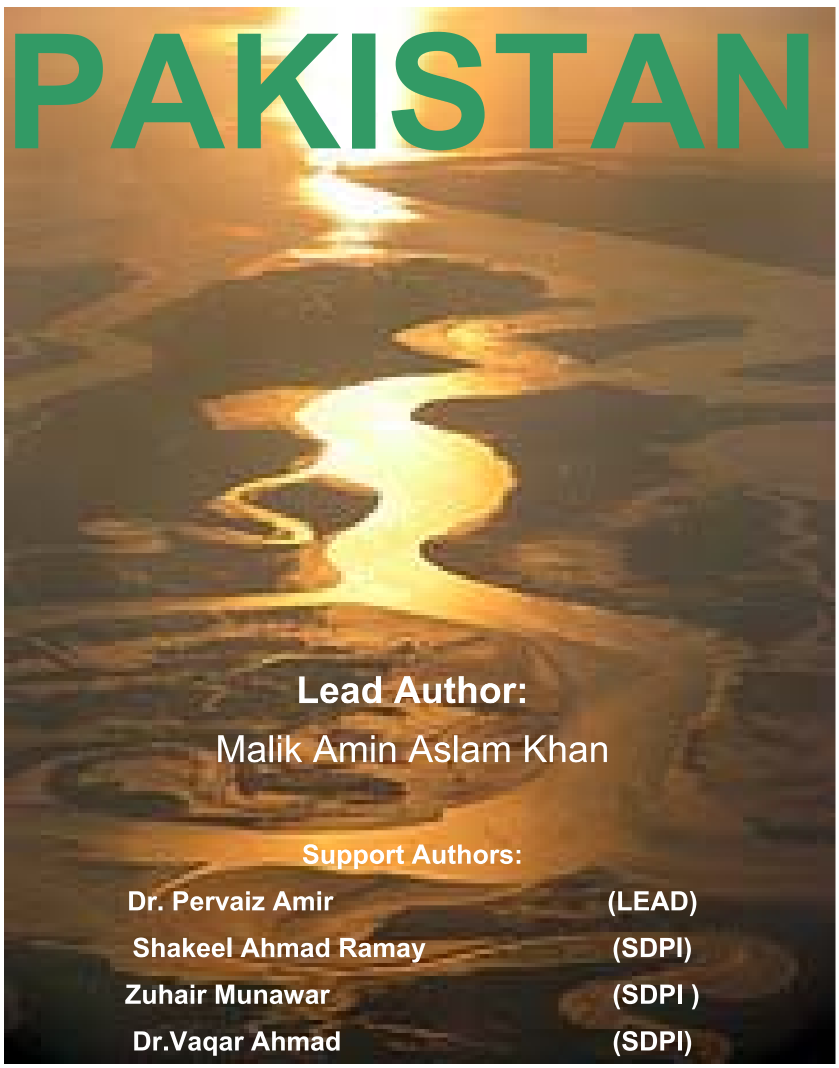
National Economic & Environmental Development Study (NEEDS)



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This report is produced as a result of National Economic, Environment and Development Study (NEEDS) project for Climate Change carried out for Pakistan in 2010-11. The study involves research work and expert group consultation with key stakeholders on climate change, in particular, the Core Group on Climate Change constituted at the Ministry of Environment. The Ministry of Environment of Pakistan has overseen the development of this study with financial support received from the Secretariat of United Nations Framework Convention on Climate Change (UNFCCC).

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Abbreviations Used:

ADB	**-**	**Asian Development Bank**
AEDB	**-**	**Alternate Energy Development Board**
AFB	**-**	**Adaptation Fund Board**
ALGAS	**-**	**Asia Least Cost Gas Abatement Strategy**
BAU	**-**	**Business As Usual**
CBMC	**-**	**Coal Bed Methane Capture**
CCS	**-**	**Carbon Capture and Storage**
CCPG	**-**	**Combined Cycle Power Generation**
CSIRO	**-**	**Commonwealth Scientific and Industrial Research Organization**
CDM	**-**	**Clean Development Mechanism**
CIF	**-**	**Clean Investment Fund**
CNG	**-**	**Compressed Natural Gas**
CO	**-**	**Carbon Monoxide**
COP	**-**	**Conference of Parties**
CO2	**-**	**Carbon Dioxide**
CTF	**-**	**Clean Technology Fund**
ESAP	**-**	**Energy Sector Action Plan (of Pakistan)**
ET	**-**	**Emission Trading**
G77	**-**	**Group of 77**
GCISC	**-**	**Global Climate Change Impact Study Centre**
GDP	**-**	**Gross Domestic Product**
GEF	**-**	**Global Environment Facility**
GHG	**-**	**Green House Gas**
GLOF	**-**	**Glacial Lake Outburst Flow**
GNP	**-**	**Gross National Product**
ICIMOD	**-**	**International Centre for Integrated Mountain Development**

