Territory to be a Union Council. The functions of Union Councils may include: improve and maintain public ways, streets and open spaces, plantation of trees and beautification of public places, provide and maintain drinking water and sanitation facilities, take measures to promote welfare, health, safety, comfort or convenience, execute development works, maintain data related to above functions and disseminate information on matters of public interest..

Adaptive Capacity at the Household and Community Level

Institutions

There are community based organizations formed by different NGOs. One of such NGOs, National Rural Support Programme has formed 7,600 CBOs. They train local communities for natural resource management including water management. CBOs develop drinking water supply schemes including stand posts/water taps, hand pumps and tube wells for domestic use and irrigation purposes with the support of NGOs. However, CBOs and NGOs have had less involvement in public health related issues and capacity to adapt in this area remains due to a lack of health facilities.

Local communities have the capacity to form groups to monitor water level in the Nullah Lai. When the water level becomes dangerous, the communities have sirens and can beat drums to warn other residents of high or rapidly rising water levels.

Increasingly in recent years, urban development in Islamabad has taken place outside of the original master plan, and in contravention of building laws and zoning, as a result of limited enforcement capacity. This is evidence to suggest there is still insufficient capacity at the city level to manage urban spatial and population growth. In addition, there is evidence to say that the urban heat island effect, as well as related increases in skin diseases and respiratory problems. This is because factories and brick kilns have been permitted within the urban area of Islamabad, and ecosystem areas around the Margalla Hills have been degraded, reducing heat and pollutant absorption capacity. As with urbanisation, this development has taken place as a result of limited capacity to enforce the Islamabad Master Plan, building codes and environmental regulations.

The Pakistan Meteorological Department undertakes water level monitoring and has an early warning system in place for flood waters on the Nullah Lai and its tributaries. This information is then passed to relevant institutions, including the media. However, there are ongoing budgetary issues. Local authorities and PMD has limited budget for its activities, which act as a barrier to improving enforcement of planning regulations, enhancing early warning systems and undertaking other necessary adaptation measures.

Information

While the above information is generated quite spontaneously at community level, challenges remain in terms of community access to more formal media channels. Many community members – especially those who have migrated do not have access to print or electronic media and rely on radio for information. A lack of information and awareness at community also exists on issues of drinking water quality and scarcity.

Infrastructure

There is severely limited infrastructure in terms of piped water to urban poor areas and filtration infrastructure. This combines the high cost of bring drinking water from outside to result in very limited access to potable drinking water.

There is also a severe lack of access to sanitation facilities, and coverage of sanitation infrastructure. This means people – especially in poor areas and areas close to the Nullah Lai, are forced to dispose of liquid waste into the Nullah and other streams. This exacerbates the flood hazard by polluting the water, resulting in flood waters that also pose severe health risks.

Wealth

In urban poor areas where piped water is not available, many residents cannot afford to buy high quality drinking water

Technology

Access to technologies for adaptation remains limited. For example there is limited use of GIS and satellite monitoring of river levels and flooding, and limited linkage between GIS technologies and urban planning. There is also limited access to information through mobile technologies in urban poor areas, depriving people of information.

Social Capital

The NGOs are arranging mobile health camps for the people and livestock. Furthermore, they are supporting the government in management of village and basic health units. In education sector they are supporting the CBOs in establishing community primary schools.

There is a gender imbalance in adaptive capacity as women and children are more likely to be at home in poor areas when cloud burst events happen or floods occur. This is especially problematic in urban poor areas that are prone to flooding along the Nullah Lai. Women also perform the role of primary care givers at the household level. However, they are often not aware of both forthcoming hazards as a result of a lack of access to media and of diagnosis of and treatment for water and vector borne diseases.

	Wealth	Technology	Information	Infrastructure	Institutions	Social Capital
City Level	%age of people below poverty line	%age of people (or households) with access to mobile phones % people of households with access to radio	%age literacy rate	%age with access to piped water and %age access to sanitation	%age people with access to early warning system	%age women's literacy

The adaptive capacity summary, shown below in Table 18/19, shows capacity across the six determinants of adaptive capacity, plus ecology in relation to climate related hazards that have or are likely to have high levels of impact in Table 18.

Table 17 : Adaptive Capacity Summary Table

Hazard	Level of Impact (see table 17)	Wealth[24]	Institutions[25]	Technology[26]	Information[27]	Infrastructure[28]	Social capital[29] and Gender	Ecology
Increase in intensity of rainfall / Cloud burst and Urban Flooding mainly due to overflow of the Nullah Lai	High	- local communities form groups to monitor the water level in the Nullah - NRSP, UPAP Urban Poverty Alleviation Program have organized local communities that are used as a platform for information sharing, rescue, relief, damage assessment & rehabilitation - Every year Monsoon Contingency Plan	❖ Water level monitoring, and early warning system by Pakistan Meteorological Department ❖ Release of early warning information to concerned institutions ❖ Lesser capacity of local institutions to respond to such situations requires capacity building programmes ❖ Stakeholder institutes include PMD, Water and	❖ Measurement of flood levels. ❖ Dredging and deepening of bed of Nullah ❖ Automated Voice Response (AVR) system. ❖ Lesser use of GIS/Satellite monitoring for timely action which needs to be strengthened ❖ Poor Land use planning which requires land use policy, regulatory framework and planning.	❖ Beating drums, siren, mobile messaging etc. to inform people. ❖ Radio & TV ❖ Muhalla/ Neighbour-hood Committees	❖ Low income people reside closest vicinity or even in the bed due to lack of housing facilities ❖ Mainly due to Nullah Lai and its five tributaries that passes through dense urban settlements requires preparation of land use zoning planning and building by laws and enforcement ❖	❖ Women and children are more vulnerable to the threat as they are at home. ❖ Projects like Urban Poverty Alleviation Programme (UPAP)/ National Rural Support Programme has organized women groups in the poor	❖ Depletion of natural Vegetation due to encroachments triggering soil erosion of embankments requires re-plantation along the embankments. ❖ During and after the floods heap of debris are accumulated which spreads foul smell and serves as breeding ground for diseases. ❖ The ecology of

[24] What wealth and financial resources are available to address this hazard?

[25] What institutions or teams exist to address this hazard and what policies are there

[26] What technology and technological capability is available to address this hazard

[27] What level of knowledge is there about the hazard can it be distributed to the people who need it

[28] What infrastructure is available and can it withstand projected climate changes

[29] What social capital is available that could address the impacts of this hazard

		is prepared by the City District Government; particularly for Nallah Lai and a budget allocation of Rs.90-120 million is allocated for implementation of the plan by Rawalpindi Development Authority/ WASA. - CDA prepares moonson plan but does not allocate separate funding but expanses are met from regular budget. - Lai Nallah Flood Risk Administration and Management Project was implemented with funding from JICA - The Project for Improvement of the Flood Forecasting and Warning System for Lai Nullah Basin 2011	Sanitation Agency (WASA) of RDA; Tehsil Municipal Administration, Rawalpindi and Federal Flood Commission. ❖ There is a Task Force of Nallah Lai, led by Rescue 1122 and represented by major city stakeholders. It prepares Evacuation Plan for inhabitants.	❖ Water level gauging station (2 stations) ❖ Rainfall gauging station (6 stations) ❖ Flood evacuation Warning Posts; by motor siren and load speaker (10 posts). Repeater station (2 stations; Telemetry/ Wireless LAN) ❖ Mobile diesel driven dewatering sets (5) ❖ Sucker / Jetting Machines (8/4)			and flood affected areas basically for their micro-finance programme but during disaster these groups play an important role in rescue, evacuation and rehabilitation measures.	recreational parks and open spaces such as the Municipal and Liaquat Park were badly affected due to debris deposited by the floods.
Increase in frequency & intensity of temperature	High	❖ Lesser awareness and sensitization among civil society	❖ Lesser capacity of local institutions to understand and respond to such situations	❖ Lesser availability of Measuring equipment ❖ Lesser	❖ Lesser awareness and sensitization of print and	❖ Poor has lesser affordability for treatment ❖ Urban heat Island	❖ Unawareness of symptoms among the women and	Increasing spread of Alien Species which needs to be replaced with indigenous plants

Increase in Diseases like allergy, skin and respiratory infections				availability of technology and scarcity of equipments for Disease testing ❖ Poor preventive and curative measures ❖ Phasing out of led from gasoline and sulfur from diesel. ❖ Motor vehicle examination ❖ Certification for road worthiness of the vehicle ❖ Introduction and promotion of energy conservation measures and Renewable Technologies	electronic media ❖ Lesser involvement of civil society & CBOs to tackle the issue	phenomenon due to violation and relaxation of Master Plan of Islamabad, zoning regulations and building bylaws. ❖ Higher level of emissions from transport, stone querying, brick kilns & industries ❖ Poor health service delivery mechanism	children	
Increase in frequency & intensity of temperature Deteriorating quality and scarcity of Drinking water	High	❖ Lesser awareness and sensitization of civil society for which structured awareness and sensitization programmes may be launched	❖ Lack of resources , which needs an increase in budget allocations of service delivery institutions ❖ Lesser awareness and sensitization of institutions for which programmes may be launched. ❖ Weak implementation of Municipal functions which	❖ Enforcement of Drinking water quality Standards ❖ Reverse osmosis, bio-remediation and Solar water purification systems may be introduced. ❖ Solid waste management especially hospital waste.	❖ Lesser awareness and sensitization of print and electronic media. ❖ For awareness raising Global hand washing day and World water day like events may be encouraged.	❖ Poor people cannot afford the price of good quality water ❖ Lack of proper infrastructure network for supply of safe drinking water at the household level ❖ Lack of availability of filter plants ❖ Lesser O&M of filter plants	❖ Awareness of women and children may be raised through awareness raising programmes .	❖ Promotion of Constructed wetlands. ❖ Tree Plantation campaigns ❖ Controlling use of pesticides to prevent underground water contamination. ❖ Protection of Watershed areas from conversion of land use and encroachments.

			needs to be strengthened			❖ Improper sewerage system ❖ Contamination of water reservoirs ❖ Leakage and rusting of drinking water pipes which needs to be improved.		

Chapter 4 Hotspot Areas

Major Hotspots in Islamabad & Rawalpindi

This section summarises the preceding exposure, sensitivity and adaptive capacity sections by pinpointing the most climate vulnerable locations in Islamabad and Rawalpindi. It does this by pinpointing the locations that are the most exposed to climate hazards, have the highest sensitivity and lowest adaptive capacity. While the hotspot section considers all hazards, it focuses on flood prone areas along the Nullah Lai and its tributaries

Islamabad

In Islamabad, major hotspots have been created due to flash floods in natural streams generated originating in the Margalla hills around which exponential growth of katchi abadies have taken place in recent years. Most of the houses in katchi abadies are built from indigenous building materials such as mud, stone, and wooden logs. Recently, the number of houses constructed with brick masonry is increasing. These katchi abadies are severely impacted during the flooding season and majority of katcha houses are damaged due to heavy rains and floods causing injuries and even death tolls to the residents. The population density around the Nullah Lai in urban areas of Islamabad is about 4,434 persons per square km (during year 2012). In Islamabad, four major hotspots have been identified. The description of these hotspots is as follows:

Hotspot 1 – Mera Jaffar

It covers areas of Mera Jaffar. According to a report compiled by the local administration[30], this is the largest katchi abadi in Islamabad, home to 28,536 residents out of Islamabad's total slum population of 81,041, who reside in 24 slums across Islamabad. is located downstream of Jodh Kas, one of the Nullah Lai's major feeder streams.

Hotspot 2 – Muslim Colony

This katchi abadi was developed due to shifting of the labourers engaged in building of Islamabad's largest hospital called as "Pakistan Institute of Medical Sciences" from the site where PIMS hospital was built. It is situated near natural streams that feed the Rawal Lake which is the primary source of supply of drinking water for the residents of Rawalpindi. This is the second largest katchi abadi of Islamabad and its present population is 15,000 residents.

Hotspot 3 – 100 Quarters

This katchi abadi was built around 100 quarters built by CDA for low paid employees along the natural stream called Saidpur Kas, one of the major feeding streams of Nullah Lai. The population of this katchi abadi is 6,150 residents.

[30] Published in national daily "The NEWS" dated 31st March 2014.

Hotspot 4 – French Colony

This katchi abadi was built due to relocation of Christian labourers from PIMS hospital construction site.

It is also known as French Colony and is situated along the natural stream called Kanitawali Kas, one of the major feeding streams of Nullah Lai. The population of this katchi abadi is 6,000 residents.

Rawalpindi

Rawalpindi falls in the downstream catchment basin of the Nullah Lai. It is a historic city built over thousands of years. The population density around the Nullah Lai in Rawalpindi is about 42,000 persons per square km in 2012. People have even constructed their houses in the bed of the Nullah. In areas around the Nullah Lai in Rawalpindi, flood inundation starts once the water level of the Nullah Lai reaches 18 feet at Gawal Mandi Bridge. In this connection, Tehsil Municipal Administration sounds a siren over the low lying areas when the water level reaches the alert water level at 16 feet. People living close to the Nullah Lai are vulnerable to flash flooding throughout the rainy season. The people most affected by flooding in Rawalpindi are those living in slum and low-lying areas. The number of people affected by floods in the area is about 400,000 (according to Emergency Relief Cell of Rawalpindi). In Rawalpindi, five major hotspots have been identified. The description of these hotspots is as follows:

Hotspot 5 – Katarian Bridge

The Nullah Lai combined with its tributaries such as Saidpur Kasi, Kanitwali, Badarwali Kasi and Tenawali Kasi, originating from Margala Hills enters Rawalpindi at new Katarian Bridge located at IJP Road at the administrative boundary between the twin cities of Rawalpindi and Islamabad. In 2011 the Katarian Bridge at Nullah Lai burst its banks after floodwater reached the 17-foot (5.1 metres) mark and during 2012, the natural drain at this point was further deepened by 10 feet (3.05 metres) to reduce the danger of floods. It is the point where solid waste material and other encroachments have considerably reduced the width of the Nullah Lai.

Hotspot 6 – Ratta Amral Bridge

This point is located at Ratta Amral Bridge including surroundings and the tributary passing up to Bhoosa Godown Ratta. It is near to the point where Dhok Ratta Nullahmeets the Nullah Lai. It is also affected by major floods in the Nullah Lai.

Hotspot 7 – Gawalmandi Market

This point is located near Gwal Mandi. It is a commercial area of Rawalpindi having many auto-mobile workshops and shops dealing with the purchase of batteries which causes addition of harmful lubricants and electronic waste into the water of the Nullah Lai. Serious flood events affect the commercial activities in the area.

Hotspot 8 – Aryan Muhalla

This point is located near Aryan Muhalla. Serious flood events occur in particular along the main stream between Gunj Mandi Bridge and the Railway Bridge, and the tributaries of Arya Nullha, Dhok Rata, Nullah and Dhok Charaghdin. At this point the force of the flood water increases substantially due to additional natural streams from Rawalpindi joining the Nullah Lai. In 2001 floods, the flood water level

reached to above two storey buildings and even impacted at some points to the third floor of the buildings.

Hotspot 9 – Soan Camp

This is the confluence of the Nullah Lai and the River Soan. It also carries water from other three major tributaries; namely (i) Nikki Lai, (ii) Pir Wadhai Kas and (iii) Dhok Ratta Nullah, as well as other six (6) tributaries or drainage channels or sewage channels, which join the mainstream between the confluences of Dhok Ratta Nullah and the Soan River. The Nullah Lai carries raw sewage and untreated effluents. This in addition to creating pollution, it also spreads a foul smell. Further, the fresh water of river Soan becomes heavily contaminated, despite being used downstream for irrigation and drinking purposes.

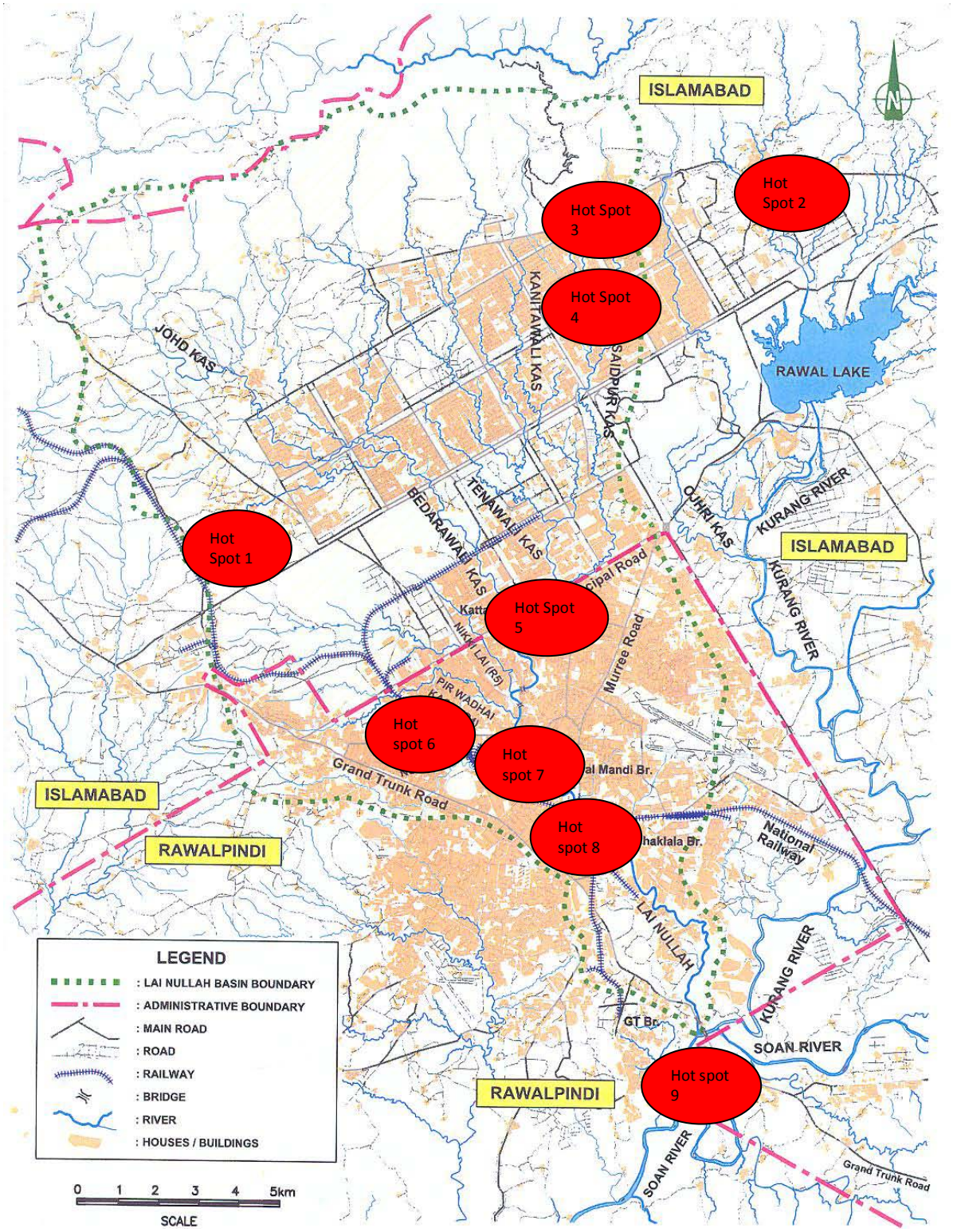

Figure 33 : Hotspots of Islamabad and Rawalpindi

Chapter 5 Possible Adaptation Options

The following is a list of possible actions that can be undertaken in Islamabad and the Islamabad Capital Territory. No one action alone can increase resilience to climate change. However, resource constraints (time, human and financial) mean that not all options can be implemented. Therefore, a prioritisation exercise needs to take place, as shown in steps 5 and 6 of the Planning for Climate Change process (shown in Figure 2). The assessment does not offer prioritisation – it merely acts as a long list of actions that could be implemented, and would be beneficial to the city and its surrounding area. Where possible, this report presents actions which are "no regret" or "low-regret" – meaning that they will still benefit the city even if the climate does not change further, and that they will bring developmental benefits. Moreover, the adaptation options presented here keep in mind the need to avoid 'mal-adaptation' – actions that fail to reduce vulnerability or shift vulnerability from one location to another.

The following recommendations are presented based on the findings of the vulnerability assessment, conclusions presented above and discussions held with stakeholders during the TWG meetings and other stakeholder workshops.

The short-medium term adaptation options are presented in the form of priority projects. This is to make their analysis easier. However, the adaptation options do not necessarily need to be implemented 'as-is' – city officials may wish to break down the proposed projects presented here into their component parts – for example if budget constraints require this.

5.1 Immediate need for climate-smart planning by City Authorities

Short to Medium-Term Need

The current analysis of climate change factors of increase in temperatures, precipitation, greenhouse gas emissions are adversely impacting lives of the residents of Islamabad, Islamabad Capital Territory and its adjoining areas of Rawalpindi. PMD data, GCISC projection models and analysis of SUPARCO on Margalla Hills soil analysis shows that these climate change related hazards would further increase. Therefore there is need to act immediately and both short to medium term and long-term measures are proposed.

Solid waste management in Urban areas

Proposed Implementing Agency: Capital Development Administration

Some solid waste including hospital and industrial waste is collected in urban areas and disposed of at open dumping sites that are deteriorating the environment, contaminating groundwater and emitting carbon dioxide and other hazardous gases and causing health problems. It is further aggravated by the extreme events that are projected to become more severe as a result of climate change. The rest of solid waste is not collected and is dumped locally by residents and businesses throughout the city.

A possible objective of the proposed project would be *to develop effective proper management of domestic, hospital and industrial waste.* This objective would be achieved by collecting solid waste from urban areas and segregating it into organic and inorganic parts, developing an integrated site for the segregation of waste, using biogas technology and composting.

The project will ensure that the following occurs in waste management: (i) segregation of waste into organic and inorganic components at the source; (ii) transferring the organic and inorganic waste separately to the integrated waste management site; (iii) transferring hospital, laboratory and radioactive waste to the integrated waste management site and safe disposal of hazardous waste in incinerator and scientifically engineered landfill sites, while ensuring other waste is not contaminated; (iv) segregation of different components of other waste material at integrated waste management site; (v) installation of a biogas digester (s) and installing a system for drying the slurry; (vi) composting of organic waste; and (vii) pellet fuels comprising of refused dry fuel and tyre dry fuel preparation viii) Exploring possibilities for waste to energy generation

Solid waste management in rural areas

Implementing agency: Islamabad Capital Territory Administration

Disposal and management of solid waste is among the main problems faced by the residents of Islamabad Capital Territory region. It is further aggravated by the extreme events in the climate change scenario. It is deteriorating the environment and causing health problems.

This proposed project is the same as the above in terms of both its objectives and the ultimate waste management system to be implemented. The only difference would be the geographic location – it would cover the Islamabad Capital Territory area, rather than the urban area of Islamabad

Waste Water Management in rural areas

Implementing agency: Islamabad Capital Territory Administration

Waste water disposal and management are significant problems faced by the residents of the Islamabad Capital Territory region. It is further aggravated by the extreme events in the climate change scenario. It is deteriorating the environment and causing health problems such as spread of water borne diseases.

The objective of the proposed project is *proper management of domestic waste water by adoption of bio-remediation and sand filter methods at community level.* The project will ensure that wastewater is managed by (i) Collecting grey water from the village in a stabilization pond; (ii) Transferring the water from the stabilization pond to a series of ponds through sand filters; (iii) purification of water in the ponds by using fungi and other bio-remedial measures; and (iv) Piping the purified water from the ponds to agricultural land for irrigation purposes. The proposed executing agency for the project is the Islamabad Capital Territory Administration. The bio-remediation of grey water has successfully been demonstrated in National Agricultural Research Centre, Islamabad. The Orangi Pilot Project and UNICEF have also replicated the technology. The project draws upon and upscales this successful experience.

Bio-engineering for recycle & re-use of grey water for enhancing climate change resilience in urban areas

Implementing agencies: Capital Development Authority and Islamabad Capital Territory Administration

The Nullah Lai carries untreated municipal waste water combined with hospital and industrial liquid waste which is very harmful for human health, as it passes through the dense urban settlements located in Islamabad and Rawalpindi. Effluent treatment plants are installed at some of the points around the Nullah but these are not functional and raw sewerage is discharged into it. Furthermore, the groundwater level in Islamabad is depleting rapidly. There is a need to capture, treat/purify water through bio-engineering

techniques – including streaming water through a number of chambers that filter and dis-infect water, without chemical treatment,allowing it to be used for domestic purposes. The objective of the project is to activate dysfunctional Effluent treatment plants, install new plants for discharging semi treated water from hospitals/laboratories into the Nullah Lai, recycling and re-use of grey water in residential, commercial and industrial buildings". The project should include the following components: (i) Installation/activation of Effluent treatment plants to arrest discharge of sewage to Nullah Lai coupled with methane production through Bio-gas plants; (ii) Installation of Effluent treatment plants at the point of discharge of Nullah Lai into river Swan coupled with bio-gas; (iii) Recycling and re-use of grey water in residential, commercial and industrial buildings; and (iv) Installation/activation of Effluent treatment plants for treatment of effluents from Hospitals and Laboratories.

Rainwater Harvesting and Ecosystem Management

Implementing agencies: Capital Development Authority and the Islamabad Capital Territory Administration

The availability of water for drinking and other domestic, agricultural and industrial uses is becoming scarcer. The groundwater table has gone down from 50 feet (approximately 15.2 metres)' to about 300 feet (approximately 91.4 metres) below the surface. Availability of surface water is also decreasing, mostly because of climate change effects and ecosystem degradation.

The objective of the proposed project is to *harvest rainwater for better ecosystem management*. Under this project the catchment ponds would be built at suitable places such as in F-9 Park and other open and green spaces and natural depressions in green belts for the retention and of water. Inverted wells (mesh) and surface ponds would be built. Rainwater harvesting systems in residential, commercial and public buildings would be established and the water would be used mostly for growing plants and other domestic uses. Tree plantation campaigns would be launched, local schools would be invited to participate. Dry-afforestation and drip irrigation techniques could be implemented for better water management. Controlled grazing techniques could be demonstrated in range areas. This project would harvest rainwater for better ecosystem management; minimize effects of urban flash flooding and increase ground water recharge.

Study of Carbon sequestration in Margalla Hills National Park

Implementing agencies: Capital Development Authority, Islamabad Capital Territory Administration and the Climate Change Division

SUPARCO in conjunction with UN-Habitat and the Climate Change Division, conducted the first phase of the study to estimate the Carbon Sequestration in Margalla Hills National Park. The results of the first parameter, soil pH, show, that most of the sampling sites are alkaline but not at a high level. Results showing high acidic contents are liable to harm the forest health through soil ecology, physio-chemical processes, humus morphology, tree growth, micro and meso fauna abundance and species richness and carbon sequestration. At high pH, different micro and meso-fauna are unable to function properly which make them unable to decompose properly, which is essential for carbon sequestration in the forest soil. On the basis of preliminary analysis of soil pH, an assumption could be made that at specific locations in the Margala Hills; there is a significant difference in Carbon and Nitrogen concentration, meso-fauna abundance, meso-fauna species richness, fungal biomass, humus morphology and ultimately the level of carbon sequestration.

Given this, it is recommended that the following issues and parameters are also studied: carbon and nitrogen concentration, Ergosterole/fungal biomass, carbon storage, humus morphology and meso-fauna biodiversity/species richness.

The final results of this project would provide information regarding impact of soil conditions on carbon sequestration; an essential component of any strategy to mitigate the emissions of greenhouse gases.

Energy conservation of buildings

Implementing agencies: Capital Development Authority, Islamabad Capital Territory Administration, ENERCON[31] and the Climate Change Division

The objective of the project is *to decrease energy consumption in domestic, commercial and public building*. This will be achieved by implementing the following energy conservation measures; (i) review and update of building by-laws for introduction of energy conservation measures; (ii) Energy audits and retrofitting of large buildings; (iii) Promoting use of LEDs and energy saver bulbs in buildings and street/road lights; (iv) Demonstration of energy efficient buildings; (v) Use of solar geysers, photovoltaic for lighting and other household items/incentives for promotion of renewable energy; (vi) Energy efficiency in road side traffic lights, LCD, LEDs, televisions, sign boards; and (vii) Power factor improvement in buildings[32].

Energy conservation in Tube-wells

Implementing agencies: Capital Development Authority, Islamabad Capital Territory Administration, and ENERCON

The objective of the project is *energy conservation in tube wells*. The components of the proposed project include: (i) Energy audits and retrofitting of tube wells; (ii) Photovoltaic and bio-gas for water pumping; (iii) Installation of new energy efficiency tube wells; and (iv) Introducing apro-poor water metering system.

Energy conservation in industrial sector

Implementing agencies: Capital Development Authority, Islamabad Capital Territory Administration, and ENERCON

The objective of the project is to *promote energy conservation measures in industrial sector*. The project includes the following components: (i) Energy audits for boilers, compressors, chillers, steam system, direct fired process, heating (Including ovens, dryers, kilns and furnaces) electric systems and retrofitting of energy using units; (ii) Power factor improvement in industrial sector; (iii) Energy efficient industrial units including brick kilns; and (iv) Combined effluent treatment plant in industrial plants and use of organic part for Energy generation

[31] National Energy Conservation Centre, a department of the Ministry of Water and Power, Government of Pakistan responsible for developing project and programmes promoting measures of energy conservation

[32]Power factor implies placing capacitors in the electrical systems so that more than accepted limits of power volume return back to the system and helps in energy losses as well safeguard electrical appliances from increased energy damages

Energy conservation in the energy transmission system

Implementing agencies: Capital Development Authority, Islamabad Capital Territory Administration, IESCO, and ENERCON

The objective of the project is to *reduce transmission losses of electricity and natural gas*. The project components include: (i) Efficient transmission of electricity and reducing transportation losses; (ii) Power factor improvement and (ii) Reducing natural gas leakage.

Energy conservation in the transport sector

Implementing agencies: Capital Development Authority, Islamabad Capital Territory Administration, and ENERCON

The objective of the proposed project is to *promote energy conservation measures in the transport sector*. The project components include: (i) Introducing multiple-buses, a circular railways, a rapid or mass transit system(possibly through Public Private Partnership); (ii) Bicycle ways; (iii) Promoting computerized vehicle tune up; (iv) Providing training and equipment for Vehicle emission testing and road worthiness and certification; (v) Introducing hybrid vehicles;(vi) Parking storey(ies) for Plazas (vii) introducing tracker technology for effective traffic management (viii) introducing scientific ways of traffic management from curriculum of nursery classes to university level.