ICG	**-**	**Integrated Coal Gasification**
ICOR	**-**	**Incremental Capital Output Ratio**
JI	**-**	**Joint Implementation**
LULUCF	**-**	**Land Use Land Use Change and Forestry**
MDB	**-**	**Multilateral Development Bank**
MDG	**-**	**Millennium Development Goals**
MNB	**-**	**Multi Nutrient Bank**
MW	**-**	**Mega Watt**
MCDE	**-**	**Million of Tons of Carbon Dioxide Equivalent**
NAMA	**-**	**Nationally Appropriate Mitigation Action**
NCAR	**-**	**National Centre for Atmospheric Research**
NCCF	**-**	**National Climate Change Fund**
N2O	**-**	**Nitrogen Dioxide**
NEEDS	**-**	**National Economic and Environment Development Study**
NIE	**-**	**National Implementing Agency**
PEPA	**-**	**Pakistan Environmental Protection Act**
PEPC	**-**	**Pakistan Environmental Protection Council**
PM	**-**	**Prime Minister**
REDD	**-**	**Reduction of Deforestation and Degradation**
SAARC	**-**	**South Asian Association of Regional Cooperation**
SCF	**-**	**Strategic Carbon Fund**
T&D	**-**	**Transmission and Distribution**
UNDP	**-**	**United Nations Development Program**
UNEP	**-**	**United Nations Environment Program**
UNFCCC	**-**	**United National Framework Convention on Climate Change**
USD	**-**	**United States Dollar**
WB	**-**	**World Bank**

INTRODUCTION

1. Introduction

Climate change is today an inescapable reality for Pakistan and is beginning to manifest itself through increasing intensity and ferocity. Pakistan is a country which, owing to its particular geographical circumstances, is highly impacted by any changes in climate making it one of the most vulnerable countries. Yet, it is one of the smallest contributors to the problem of climate change and can, thus, be termed one of the worst victims of “climate injustice”.

Dealing with climate change is no longer a choice for the country – it is an imperative which it has to cope with and adapt to in the foreseeable future. The country does not have the luxury of an “exit” strategy when it comes to facing up to the climate challenge. The costs associated with this interaction need to be estimated to a reasonable degree of accuracy to allow the country to plan, strategize and prepare for this challenge.

As stated, Pakistan is one of the lowest contributors to this global problem but, nevertheless, it has played a leading role in trying to formulate global consensus in addressing this issue demanding collective cooperation. Also, the country is cognizant of its development priorities and is actively seeking both, financial and technological support, to place its undeniable future growth on to a low carbon trajectory.

The NEEDS study aims to bring out some of the priority areas for possible climate mitigation while drawing out the probable future course of Pakistan’s growth and the costs associated with moving towards a low carbon development pathway. In addition, the priority sectors of climate impact are outlined along with the strategic options for, forced as well as planned, adaptation with the aim of estimating associated costs of adapting to climate change for the country.

1.1 Country profile within the climate context:

Pakistan is situated between the latitudes of 24° and 37° north and longitudes of 61° to 75° east, stretching over 1600 kilometers from north to south and 885 kilometers from east to west forming a rectangular mass covering about 880,000 square kilometers with a coastline of 1046 kilometers. Due to its highly diverse physiographic and climatic conditions, Pakistan has been classified into 11 geographical, ten agro-ecological and 9 major ecological zones.

The country’s extreme vulnerability to climate change is a logical certainty owing to its geographic location, elevation as well as demographics. Pakistan lies on a steep incline, dropping sharply from almost 8500 meters down to sea level within a distance of less than 3000 km. This situation is augmented by the presence of huge glacial reserves in the north of the country which melt and flow through the country, supplying more than 70% of the river flows. This frozen “blue gold” is the country’s most precious reserve and sustains the agro based economy aided by the unpredictable monsoon rains of the summer. The glacial melt and the monsoon rains overlap in the three month summer period providing the irrigation water needed for the arid country but also, ironically, dangerously raising the risk of flash floods in the rivers. The dense population base which resides along these flood plains and is, subsequently, directly impacted multiplies the country's vulnerability. All this is established scientific knowledge. Climate Change is now beginning to add a new erratic and volatile ingredient into this water cocktail. It is not only augmenting the melting of the glaciers in the north but also enhancing the unpredictability of the monsoons.