5.2. Streamlined Planning at the Federal, District and Local Levels

Implementing Agencies: Climate Change Division (Federal level) and Provincial Planning and Development Departments

The objective of the proposed project would be *improved planning and coordination on climate change* between federal, district and local levels. The project would achieve enhanced planning at local levels and would enable all levels of government to translate national policy directives into local actions. Possible actions would i) include training for local officials, ii) further planning exercises conducted in new target areas, iii) The creating of climate change offices/departments at sub-national levels of government with dedicated officers to ensure that adaptation or 'resilience building' measures are mainstreamed in all local government planning

5.2.1 Certification and registration of real-estate developers and enforcement of building codes

Implementing agencies: Capital Development Authority, Pakistan Council for Architects and Town planners and Pakistan Engineering Council

The objective of this proposed project is *to achieve climate-smart construction practices in Islamabad*. The project would be achieved by i) updating the building code and strengthening its enforcement, ii) Creating a registry of real-estate developers (for residential, commercial and industrial buildings). Iii) Certifying real-estate developers who build according to international green and resilient standards, such as 'LEED'

5.2.2 Supporting the development of Public-Private Partnerships

Implementing Agencies: Capital Development Authority

The objective of this project is to *improve basic urban services* through the implementation of public private partnerships. This would require a regulatory framework that supports and encourages the development of

public-private partnerships in a transparent manner. Once completed, pilot PPPs would be implemented in selected areas in key service areas, such as waste management

5.2.3. Eco-system based adaptation and management for Islamabad

Implementing Agencies: Capital Development Authority, Islamabad Capital Territory Administration, Capital Administration Development Division

The objective of this proposed project is to improve eco-system health in Islamabad, Islamabad Capital Territory and the Margalla Hills. The project would be large in scope and have a number of different components, recognising the challenge of ecosystem management and preservation that Islamabad faces. Among the number of activity groups that should be considered in an ecosystem management project are:
Protection of remaining natural vegetation in Islamabad and the ICT through regulations and effective and enforced planning , ii) Improved protection of existing ecosystems, including Zone 3 and the Margalla Hills National Park so that they retain their character, biodiversity and continue to provide ecosystem services. This includes acquiring and protecting land, where necessary. Iii) Replace damaging alien tree and plant species with indigenous plant species. Iv) Utilize marginal and vacant land and regenerate it as urban green ecosystems, v) Utilise ecosystems to filter pollutants in the Nullah Lai and other streams, vi) Strengthening law enforcement to reduce illegal activities in national parks, ecosystems areas and protected areas.

5.2.4. Reducing pollution from Brick Kilns

Implementing Agencies: Capital Development Authority, Pakistan Environment Protection Agency.

The objective of this proposed project would be to *reduce pollution from the brick kiln industry.* The project includes the following components: (i) Environmental impact assessment of brick kilns; (ii) Promoting use of efficient combustion technologies; and (iii) Demonstration of environmentally clean brick kilns through pilots.

5.2.5. Adaptation in Healthcare

Implementing Agencies: Capital Development Authorities, Islamabad Capital Territory Administration, Ministry of Health

The objective of this proposed project is to *reduce incidence of climate related disease and improve treatment, including access to treatment.* The proposed project would include i) Measures to prevent the breeding and spread of mosquitoes, ii) Mobile health units to deliver basic treatment services to outlying areas that have poor health coverage, iii) Partner with local healthcare NGOs to improve health care services, iv) Improve laboratory and analytical facilities

5.2.6 Flood Protection

Implementing agencies: Capital Development Authority, Islamabad Capital Territory Administration, Capital Administration Development Division

The objective of this project is to *reduce the impacts of floods* especially flooding that arises as a result of cloud burst events. This proposed project is large and broad in scope, but will consider the following types of activities; i)improved drainage, ii) improved bank protection – especially on the Nullah Lai and its tributary streams, iii) improved urban planning to prevent proliferation of settlements in flood prone areas

Additional and Cross-cutting measures

In addition to the aforementioned priority project measures, there are a number of cross-cutting or generalised priority actions that need to take place in order to support the implementation of the priority projects. These actions are listed below. As part of the planning exercise, these activities need to be strategized, prioritized and aligned with existing government initiatives:

- Integrate and streamline coordination of planning and implementation authorities at three levels of government; Federal, District and Local
- Build capacity of relevant institutions to address climate change challenges within existing institutions and create dedicated climate change units at district and local levels, with dedicated officers and designate climate change sensitive planning experts in public administration and relevant institutions
- Ensure that the original masterplan of Islamabad is implemented effectively and in the spirit it was developed, considering environmental sustainability, economic growth as well as likely future conditions, such as population growth, urban agglomeration and climate conditions
- Reform physical and spatial planning so that it is more democratic, transparent and participatory.
- Develop strict regulations for liquid and gaseous waste management
- Establish effective regulation for controlling illegal settlements in water shed areas
- Improve law enforcement and regulatory frameworks across district and local government. This would ensure that the adaptation measures proposed above can be implemented effectively. This is particularly true in the case of building code enforcement, preservation of eco-system areas, pollution control and land use and zoning

Medium to Long-term Need - Awareness raising for Climate Change impacts through educational institutions and other stakeholders

1. There is an equally important need for the government to review institutional planning capacity of city authorities to undertake mitigation and adaptation measures in the long-term. For long-term gains the government must review the institutional planning capacity of city authorities of the Capital Development Authority, Capital Administration Development Division and Islamabad Capital Territory in undertaking climate smart planning and making Islamabad and Islamabad Capital Territory climate resilient in the long-term. This may include the assessment of the technical capacity of these city authorities in undertaking pro-active climate change mitigation measures. A detailed review is needed so as to effectively anchor the required capacities in these city level institutions.

2. There is a need to seriously consider undertaking an urgent review of the revised Master Plan, building by-laws and town planning regulations to incorporate climate change concerns and adoption of climate smart planning processes. These institutions may establish a dedicated Climate Change Unit to adequately address emerging climate change challenges, adequately equip the concerned institutions with proper training and capacity building programmes.

3. The government has excellent knowledge resources and analysis capability in the shape of PMD, SUPARCO and GCISC. The data and expertise they acquire needs to be shared freely and effectively with city officials. This includes sharing GIS data on encroachment of settlements on ecosystem and/or protected areas. The city government agencies will be strengthened and enabled to make informed, evidence-based decisions. This is an essential component in undertaking climate smart planning. A review of institutional planning capacity should also review the human resources in both scientific and city government institutions to ensure that data is shared as required

The Climate Change Division is the custodian of the implementation of Climate Change Policy at the National level. There is also a need to build the capacity of provincial governments in devising their own climate change policies, strategies and action plans. The CCD can help build capacities of provincial governments by replicating this vulnerability assessment in other cities of the country. This will also be in line with the decision of the Federal Cabinet to do similar exercises in provinces after Islamabad and in the spirit of the 18th constitutional amendment.

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Annex-I

Vulnerability Assessment proforma

Vulnerability Assessment Exercise																														
Components	**Precipitation(rainfall)**					**Temperature**										**Extreme Weather Events**														
						Heat island impact					**Ground Water Depletion**					**Flooding**					**Landslides**					**Slope Failure**				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Exposure																														
To what extent, Islamabad, Rawalpindi, Islamabad Capital Territory is exposed to																														
Sensitivity																														
The degree to which affected by climate change hazards																														
(People) women, youth and poor																														
Places																														
Institutions																														
Capital Development Authority																														
Islamabad Capital Territory																														
CADD																														
any other																														
Adaptive Capacity																														
Capacity to respond to the climate change impacts																														
Capital Development Authority																														
Islamabad Capital Territory																														
CADD																														

Rating value: 1=Low, 2=Medium Low, 3=Medium, 4=Medium- High, 5=High

Capacity Assessment Exercise																					
Components	**Capital Development Authority**					**Islamabad Capital Territory**					**CADD**					**Other**					
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	
Urban Planning																					
CC related infrastructure, Utility services planning and design																					
Informal settlements & IDP settlements																					
Land Use and Building Control																					
Health and Hygiene Management																					
Spread of vector borne disease such and cholera, diarrhoea, dengue due to contaminated water sources, statements water ponds.																					
National Part forest and Eco system Management																					
Conversion of land use																					
Encroachment																					
Forest fires																					
Disaster Risk reduction and Management																					
Ability to cope with CC impacts water electricity and gas shortages, flooding of storm water and sewerage drains, landslides and slope failure.																					
Early warning system																					
Evacuation and resettlements																					

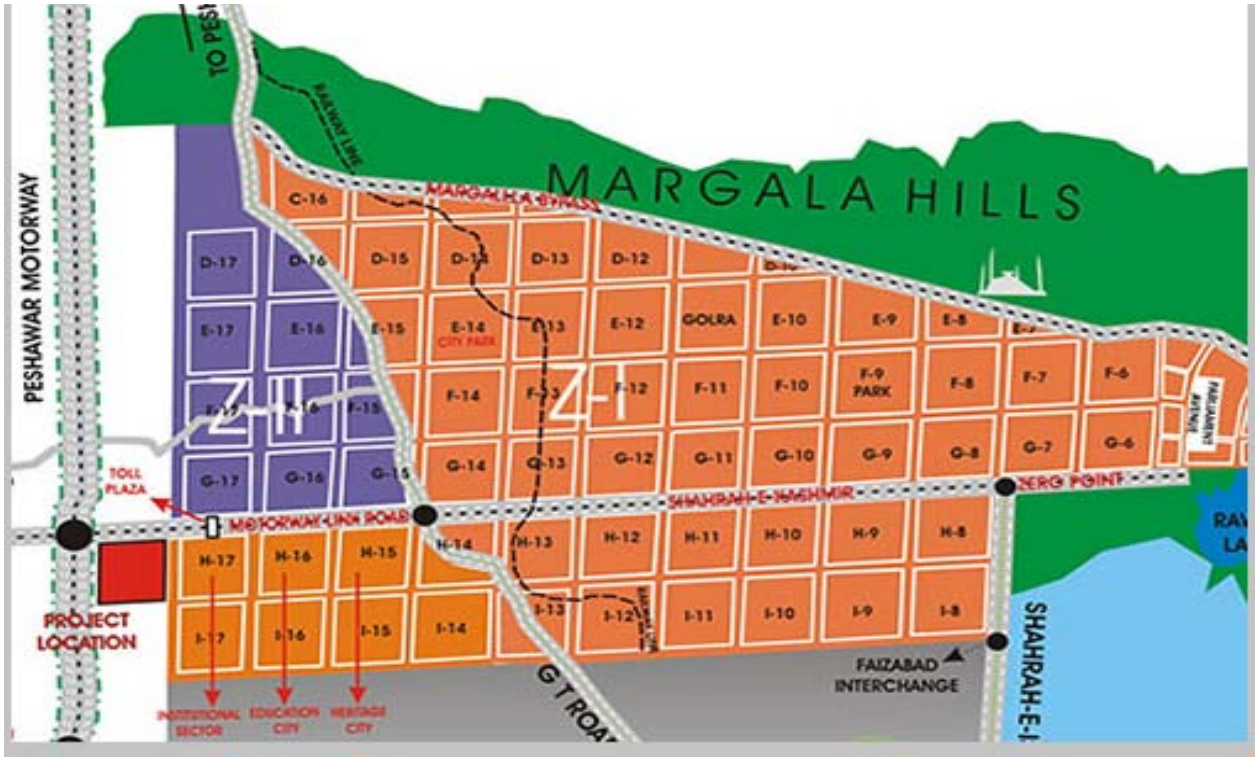
Rating value: 1=Low, 2=Medium Low, 3=Medium, 4=Medium- High, 5=High

Institutional Structure and capacity gaps of city authorities	
Components	**Note: Use separate flipchart for each category of information**
Mandate/Roles and responsibilities	
Organizational structure	
Departmental structure for caring out planning and designing of infrastructure services and utilities	
Details of plans and programmes developed for addressing CC related vulnerabilities :	
Infrastructure (storm water drainage sewerage and sanitation services , ground water recharge, water shortage demand management, solid waste management	
Land use and building control enforcement of land use and building control regulations , soil water management	
Health and hygiene management , vector borne disease control plan and programmes	
Capacity Gapes	

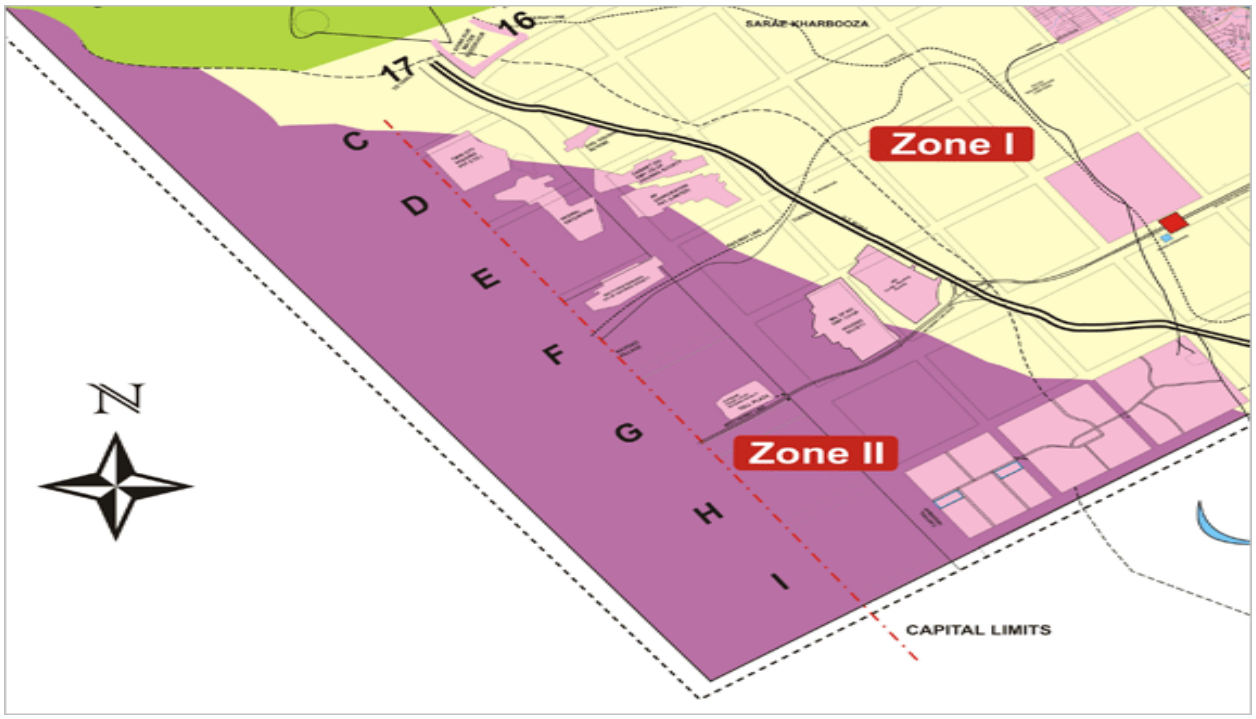
Annex-II

Zones of Islamabad Capital Territory

Map of Islamabad Capital Territory limits and its zones are as follows:

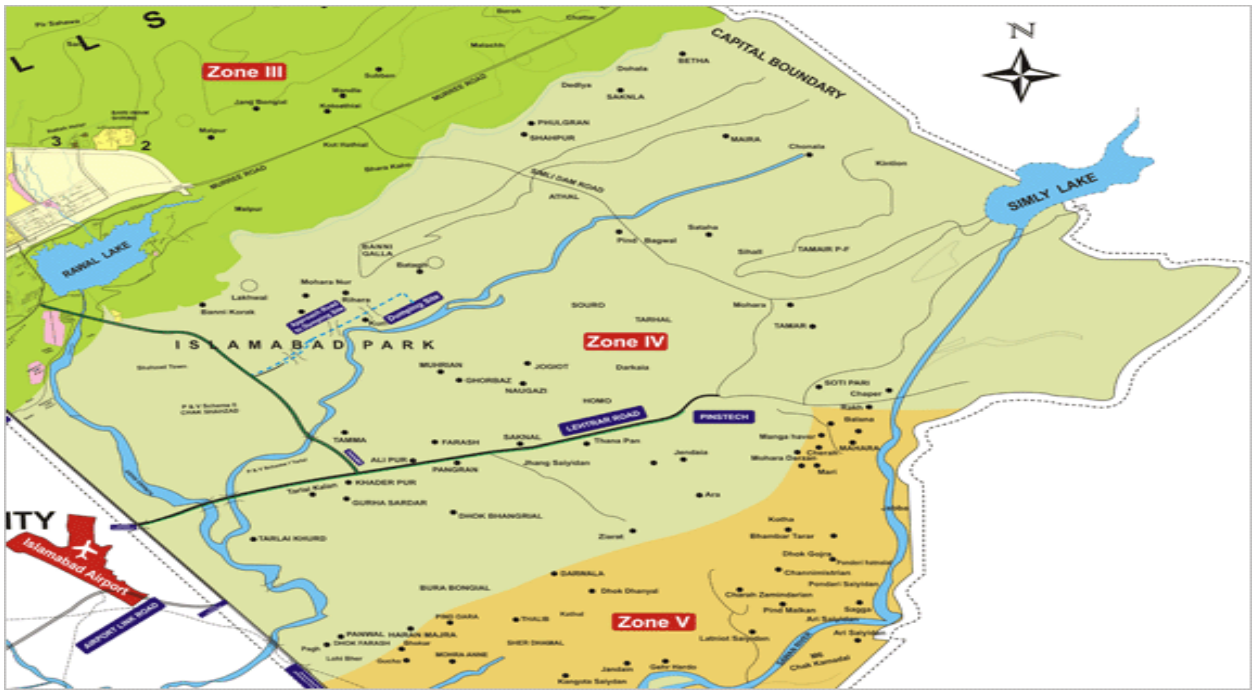


Zone I-Urban Sectors up to G.T. Road; Capital Development Authority exclusively responsible for Development (Islamabad Capital Territory Administration)



Zone II-Rural, Residential Sectors – Beyond G.T. Road; Private Housing Schemes (Islamabad Capital Territory Administration)

Zone III-Rural, Margalla Hills & 2 km around Rawal Lake; National Park for preservation and conservation (ICT Administration)

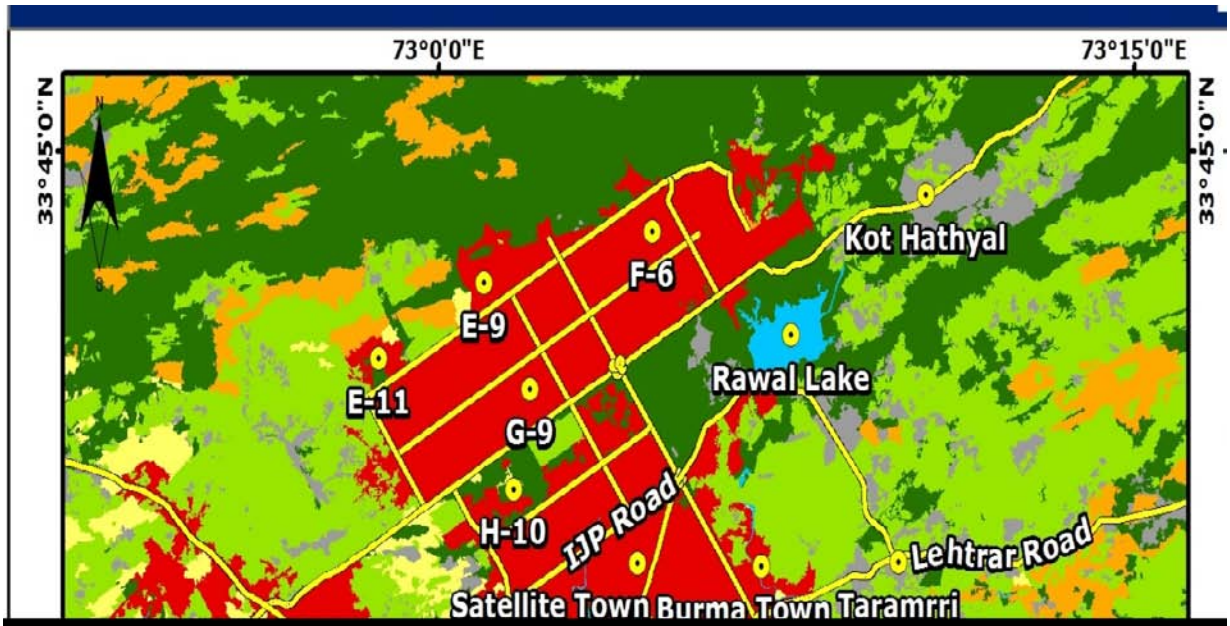


Zone IV-Rural, South of Rawal Lake and areas around Lehtrar road; Predominantly green zone for Agro farms, Sports, Recreation, Large institutions, No private housing schemes permitted. (Islamabad Capital Territory Administration)

Zone V-Rural, areas around Soanriver up to G.T. road, Private housing schemes (Islamabad Capital Territory Administration)

Annex-III

Urban Land cover Map of Islamabad, Year 2000 (SUPARCO)



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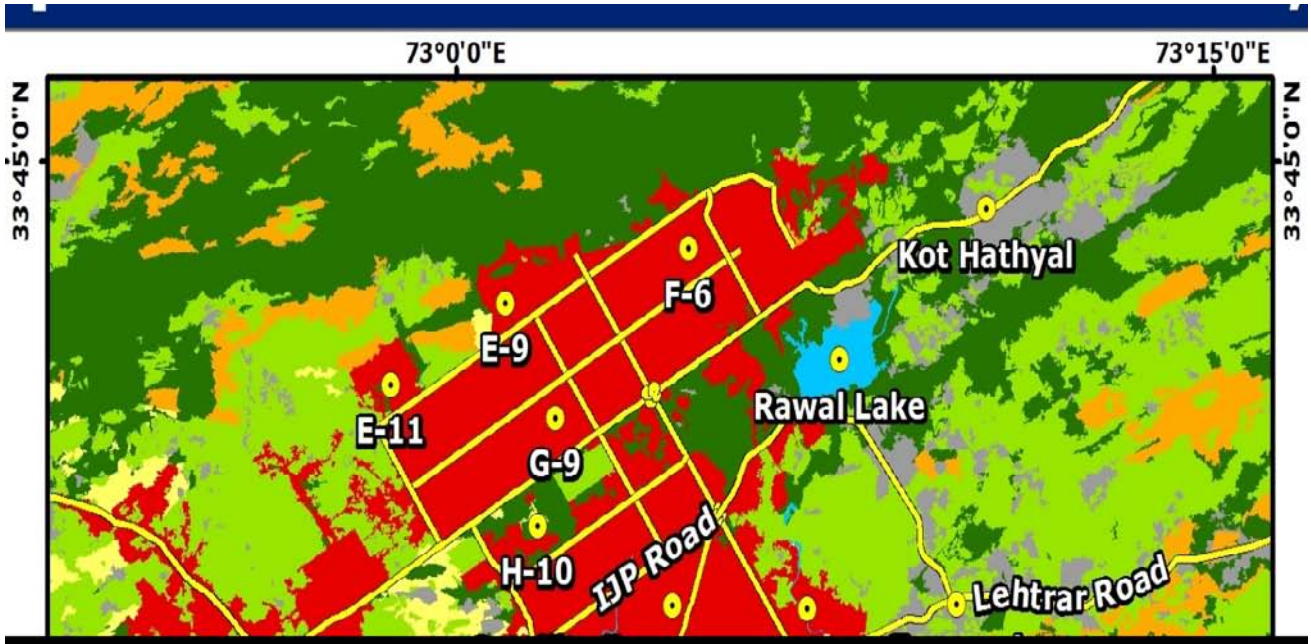
Annex-IV

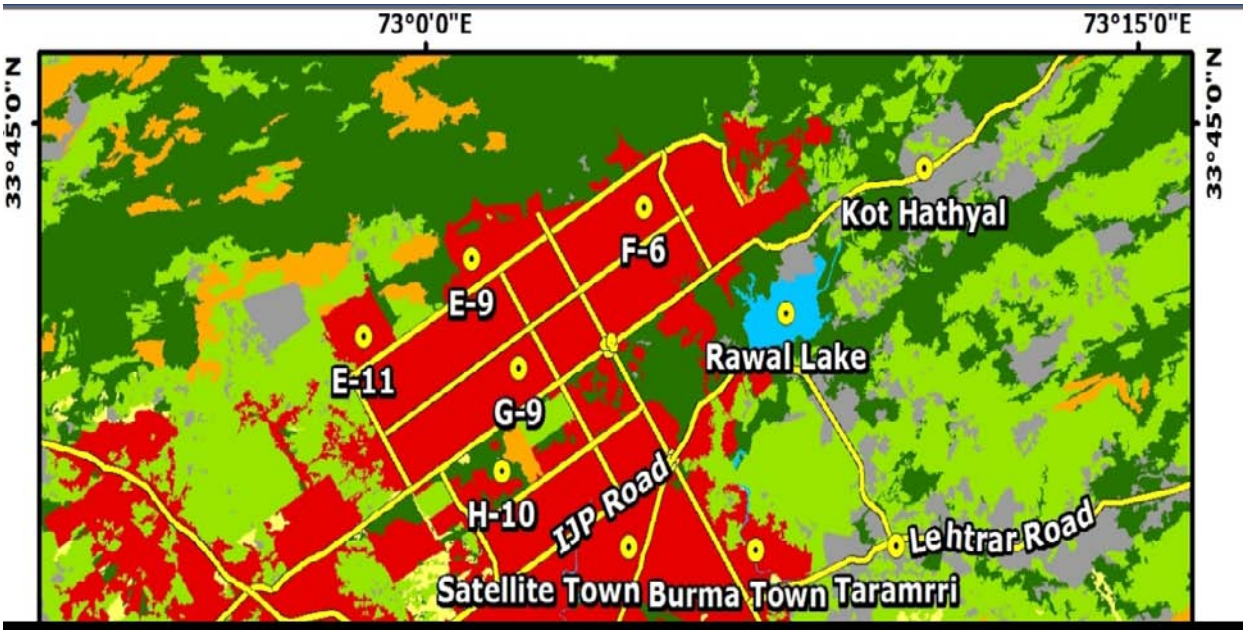
Urban Land cover Map of Islamabad, Year 2005 (SUPARCO)


73°0'0"E
73°15'0"E
33°45'0"N
33°45'0"N
Kot Hathyal
F-6
E-9
Rawal Lake
E-11
G-9
H-10
IJP Road
Lehtrar Road

[redacted]

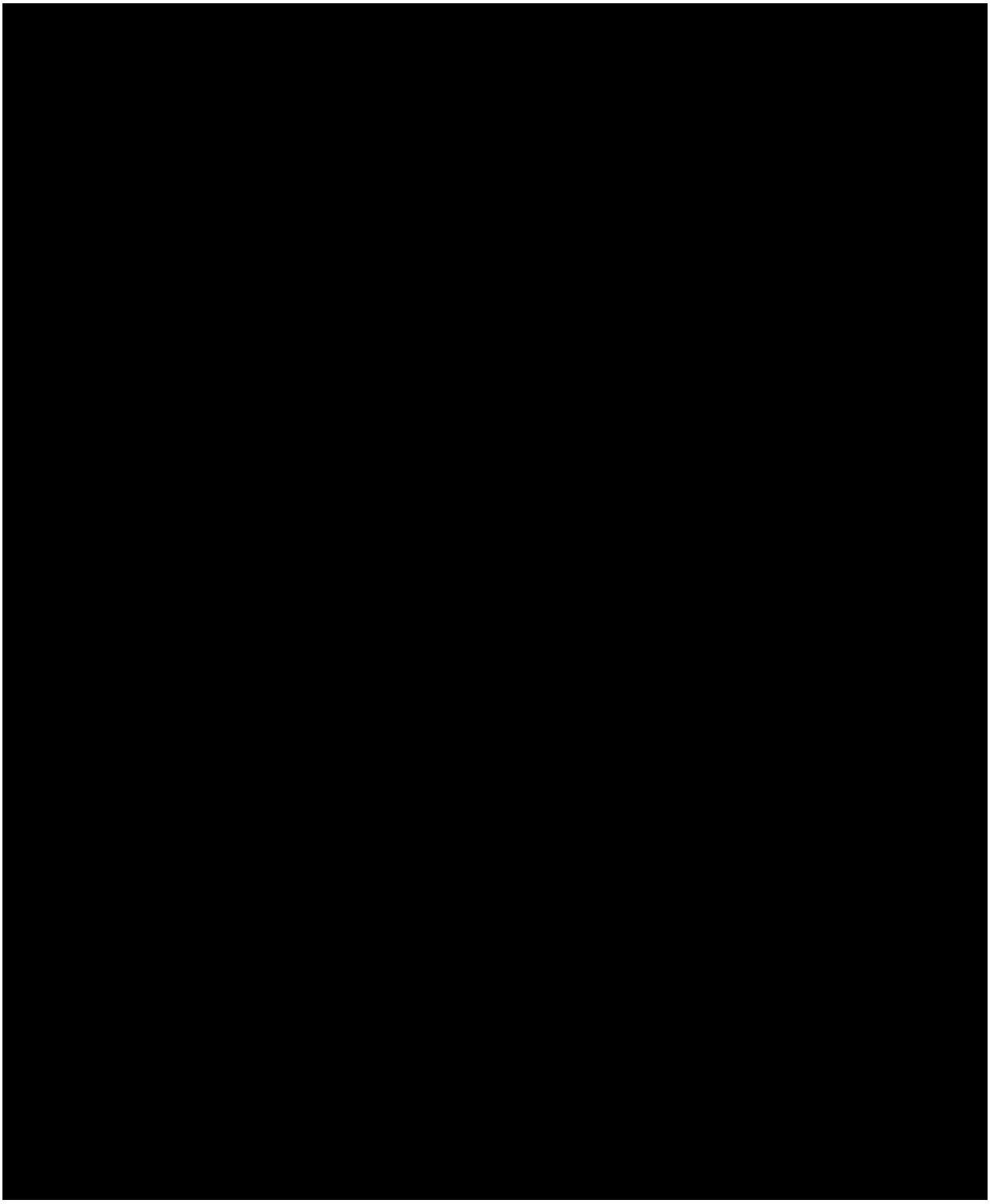
Annex-V

Urban Land cover Map of Islamabad, Year 2010 (SUPARCO)



Annex-VI

Urban Land cover Map of Islamabad, Year 2013 (SUPARCO)



Annex-VII

Urban Land cover Map of Islamabad, Year 2000-2013 (SUPARCO)

***Annex*-VIII**

Climate Change Trends: Methodology & Results

Data and Methodology used

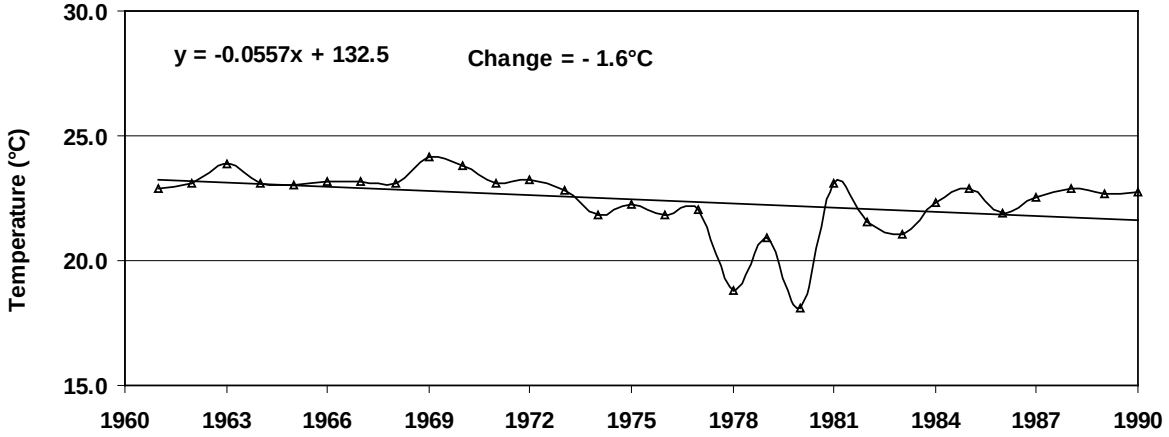
Climate profile of Islamabad Capital Territory (Grid II), where meteorological data was available and extreme values of some meteorological parameters, such as temperature, precipitation and wind speed and direction are based on the 30-year normal (1961-90) and subsequent meteorological data till to-date to give the base line pattern in the Islamabad Capital Territory region and its surroundings. Past climate changes, both for temperature and precipitation are worked out using the NCEP USA's observed reanalysis monthly data. Projected climate changes are worked out using the outputs of the ECHAM4; GCM downscaled to both the grids using PRECIS, the Regional Climate Model of Hadley Centre, UK. Regression analysis is used to assess the trend changes. These are worked out for IPCC-A2scenarios for the three 30-year time slices namely, 2020s (2010-2039), 2050 (2040-2069) and 2080s (2070-2099) with respect to the baseline (1961-1990).GRID map of Islamabad Capital Territory is as follows:

Gridded Map of Islamabad Capital Territory, Grid II and Grid I[33]

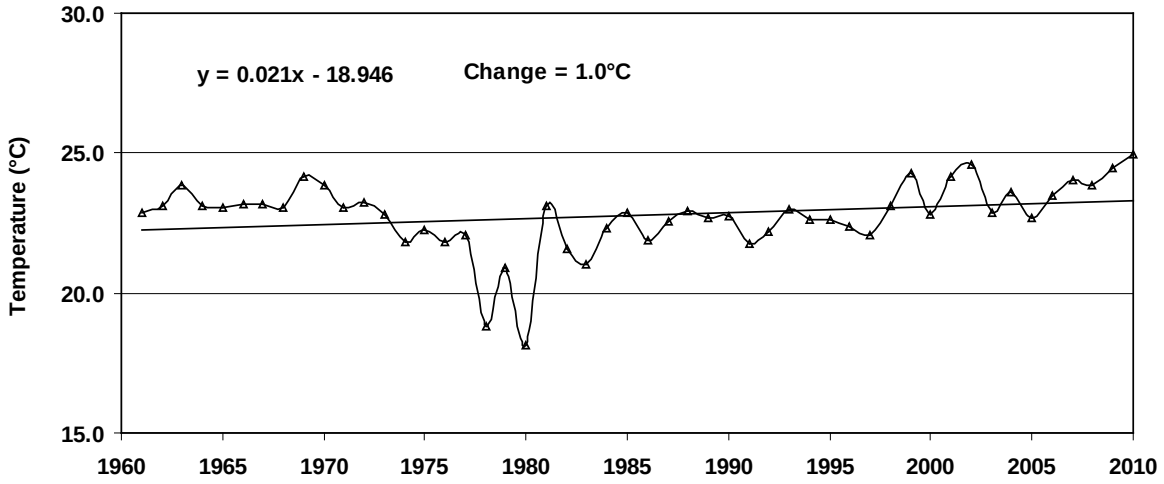
[33]Sheikh, Muhammad Munir, ShahbazMehmood and NaeemManzoor, "Islamabad Capital Territory (ICT) in the context of climate change: past and projected. Un-published (all analytical tables in Annex VIII)

Graphs of the annual mean temperature trends (°C) of Grid I and II for the year 1961-1990 and 1961-2010

Grid I

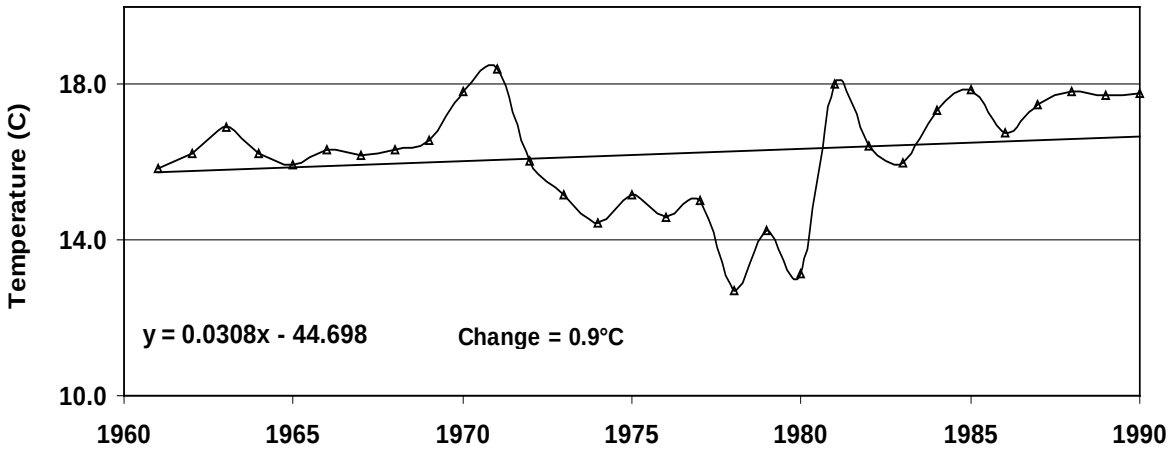


Annual Mean Temperature Trend (°C) at Grid I during 1961-1990

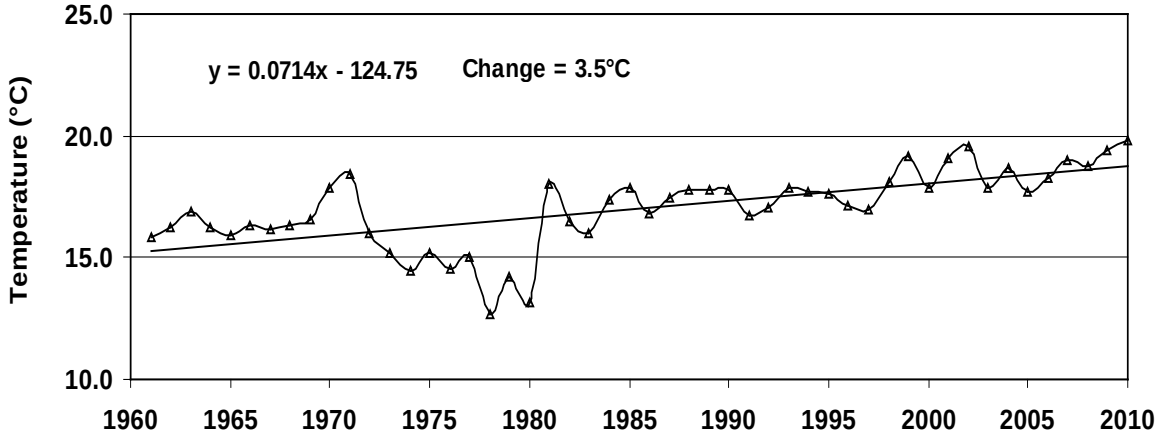


Annual Mean Temperature Trend (°C) at Grid I during 1961-2010

Grid II



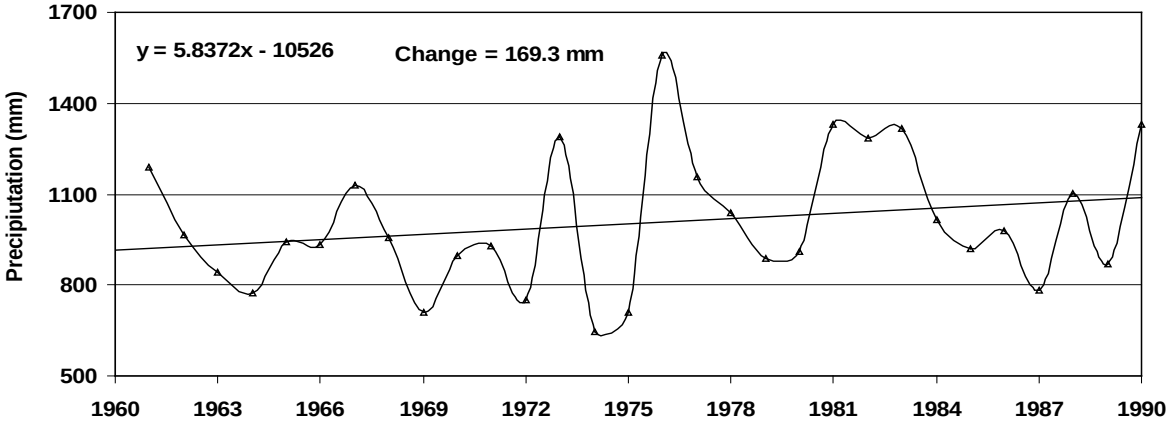
Annual Mean Temperature Trend (°C) at Grid II during 1961-1990



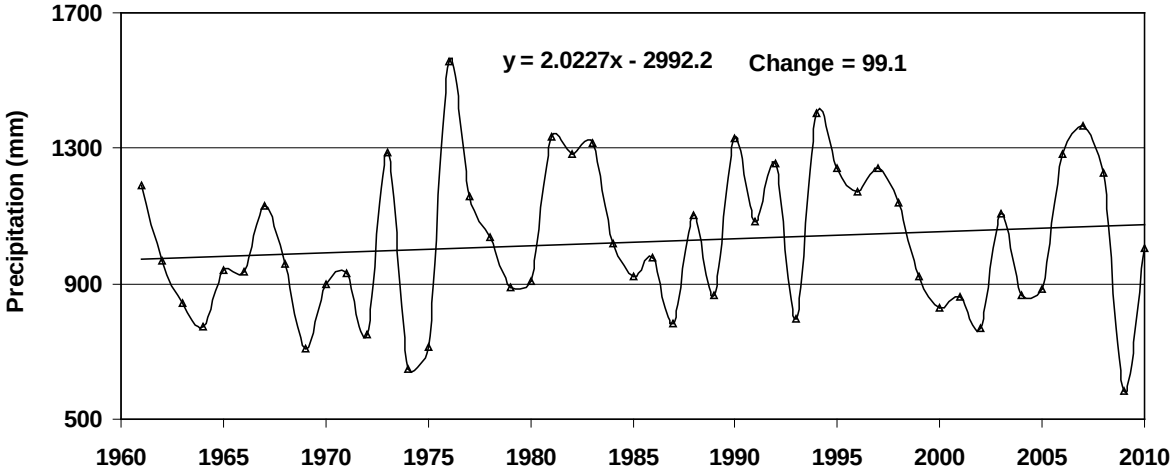
Annual Mean Temperature Trend (°C) at Grid II during 1961-2010

Graphs of the annual mean temperature trends (°C) of Grid I and II for the year 1961-1990 and 1961-2010