While there is a global scientific debate going on about the level and timing of the glacial melt, the signs in Pakistan are ominously clear. According to a recent research report (ICIMOD) the country has a vast glacial area which covers about 15000 square km comprising 5000 glaciers which are in rapid retreat. The rate of this retreat, according to the report, has gone up by 23% in the previous decade. The high quantum of glacial lakes forming in the North (2500 have been recorded in Pakistan representing 50% of the country's glaciers) as well as the increased downstream water outflows, even in low monsoon years, are undeniable testaments of the glacial melt. An associated worrying aspect of this climate induced phenomena are the 52 lakes which are categorized as "potentially dangerous". In these lakes, which are inherently unstable, the potential of a sudden outburst resulting in a rapid outflow of the stored water remains extremely high. Such a glacial lake outburst flow or GLOF has been also termed as a "mountain tsunami" due to the wave form in which a huge volume of water is suddenly released. This can lead to catastrophic devastation and flooding up to hundreds of kilometers downstream. Reports suggest that the frequency of such glacial hazards in the Himalayas and Hindu-kush region of Pakistan has increased considerably in the past decades.

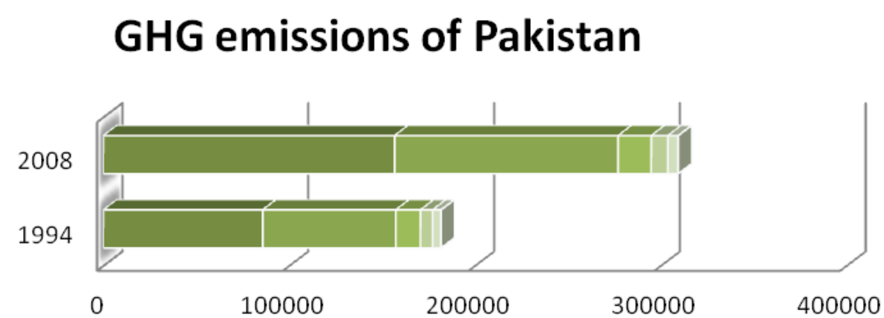
Out of Pakistan's total area 24% is cultivated out of which 80% is irrigated by water flowing through the, predominantly, glacier fed rivers of the county. The country boasts the largest contagious irrigation system in the world. Forests and grazing lands cover about 4% and around 31% is unfit for agriculture with large patches of waterlogged and saline lands.

In this backdrop, climate change affects almost all the sectors of the country particularly impacting upon its water resources, energy, health, forestry, biodiversity and with a major impact on agricultural productivity. Any increase in temperatures alters the bio-physical relationships by changing growing periods of the crops, altering scheduling of cropping seasons, increasing crop stresses (thermal and moisture stresses), changing irrigation water requirements, altering soil characteristics, and increasing the risk of pests and diseases, thus badly affecting the agricultural productivity.

While being at the receiving end of climate impacts the country is, ironically, one of the lowest contributors to the problem both in historic as well as current terms. At present, Pakistan contributes 0.8 per cent of the total global GHG emission and ranking 135th globally on a per-capita basis2. Although Pakistan's per capita energy consumption and cumulative CO_2 emissions are extremely low, the CO_2 emissions per unit of energy consumption are relatively high. Pakistan's total GHG emissions were 310 million tons of CO_2 equivalents (MtCDE) in 20083 as shown in the comparative Table-1. These emissions comprised of carbon dioxide (54%), methane (36%), nitrous oxide (9%), carbon monoxide (1%) and Non-Methane Volatile Organic Compounds (0.3%).4

In terms of sectoral distribution, the energy sector (including transport) is the most significant contributor to GHG emissions in Pakistan totaling 157 million t CO_2 in year 2007-08 which accounts for over 51% of country's total emissions (0.45 % of world's total). Other sectors include Agriculture and Livestock - 39%, Industrial Processes - 6%, LULUCF - 3%, and Wastes - 1%.[5] Thus almost 90% of Pakistan's GHG emissions came from the Energy and Agriculture-Livestock sectors and, subsequently, this is the area where the thrust of Pakistan's mitigation efforts needs to be focused.

Although, the emissions in the LULUCF sector are a small percentage, it is an issue of concern that currently Pakistan has an extremely low forest cover (4.8%) which is coupled with a high rate of deforestation of about 0.2 - 0.4 % per annum. This, however, provides an opportunity for the utilization of global financial instruments to avoid and reverse deforestation (REDD+).