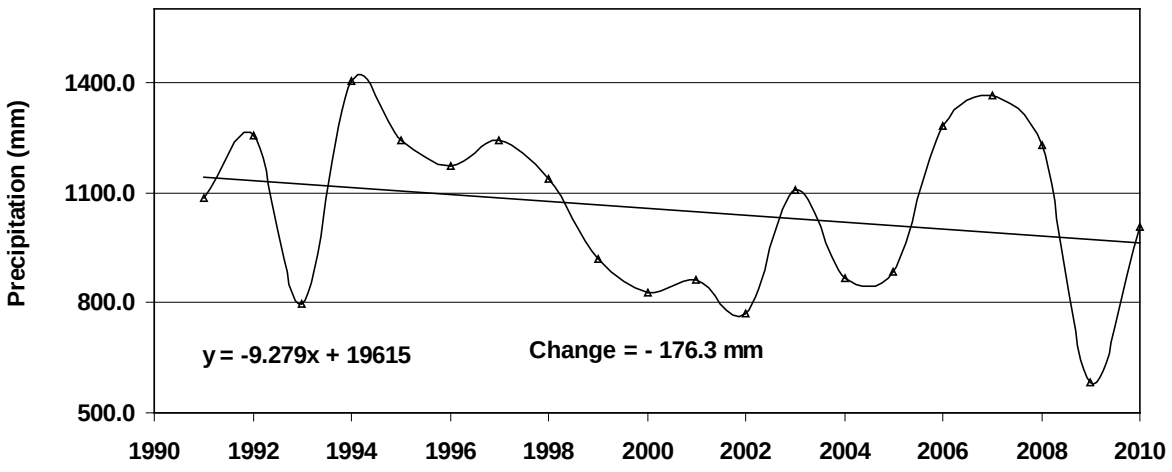
Grid I



Annual Precipitation Trend (mm) at Grid I during 1961-1990

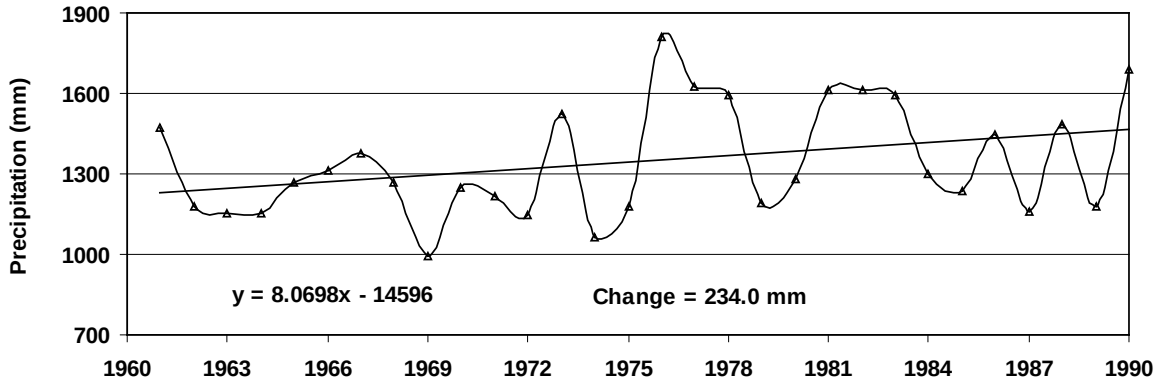


Annual Precipitation Trend (mm) at Grid I during 1961-2010

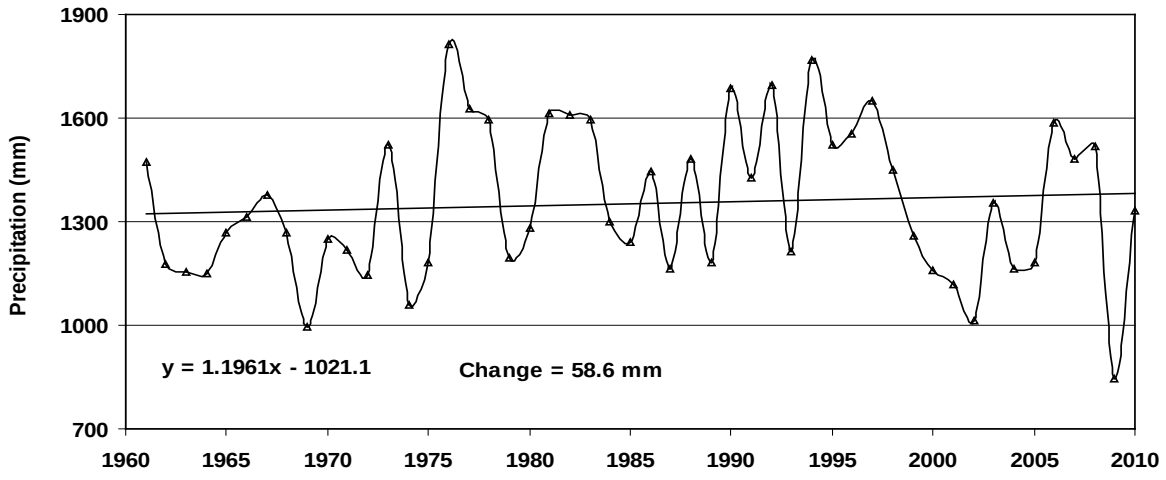


Annual Precipitation Trend (mm) at Grid I during 1991-2010

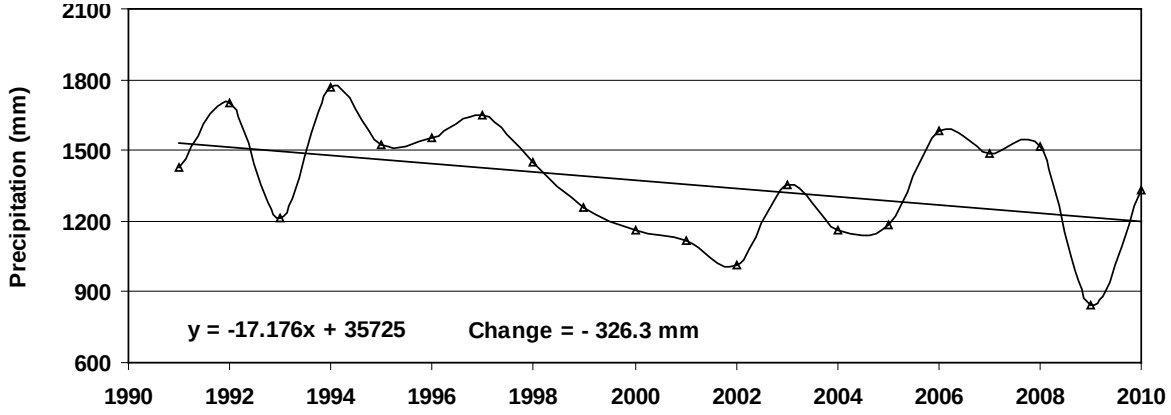
Grid II



Annual Precipitation Trend (mm) at Grid II during 1961-1990



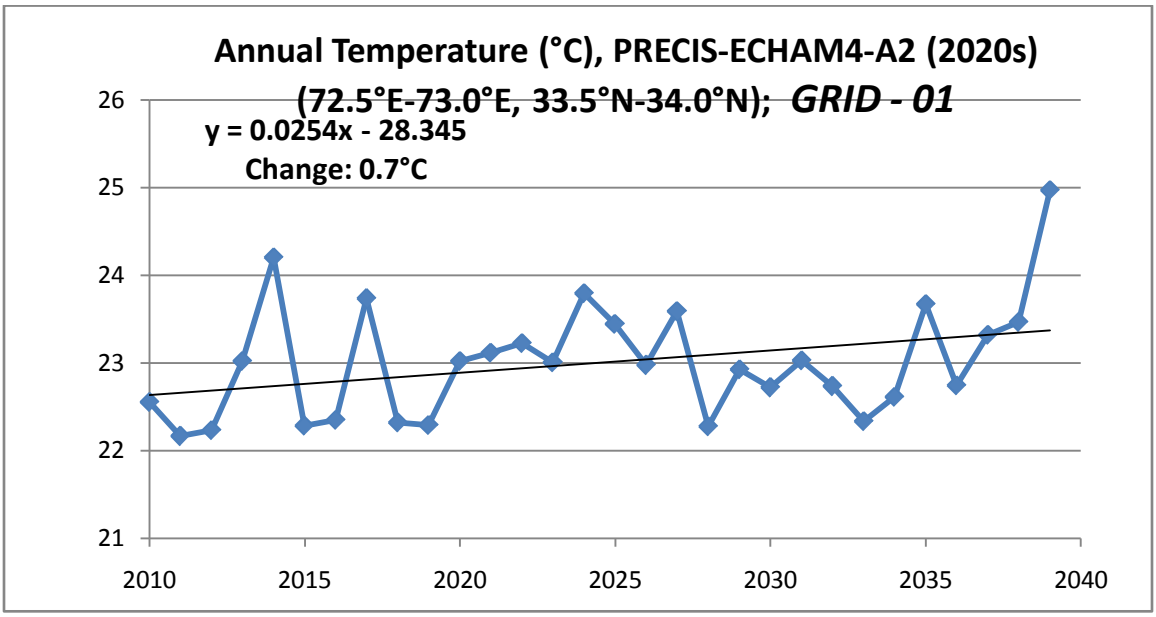
Annual Precipitation Trend (mm) at Grid II during 1961-2010



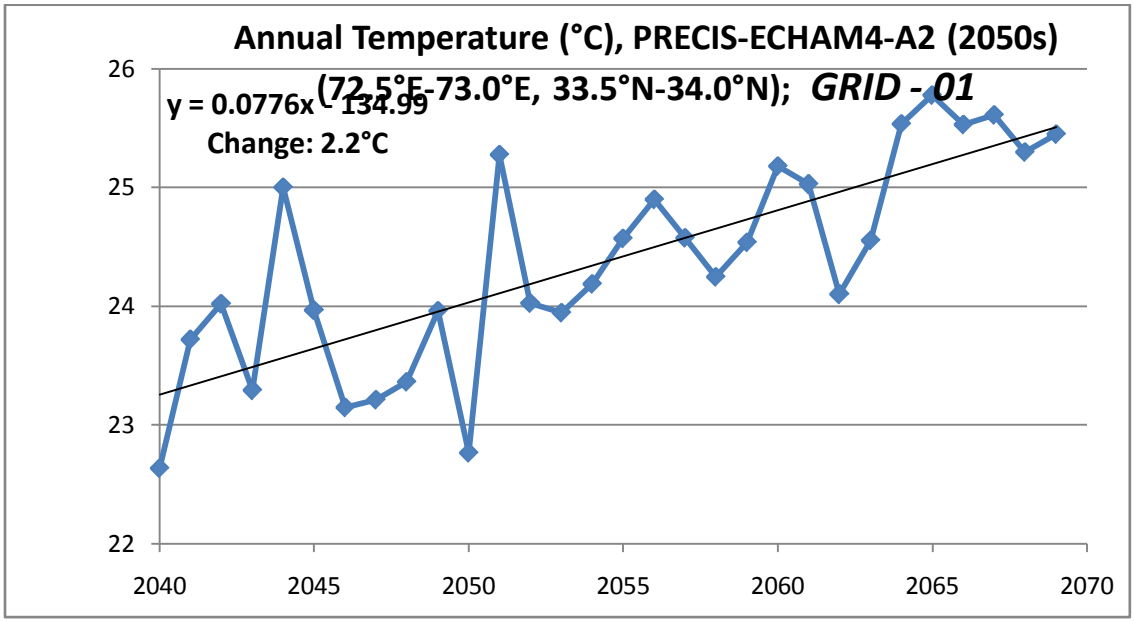
Annual Precipitation Trend (mm) at Grid II during 1991-2010

Graphs of the projected annual temperature (°C) of Grid I and II for the year 2020s, 2050s and 2080s

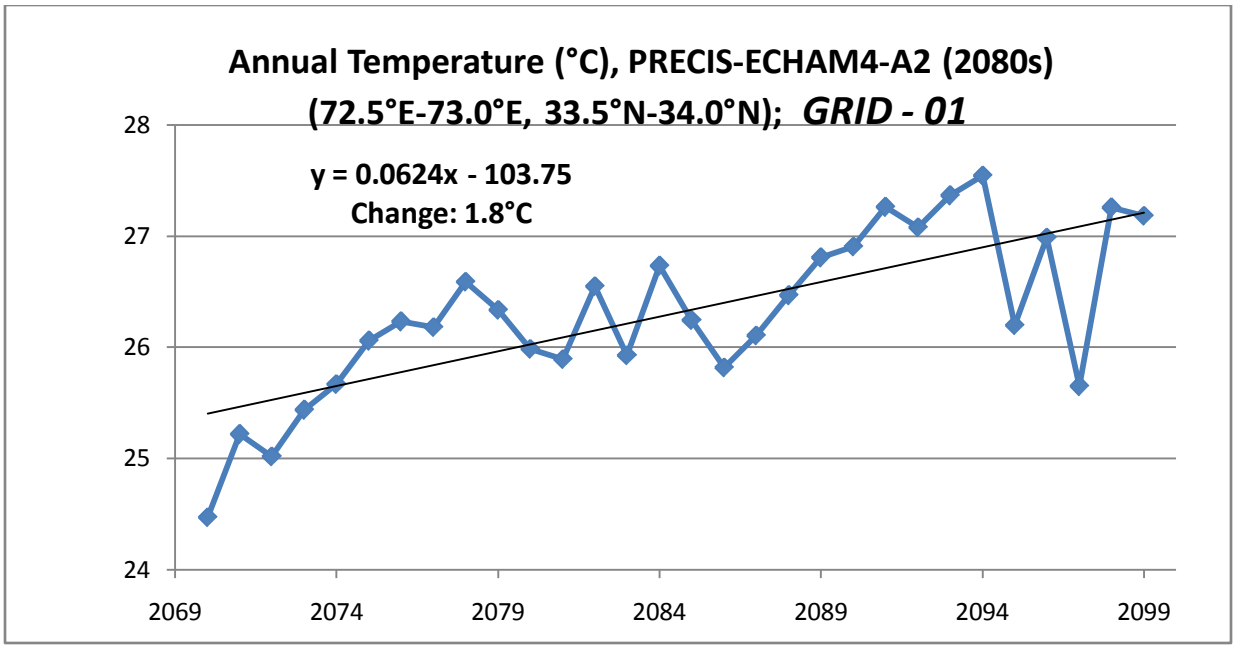
GRID I



Annual Temperature (°C), PRECIS-ECHAM4-A2 (2020s)

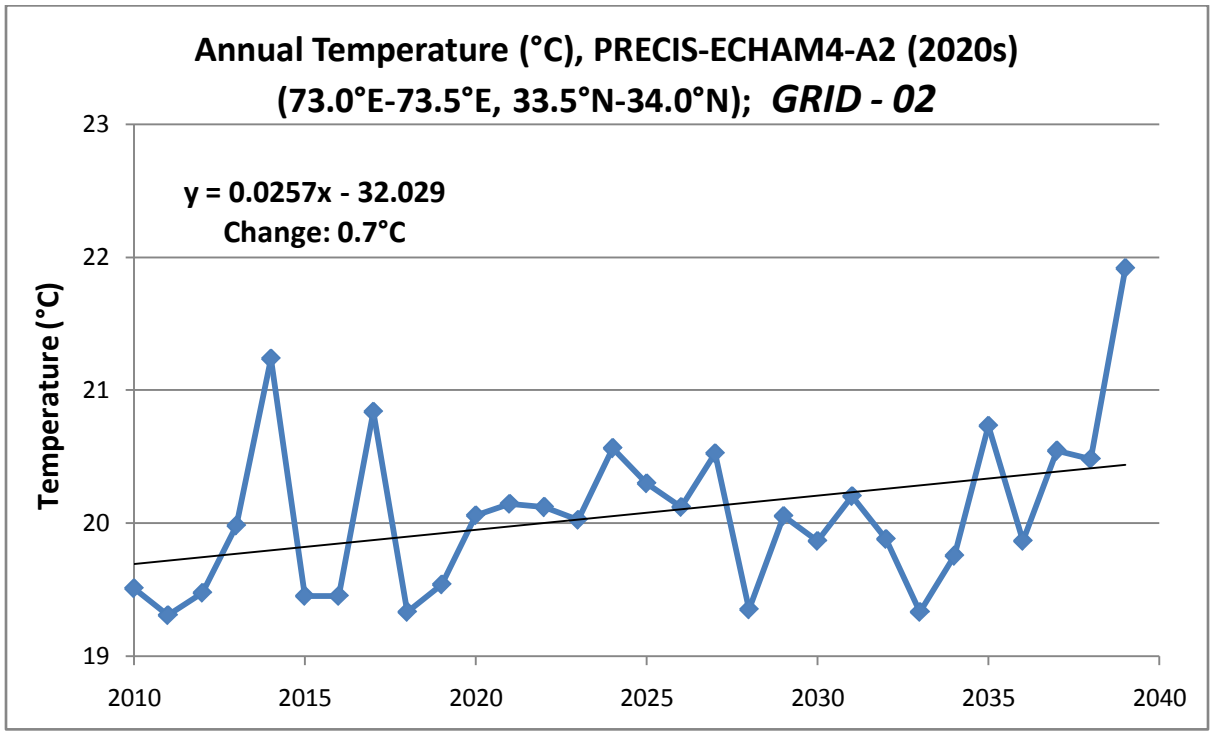


Annual Temperature (°C), PRECIS-ECHAM4-A2 (2050s)

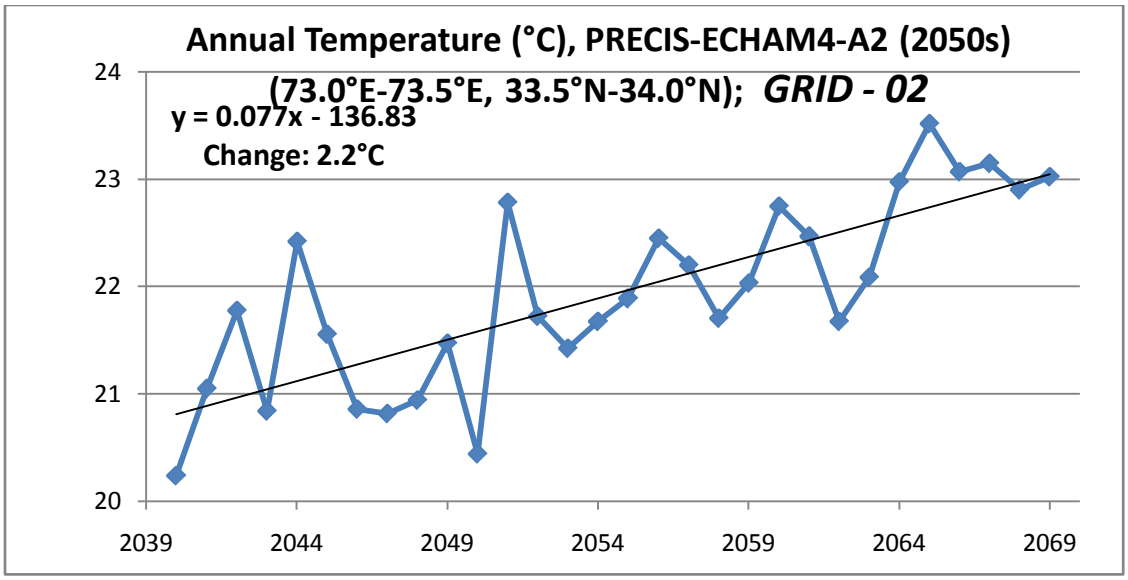


Annual Temperature (°C), PRECIS-ECHAM4-A2 (2080s)

GRID II

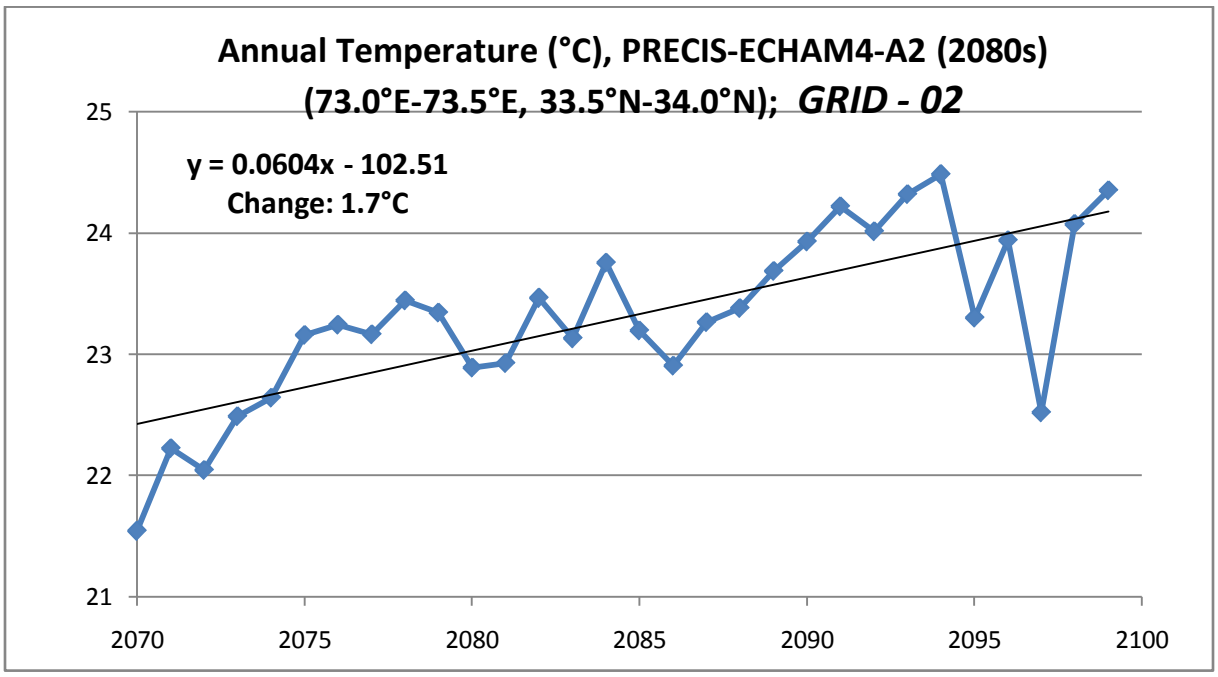


Annual Temperature (°C), PRECIS-ECHAM4-A2 (2020s)



Annual Temperature (°C), PRECIS-ECHAM4-A2 (2050s)

GRID II



Annual Temperature (°C), PRECIS-ECHAM4-A2 (2080s)

Annex-IX

Carbon Sequestration in Margalla Hills National Park

In order to conduct analysis of exposure, sensitivity and assess the adoptive capacity to manage the effects of Climate Change in Islamabad, SUPARCO with the collaboration of UN-Habitat and Climate Change Division, conducted first phase of the study to estimate the Carbon Sequestration in Margalla Hills National Park. To assess the current soil condition, pH was foremost parameter that was taken. For this purpose, a homogenous distribution of sampling points was taken through Arc-GIS specifically in Margalla Hills that comes under Islamabad Capital Territory.