	1994	2008
Energy	85816	156821
Agriculture	71632	120284
Industrial Processes	13297	17866
LULUCF	6527	8920
Wastes	4454	5505

Table-1 : GHG emissions of Pakistan (1994 – 2008)

(All data is in million ton carbon dioxide equivalents (MtCDE))

Given the above scenario of an extremely high vulnerability and very low quantum of GHG emissions, it is quite logical that the focus of Pakistan's climate change response is likely to be on adaptation measures – trying to cope with and face up to extreme climate impacts. However, while the country still requires considerable future emissions space to account for its anticipated rapid economic growth it can, simultaneously, play an effective and responsible global role by ensuring that this growth happens along a low-carbon trajectory. This can be done by integrating a host of carbon mitigation options and measures into its future development plans. Both the above interactions on adaptation as well as mitigation requires a conducive policy and institutional environment at the national level coupled with adequate financial and technical support to be garnered through global cooperation.

1.2 Existing policy and Institutional initiatives on climate change:

Climate related policy in Pakistan has to be multi-faceted endeavor cutting across a number of priority sectors as well as being embedded in an interlinked array of economic and political decisions. Moreover, any such response has to be developed within the overall context of the international policy framework comprising the Climate Change Convention and the Kyoto Protocol as well as the national environmental context. Within these broad parameters, the national policy response for managing the Climate Change problem can be classified into three major categories namely mitigation, adaptation and associated institutional/capacity support.

Pakistan has responded to the overall environmental challenge by enacting several pieces of legislation and policy initiatives aimed at incorporating environmental concerns into mainstream development planning. This policy response is embedded in the PEPA (1997) Act with the PEPC being the apex decision making body. The associated implementation frameworks consisting of the Ministry of Environment and the EPAs at federal and provincial levels have been formalized through the National Environment Policy (2005. In addition, Pakistan has approved an array of environment related policies including; National Forest Policy (Draft), National Energy Conservation Policy (2006), National Renewable Energy Policy (2006) and Policy for Development of Renewable Energy for Power Generation (2006).

On the Climate Change front, Pakistan signed the United Nations Framework Convention on Climate Change (UNFCCC) as a Non Annex- I Party in June 1994. The country, subsequently, adopted the Kyoto Protocol in 1997 and acceded to it on 11th January 2005. As a follow up to these international commitments, the country has undertaken climate related studies including the ALGAS study, the UNEP country study on adaptation, the first National Communications on Climate Change (submitted in 199) and recently compiled a high level report called the Task Force report on Climate Change (2008).

All these reports have managed to create institutional and stakeholder awareness about the climate issue as well as build a strong constituency for formulation of a comprehensive national policy on climate change which can be driven by a clear national goal and guiding principles and implemented through a targeted action plan. In this respect, the country announced and implemented the CDM Operational Strategy (2005) as a signal for its entry into the global carbon market and is presently in the final stages of formulating its National Policy on Climate Change.

It is essential that the Climate Change policy in Pakistan needs to be fully integrated with the national development and environmental priorities which are outlined in the Vision 2030 as well as the Medium Term Development Framework (2005-2010) documents. It is a promising sign that climate change is being considered, as a focused chapter, under the, yet to be announced, Peoples Development Plan (2010-2015). This shows that there is a concerted effort to mainstream climate change within the overall development plans of the country.

On the institutional front, the Cabinet Committee on Climate Change was formulated in 1995 to provide a policy coordination forum for dealing with climate change. This was later changed to the Prime

Ministers Committee on Climate Change in 2004 which also aimed for establishing a high level inter-ministerial linkage and proved to be extremely effective in initiating the country's entry into the global carbon market. Also, the autonomous Global Change Impact Studies Centre (GCISC) was established to act as the secretariat of the PM Committee on Climate Change and is now the primary scientific research body that is engaged in conducting research on impacts and adaptation to climate change in the country and also at regional level. The PM Committee on Climate Change has, however, suffered from a lack of sustainability which needs to be redressed and there is considerable merit in reactivating and utilizing it to provide a forum for climate integrating climate change into mainstream policy making.

The present study has, drawn upon the climate related studies already carried out in Pakistan, to provide a focus on the priority sectors for coordinated mitigation and adaptation responses within the country. In this regards, the energy, water resources, transport, agriculture/livestock, forestry, extreme events/disaster and industrial development sectors have been identified as the key sectors that form the basis for the country's economic development. The pivotal role of these climate linked sectors point towards the centrality of the climate issue for mainstream development in Pakistan. A majority of these sectors have a two interaction with climate change whereby they not only have implications for future emissions growth in the country but are also directly impacted by climate change. These sectors have been, subsequently, analyzed to bring out the priority mitigation and adaptation actions that can be undertaken to ensure a climate sensitive development in the country.

The *Energy/Transport* sector is the single largest source of carbon and, subsequently, also offers the greatest potential for credible reductions as well as positive synergies with local sustainable development priorities in areas such as energy conservation, efficiency enhancement and renewable promotion. The Ag*riculture* sector forms the mainstay of the economy and is the critical commodity producing sector. However, it is also one of the sectors which is threatened by the adverse affects of any shifts in climate patterns and changes in precipitation thus compelling the designing of an effective adaptation response. There is, also, a substantial opportunity for undertaking "win-win" mitigation activities in this sector corresponding to national agricultural priorities which can lead to cost savings, conservation of valuable inputs such as water as well as effective GHG reductions. In the *Forestry* sector, Pakistan suffers from an alarming rate of deforestation but, at the same time, a potential enhancement of the sink capacity is predicted due to the local effects of Climate Change. The arena, thus, affords an opportunity to internalize the "carbon sink value" of this over-exploited resource and allow for sustainable realization of the "sink enhancement" potential through innovative financial instruments such as REDD+ as well as attain valuable co-benefits such as bio-diversity protection. The *Water* resources sector is both the engine and the primary agent of development in Pakistan but, quite alarmingly, the Indus River system that is the main source of water in Pakistan is particularly vulnerable to changes in climate and rainfall. There is a need for focusing on issues of flood management, water conservation, increasing the efficiency of water distribution as well as enhancing the water storage capacity through small and large dams.

The priority measures and options for mitigation and adaptation in the country have been used as a basis to formulate a future climate emissions as well as vulnerability and impact scenario in the currently, respectively. The financial implications are then drawn out through projected growth models and/or other inference methodologies to estimate the indicative needs for financing of future climate mitigation and adaptation in Pakistan.

1.3 Pakistan in the global climate negotiations:

Pakistan has shown a very strong commitment to play an effective role in global efforts aiming to mitigate and adapt to climate change. Pakistan has been actively participating in the global dialogue since the historic Rio Earth Summit in 1992. The country has also effectively contributed to global dialogue on climate change, sustainable development and conservation and is a signatory to number of conventions and protocols including the United Nations Framework Convention on Climate Change (UNFCCC).

Pakistan has been a responsible and active participant in the global negotiations right from the inception of the climate debate. As the chair of the G77 negotiating group in 1992 as well as 2007, Pakistan spearheaded consensus building on the basic founding principles of the UNFCCC as well as agreement on the four building blocks of climate change – Mitigation, Adaptation, Technology and Finance - which have framed the debate ever since.

MITIGATION SECTION

2.1.1 Energy Sector

The Energy sector is not only the single largest source of GHG emissions in Pakistan contributing almost 51% of these emissions but also a sector where a significant future growth in emissions is anticipated owing to the need to fuel the country's development needs. Given the significant contribution of the energy sector in the total inventory of GHGs it is obvious that this sector should also be the central focus of climate change mitigation in Pakistan.

Situational Analysis:

In 2008-09 Pakistan's energy consumption was 37.3 million tonnes equivalent to oil (mtoe) which was met from a supply mix of gas (43.4%), oil (29%), electricity (15.3%), coal (10.4%), and LPG (1.5%)[6] – all of which cumulatively accounted for almost 51% of the national GHG emissions. Compared to the previous ten years, petroleum usage has increased by 0.5% per annum, gas by 6.8%, electricity by 5%, and coal by 12.5% per annum.[7] While in the past five years, gas consumption has risen by 9%, coal by 1.5% and oil consumption has declined by 9.5%.[8]

This trend suggests that energy supply mix is shifting away from petroleum products towards gas, coal, and other energy resources. As most of coal and gas resources consumed are indigenous this has allowed considerable savings in foreign reserves. The increased reliance upon natural gas, however, cannot be expected to continue owing to the rapid depletion of Pakistan's natural gas resources. Moreover, the option for sustaining or increasing reliance upon natural gas by importing from Iran or Central Asian countries is being explored but remains uncertain owing to political as well as economic constraints. The only sizable fossil fuel resource available in Pakistan remains its vast coal reserves estimated at 185 billion tonnes or about 2% of the world coal resources.[9]. Taking the above factors into account, increased reliance on coal seems to be the only and most viable option available for Pakistan to fuel its future energy needs.