The results of the first parameter, soil pH show, that most of the sampling sites are alkaline but not at high level. The alarming situation found at very few sampling points where the layers of organic horizon were found acidic. The results (Acidic) are in fact indicating the beginning of a situation which could have direct consequences in forest. A comprehensive and repeated survey would indeed be required to figure out the clearer picture of soil condition and assist in assessment of the acidic affected areas. Nevertheless, this assessment is the first of its kind, being conducted in collaboration with UN-Habitat and MoCC.

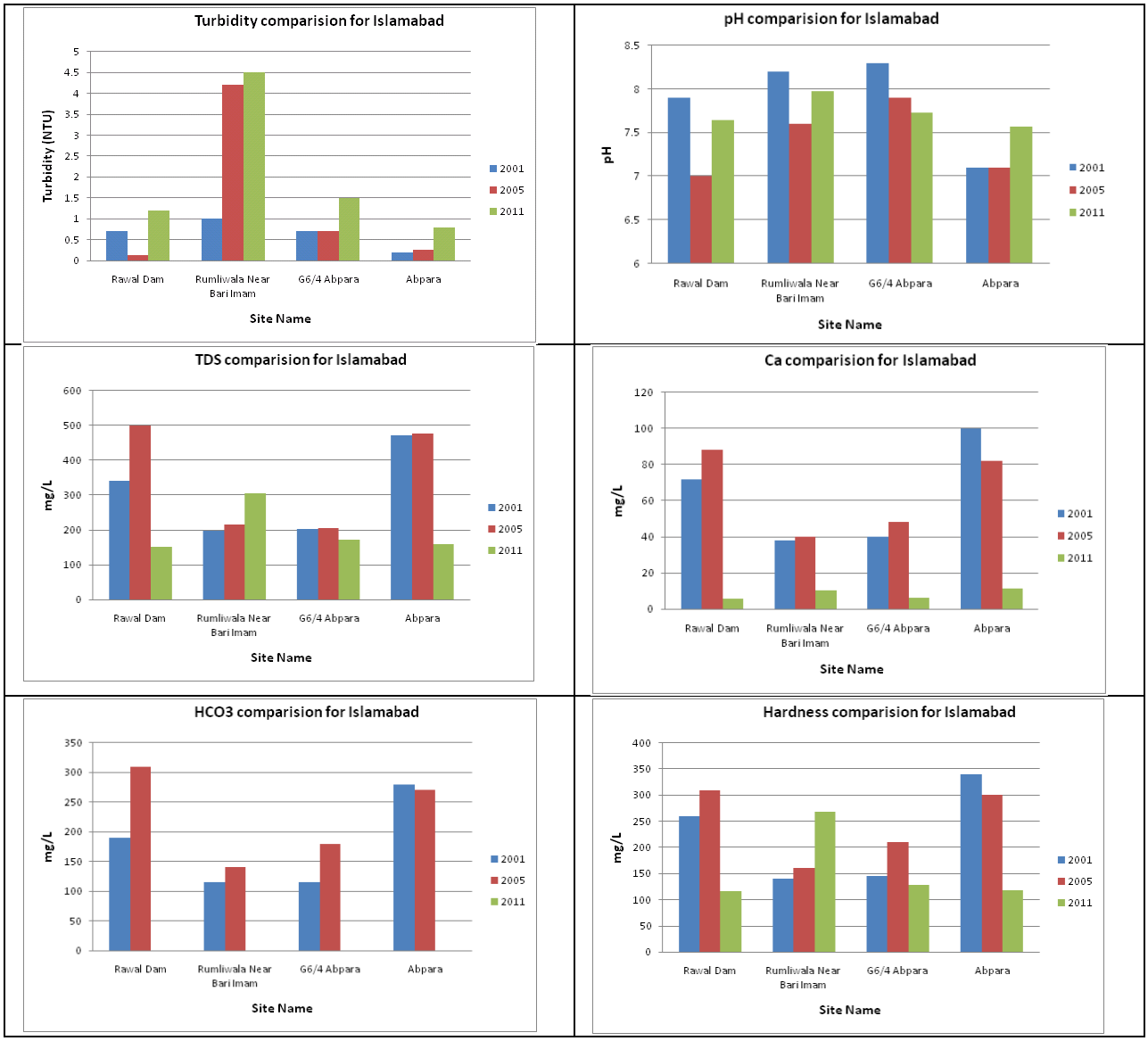
Results showing high acidic contents are liable to harm the forest health through soil ecology, physio-chemical processes, humus morphology, tree growth, micro and meso fauna abundance and species richness and carbon sequestration. High acidity also brings effective chemical changes in soil which would make essential elements unavailable to the trees which would harm the growth process of the trees. Micro and meso fauna are also highly sensitive to the tiny chemical changes in their microclimate. At high pH, different micro and meso-fauna are unable to function properly which make them unable to participate in the decomposition process which is highly essential for the carbon sequestration in the forest soil.

On the basis of preliminary results (pH), an assumption could be made that on specific locations in MargalaHills, there would be significant difference in Carbon and Nitrogen concentration, meso-fauna abundance, meso-fauna species richness, fungal biomass, humus morphology and ultimately the Carbon sequestration. It is clear that this process of acidification has been triggered in the said forest and it is highly recommended to verify the complete forest and adopt appropriate measures to normalize the physio-chemical processes through pH.

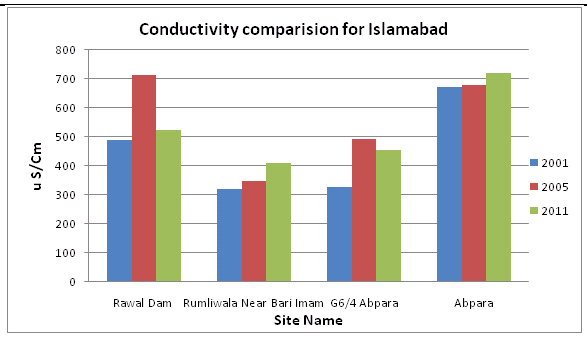
Moreover, after having the results of other parameters, a conclusive discussion and recommendations can be made. The remaining parameters are: carbon and nitrogen concentration, Ergosterole/fungal biomass, carbon storage, humus morphology and meso-fauna biodiversity/species richness. The final results of this project would provide information regarding impact of soil conditions on Carbon Sequestration in context of Climate Change.

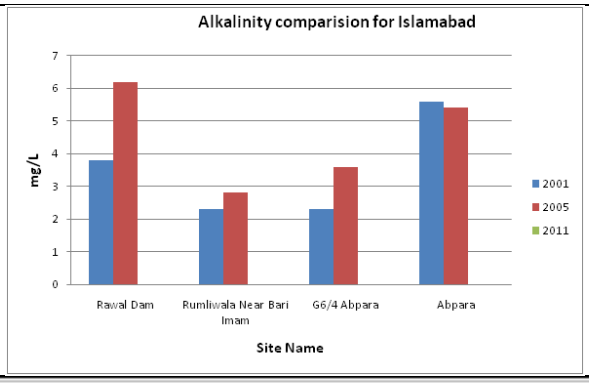
Annex-X

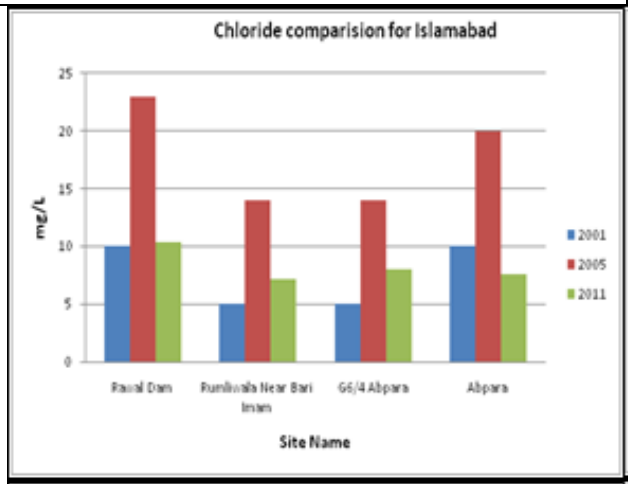
Results of Dirking Water Quality at various sites at Islamabad[34]

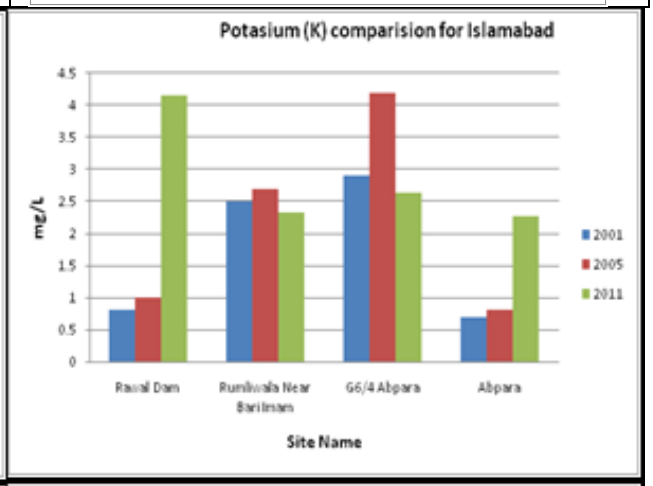


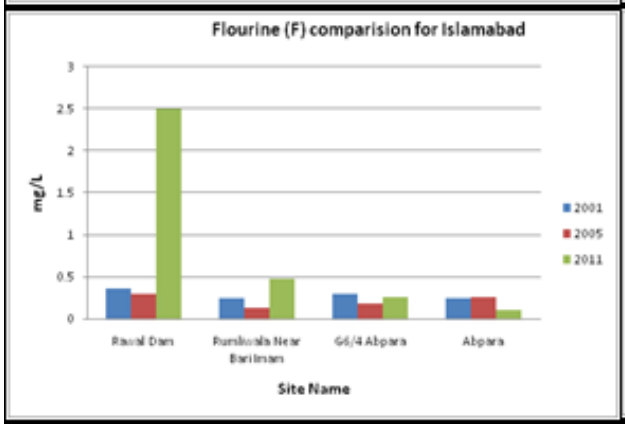
[34]National Environmental Information Management System, Final Report 2013 by SUPARCO & Ministry of Climate Change

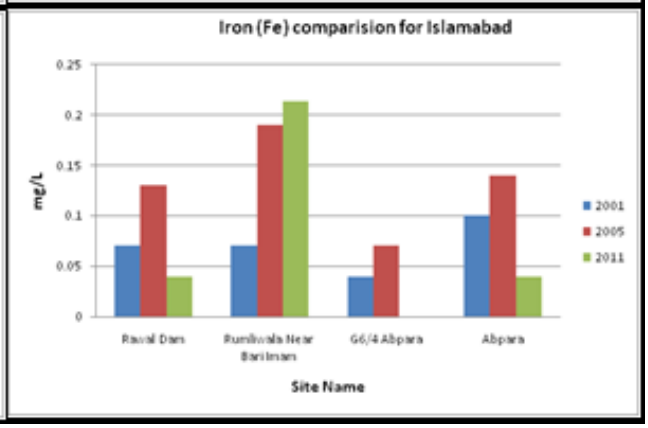

Conductivity comparision for Islamabad
u S/Cm
800
700
600
500
400
300
200
100
0
Rawal Dam
Rumliwala Near Bari Imam
G6/4 Abpara
Abpara
Site Name
2001
2005
2011


Alkalinity comparision for Islamabad
mg/L
7
6
5
4
3
2
1
0
Rawal Dam
Rumliwala Near Bari Imam
G6/4 Abpara
Abpara
Site Name
2001
2005
2011

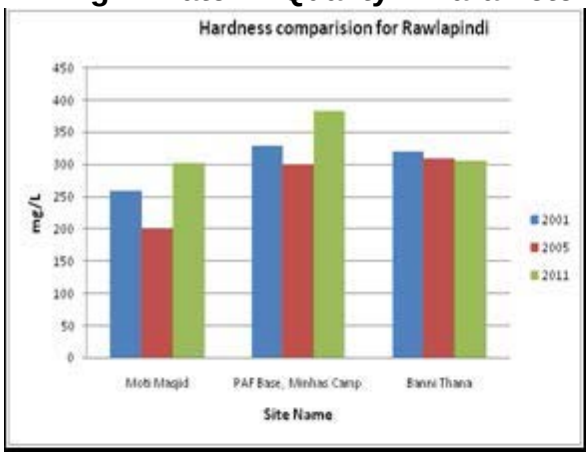

Chloride comparision for Islamabad
mg/L
25
20
15
10
5
0
Rawal Dam
Rumliwala Near Bari Imam
G6/4 Abpara
Abpara
Site Name
2001
2005
2011

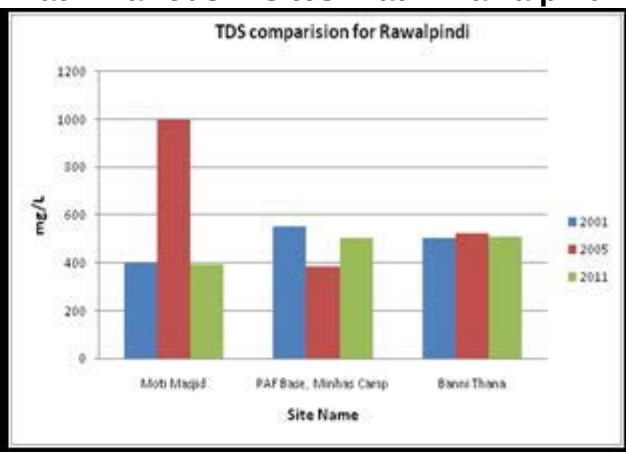

Potasium (K) comparision for Islamabad
mg/L
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
Rawal Dam
Rumliwala Near Bari Imam
G6/4 Abpara
Abpara
Site Name
2001
2005
2011