In terms of energy demand, the country is presently faced with a situation of unmet demand. Pakistan's current installed electricity capacity is 20,000MW which is not enough to meet the country's current electricity demand[10] leading to frequent load-shedding especially during peak consumption times. The energy shortfall is currently estimated to lie in the 2500-5000MW range[11] and, according to estimates, the energy crisis cost the country $6 billion in 2008[12] while causing losses upwards of 2% of GDP in 2009-10[13]. Also, this situation has also led domestic and industrial users to rely upon inefficient electricity generators running either on natural gas or furnace oil which, in turn, has increased average energy usage costs as well as GHG emissions.

Interestingly, Pakistan has one of the highest rates of transmission and distribution losses in the world while the non-productive domestic/residence sector (42.15%) is responsible for more electricity consumption than the industrial sector (23.92%) or the agricultural sector (14.03%).[14] All of this point towards a considerable potential for the conservation of energy in Pakistan estimated to, potentially, save up to $4 billion through a host of measures.[15]

Future Scenario:

The GHG inventory of Pakistan shows that energy sector emissions were 157 MtCDE (50.7% of total emissions) in 2008 and these were expected to grow 17 fold by 2050 to 2730 MtCDE (64% of total emissions).[16] The reason why these emissions are expected to grow significant by 2050 is because the size of the energy sector is expected to increase considerably due to higher population, industry needs and expected growth across all sectors of economy. Emissions are also expected to increase dramatically by 2050 as the country will be meeting the increased energy demands through an increased reliance upon coal resources - which are reportedly equivalent to the combined oil reserves of Saudi Arabia and Iran.

Energy Demand Projections by Fuel in Pakistan's Energy Security Action Plan (2005 – 2030)[17]

	2005		2030	
	Mtoe	Share (%)	Mtoe	Share (%)
Oil	16.33	29.4	66. 84	18.5
Natural Gas	28.17	50.8	162.58	45
Coal	4.22	7.6	68.65	19
Hydro	6.13	11	38.93	10.8
Renewable	0	0	9.2	2.5
Nuclear	0.67	1.2	15.11	4.2
Total	55.5	100	361.31	100

Table -2 : Energy Demand Projections (2005-2030)

As the Energy Security Action Plan projections (Table-2) above show, share of oil and natural gas will fall while share of renewable and nuclear energy is expected to rise by 2030. The share of coal is expected to gallop to 19% in 2030 from just 7.6% in 2005. The energy mix described above should increase emission intensity from the energy sector due to higher reliance upon coal, which is the most carbon intensive of fossil fuels. It should be noted that these ESAP projections are considered to be very conservative. Depletion of natural gas resources, a lack of available finance for renewable energy, and the need to reduce the current energy shortfall in the shortest possible manner could mean that the reliance upon coal and ensuing emissions could be higher in the future than the ESAP projects.

Priority mitigation measures:

The options for mitigating climate change are vast in the energy sector both on the demand as well as supply side. On the demand side, the options focus on the transport, residence as well as industrial sector and on the supply side they focus on shifts in the fuel mix (renewable energy promotion) and efficiency enchantments.

As stated, *on the energy supply side*, it can be realistically assumed that reliance upon coal for energy purposes is likely to increase in Pakistan which should increase the associated GHG emissions. However, this enhanced coal usage needs to be packaged through a creative and sustainable energy framework which can shift the country towards a low carbon pathway compared to the business-as-usual scenario. Such a mitigation framework can include deployment of cleaner coal technologies, increased renewable energy utilisation as well as energy conservation measures.

- *Clean coal technologies* such as Coal Bed Methane Capture (CBMC), Integrated Coal Gasification Combined Cycle Power Generation (ICG-CCPG), aided by employing innovative CCS or CO_2 Capture, and Storage can be one of the primary measures for mitigation GHG emissions. However, their deployment is contingent upon the availability of not only the appropriate technologies but also adequate additional financing.

- Fuel *switching from furnace oil to natural gas* also remains a viable option but, as stated, earlier it depends upon the availability of gas. Although domestic reserves are depleting, the possibility of imported gas remains an active one and can be utilised to convert the thermal power plants to gas as most have dual-fuel options.

- The increased utilisation of *renewable energy* is another area which is promising for mitigating emissions from the energy sector. AEDB already expects development of wind and solar energy to meet at least 5% of total installed capacity through RE resources by 2030.[18] A very important advantage of renewable energy besides from reduced GHG emissions is that it would decrease Pakistan's reliance upon foreign countries for its energy needs. Listed in Table-3 below are some renewable technologies that have considerable potential in Pakistan:

Technology	Description	Current Achievement	Potential
Solar	Pakistan receives some of the highest isolation the world. Some use of solar water heaters has been made but overall costs have been prohibitive. Balochistan, Sindh and Southern Punjab receives 2 MW H/m^2 Solar radiation 3000 hours of sunshine/year Average Solar Radiation 5.5 kw/m^2 per day.	0 MW Some Pilot Projects	2.9 Million MW
Wind	Gharo Corridor alone has potential of 11,000MW with a >30% load factor. Pakistan has significant potential for Wind power but this has not been exploited yet. Some Pilot projects but none on a significant scale	0 MW Some Pilot projects	200,000 MW +
Hydro	Pakistan is only making use of 14% of its hydropower potential. Besides from providing energy, development of this potential would also improve irrigation water availability and flood management.	6440 MW	46,000 MW
Biologically derived energy	Biogas generation from organic wastes, Distillation of the products of fermentation of carbohydrates to produce ethanol could save Pakistan valuable foreign reserves. There is also potential for the production of Bio diesel however care is needed to ensure a sustainable outcome when land use is balanced	Use being made but not on a significant scale	4,000 MW

	against land for crop production.		
Geothermal	The occurrence of hot water zones in southern Baluchistan, Sindh and Khyber-Paktunkhwa (NWFP) suggest potential renewable development. However besides from some experimental plants, not much work has been done towards this field.	Pilot Project	80,000 MW

*Data used from Pakistan Council of Renewable Energy Technologies[19], Alternative Energy Development Board[20], and TFCC Report[21]

Table-3: Renewable Energy Options in Pakistan

- Additionally the increased development of *nuclear energy* remains a viable option for mitigating future GHG emissions in Pakistan.

- Pakistan also needs to focus on the *conservation of energy* aw well as improvements of *energy efficiency* and the significant cost as well as emissions savings it provides. Transmission and Distribution (T&D) losses amounted to 19.6% of net system energy in 2009-10[22] which amounts to one of the highest rates in the world. Electricity theft, old electricity wiring, and old transformers have a large role to play in this. In addition, the domestic sector in Pakistan accounts for 42.15%[23] of electricity consumed in Pakistan

On the demand side, energy conservation strategies need to be promoted in order to reduce electricity consumed by the domestic, industrial and transport sector. According to Alternative Energy Development Board (AEDB), Pakistan can save 30% energy in Industrial sectors, 20% in transport sector, 20% in the agricultural sector, and 30% through energy efficient building designs[24] which can cumulatively save up to $4 billion annually.[25] Policies such as retrofitting new efficient lighting, introduction of preferential status and tax incentives to energy efficient domestic products and imports, introduction of more efficient generators, upgrade of transmission lines and transformers to reduce losses, upgrade steam boiler for greater efficiency, improvements in street lighting, replacement of coal boilers with gas-fires units and bio-fuels in place of diesel, and improvements in building design can reduce electricity demand and hence reduce GHG emissions. Developing an energy code and energy efficiency standards could also be very helpful. Conserving energy and diverting it towards more productive uses can also be a much cheaper option than developing new energy sources as Table-4 given below demonstrates:

Energy Source	Conservation	Waste-to-Energy	Small Hydro	Wind	Solar
Cost/Unit	1-3 Cents	5 -7 Cents	6 – 7 Cents	12 Cents	21 Cents

Table-4: Cost of Energy options in Pakistan:[26]

The transport, industrial and waste management sectors, which can be sub-sectors of the energy demand side, are dealt with separately owing to their importance as stand alone options for mitigation.

2.1.2 Transport

Situational Analysis:

The transport sector is responsible for about 21% of the national emissions [27] while also responsible for more than half of the oil consumed in Pakistan[28]. Thus managing emissions in this sector remains crucial for tackling climate change.