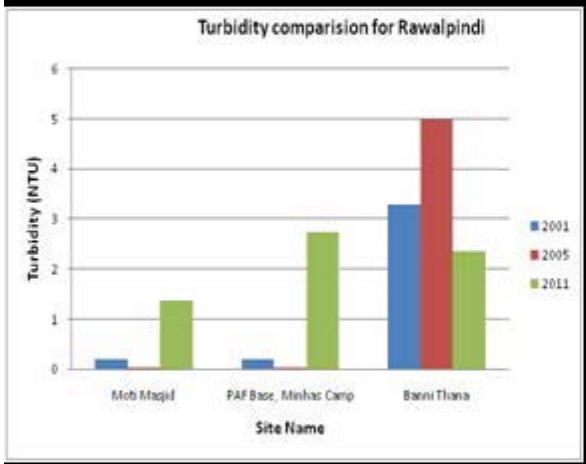

Flourine (F) comparision for Islamabad
mg/L
3
2.5
2
1.5
1
0.5
0
Rawal Dam
Rumliwala Near Bari Imam
G6/4 Abpara
Abpara
Site Name
2001
2005
2011

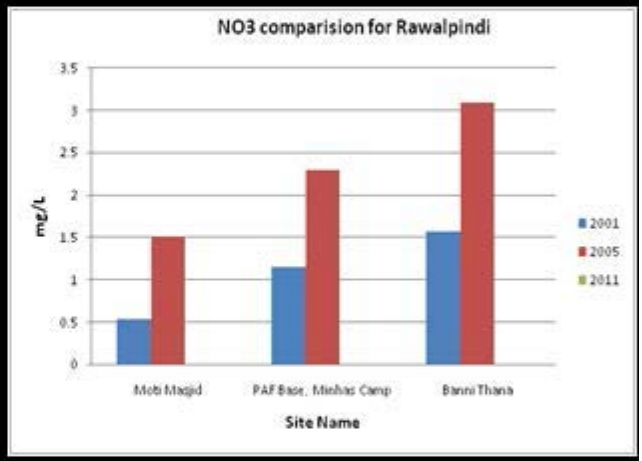

Iron (Fe) comparision for Islamabad
mg/L
0.25
0.2
0.15
0.1
0.05
0
Rawal Dam
Rumliwala Near Bari Imam
G6/4 Abpara
Abpara
Site Name
2001
2005
2011

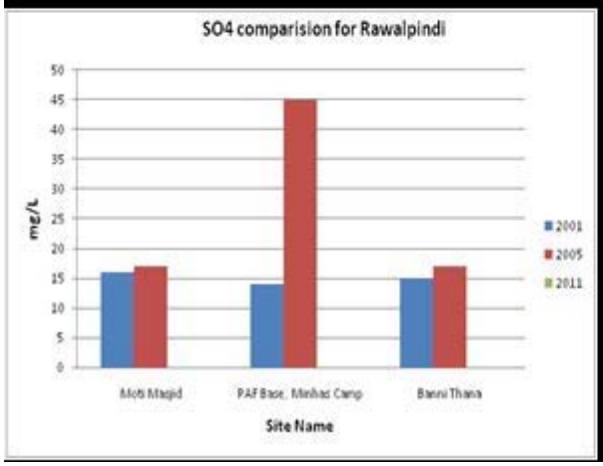
Annex-XI Results of Dirking Water Quality Parameters at various sites at Rawalpindi[35]

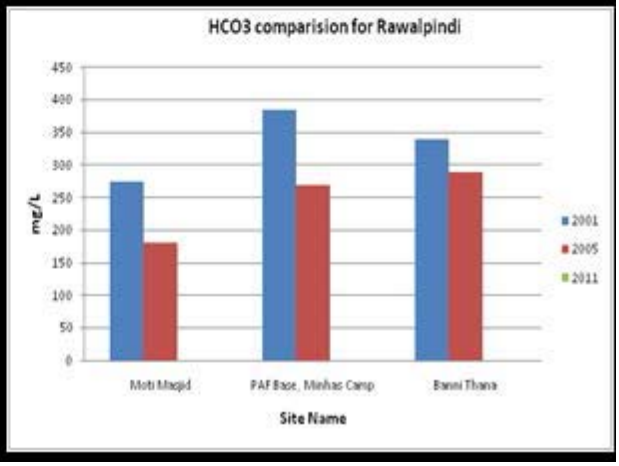




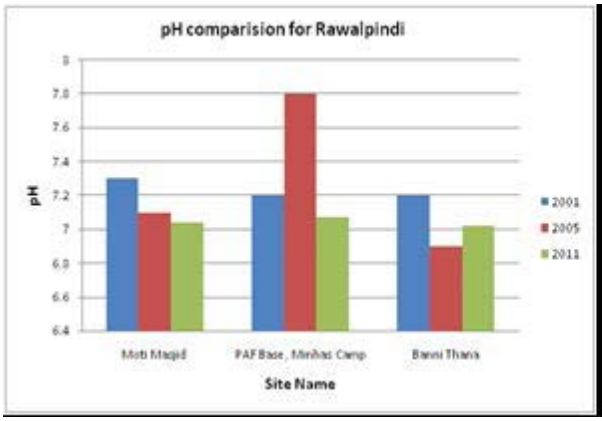


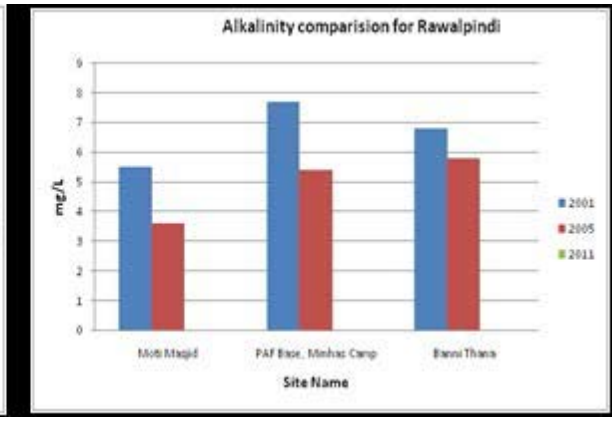


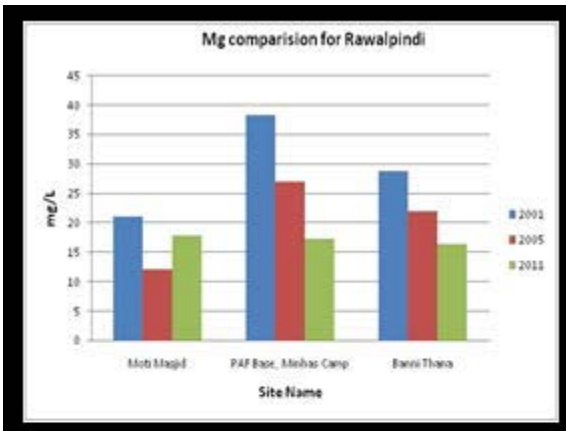


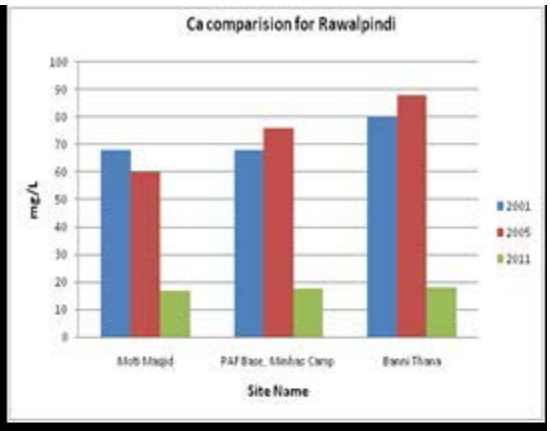


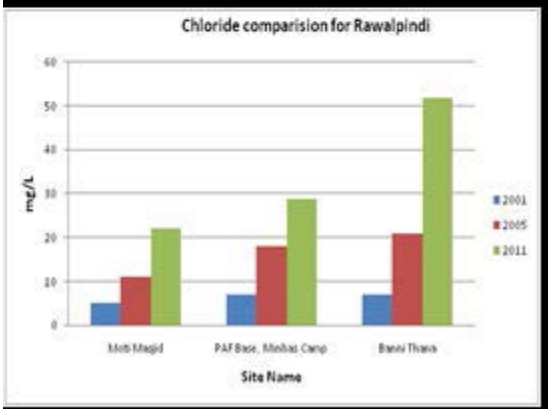
[35]National Environmental Information Management System, Final Report 2013 by SUPARCO & Ministry of Climate Change

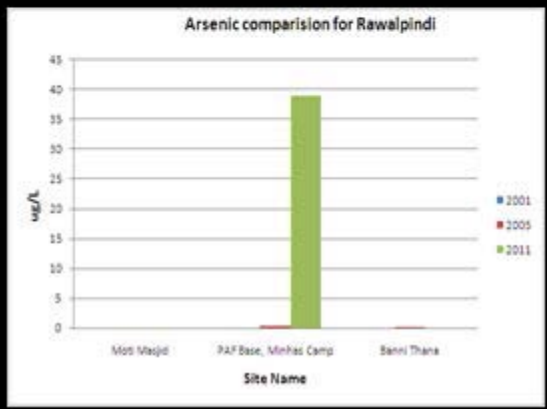

pH comparision for Rawalpindi
pH
Moti Masjid
PAF Base, Minhas Camp
Banni Thana
Site Name
2001
2005
2011

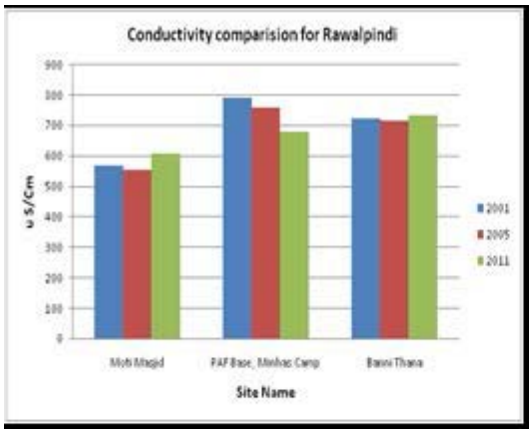

Alkalinity comparision for Rawalpindi
mg/L
Moti Masjid
PAF Base, Minhas Camp
Banni Thana
Site Name
2001
2005
2011

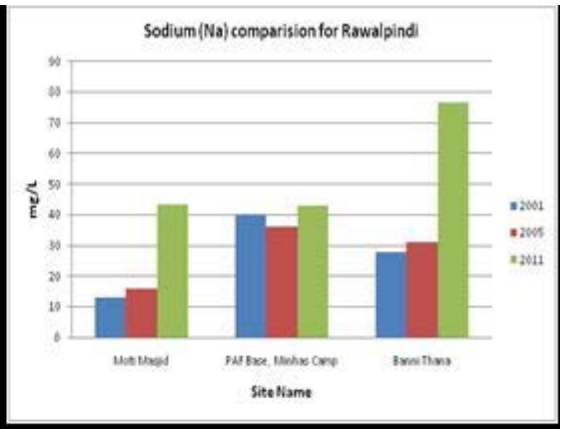

Mg comparision for Rawalpindi
mg/L
Moti Masjid
PAF Base, Minhas Camp
Banni Thana
Site Name
2001
2005
2011

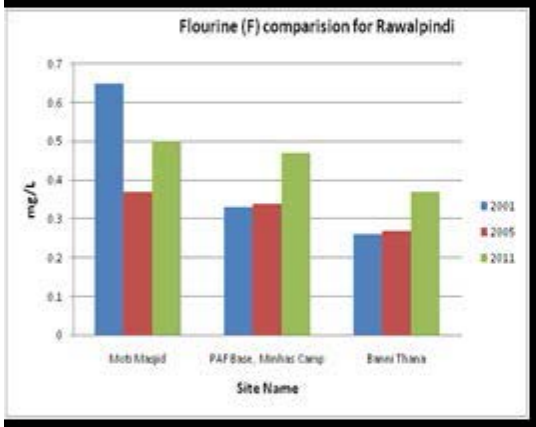

Ca comparision for Rawalpindi
mg/L
Moti Masjid
PAF Base, Minhas Camp
Banni Thana
Site Name
2001
2005
2011

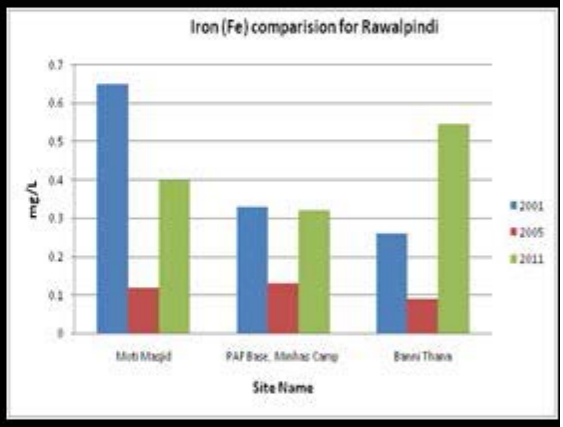

Chloride comparision for Rawalpindi
mg/L
Moti Masjid
PAF Base, Minhas Camp
Banni Thana
Site Name
2001
2005
2011

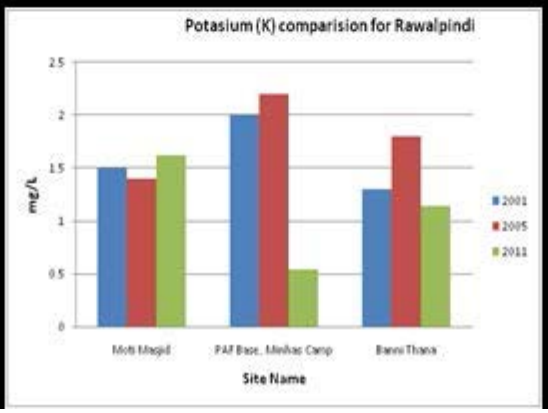

Arsenic comparision for Rawalpindi
ug/L
Moti Masjid
PAF Base, Minhas Camp
Banni Thana
Site Name
2001
2005
2011


Conductivity comparision for Rawalpindi
u S/Cm
900
800
700
600
500
400
300
200
100
0
Moti Masjid
PAF Base, Minhas Camp
Banni Thana
Site Name
2001
2005
2011


Sodium (Na) comparision for Rawalpindi
mg/L
90
80
70
60
50
40
30
20
10
0
Moti Masjid
PAF Base, Minhas Camp
Banni Thana
Site Name
2001
2005
2011


Flourine (F) comparision for Rawalpindi
mg/L
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Moti Masjid
PAF Base, Minhas Camp
Banni Thana
Site Name
2001
2005
2011


Iron (Fe) comparision for Rawalpindi
mg/L
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Moti Masjid
PAF Base, Minhas Camp
Banni Thana
Site Name
2001
2005
2011


Potasium (K) comparision for Rawalpindi
mg/L
2.5
2
1.5
1
0.5
0
Moti Masjid
PAF Base, Minhas Camp
Banni Thana
Site Name
2001
2005
2011

Annex 12 – Indigenous Tree Species in the Margalla Hills National Park

Description of indigenous species of trees of Margalla Hills National Park is as follows:

UN HABITAT
UNITED NATIONS HUMAN SETTLEMENTS PROGRAMME

GPO Box 1980, Islamabad, Pakistan
Tel: +92-51-8357358 Fax: +92-51-8357363-4
Web: http://www.unhabitat.org.pk