Within the transport sector, road transport is dominant as it is responsible for carrying 91% of the national passenger traffic and 96% of the freight movement.[29] As the population and the economy have grown, the size and number of vehicles has drastically increased as shown in Figure-1 below. Whereas in 2000, Pakistan had 4 million vehicles on the road, this has increased to 9.8 million by 2010.[30]

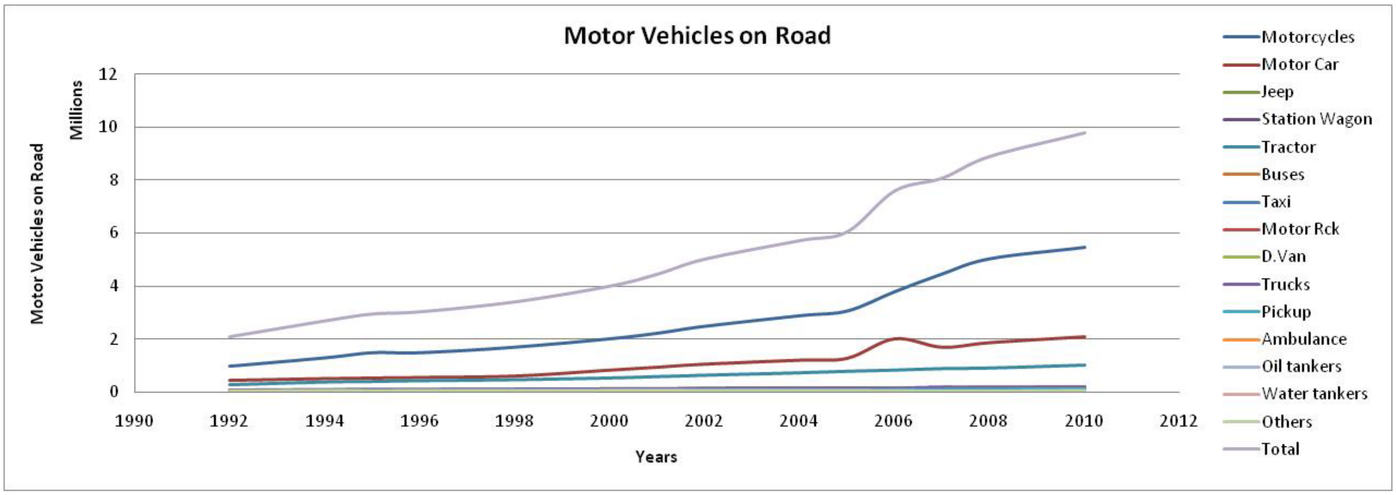


Figure – 1 : Rise of Motor Vehicles in Pakistan

The easy availability of credit in the past few years and lack of a proper public transportation system has caused the increase in the number of vehicles. Although public transport usage is still high in Pakistan, people move to private vehicles as soon as it is economically viable. This is usually due to public transport's sluggish image, inconsistency of service, lack of convenience and comfort, security issues, and perceived diminished status.

In recent years a significant amount of motor vehicles have switched to CNG largely due to the price differentials between prices of oil and gas. It is estimated that by December 2009, Pakistan had the highest amount of natural gas vehicles in the world at 2.3 million vehicles running on CNG.[31] The use of CNG in vehicles is less polluting than petrol or diesel as emissions from CNG vehicles consists of water vapours and carbon monoxide. The CO content in CNG exhaust is 90% less than CO found in gasoline (petrol) exhausts. However reliance upon CNG vehicles is not expected to continue due to Pakistan's depleting natural gas resources.

In the past, there has been a major investment into the road infrastructure in Pakistan while the railway infrastructure has been largely ignored. Most of the railway infrastructure existing today had already been constructed before 1947 and no new routes have been laid since 1982.[32] Some light-traffic branch lines have been closed and the government has recently announced that it plans to close down further light-traffic branch lines. These factors have led to decline in condition of the infrastructure and performance of Pakistan Railways. Pakistan Railways' inland traffic has been reduced from 41% to 10% for passengers and from 73% to 4% for freight traffic.[33] Furthermore, significant damage had been caused to Pakistan Railways' stations and rolling stocks during the 2007 riots and civil unrest. These damaged assets were not repaired and further damage was done to the railway infrastructure by the 2010 floods. It is estimated that damage caused to railway infrastructure is more than 1 billion rupees.[34]

Future Scenario and priority mitigation measures:

The absence of a public transportation system and the deteriorating condition of the railway system in Pakistan has led to the transport of people and cargo by road transport. This has exerted great pressure on the road infrastructure for maintenance and construction of new roads. Further development of the economy and increasing population density in urban areas will pose a further stress on the road network. Excessive reliance upon road transport should also increase congestion, decrease air quality in high traffic areas, and dramatically increase GHG emissions.

Described below are policy options that can help reduce GHG emissions in the Transport sector:

- *Increased usage of public transport* - Orienting away from private vehicles and towards public transport is extremely important for future sustainable development in the country and carries other considerable benefits such as avoiding congestion, pollution, high consumption of fossil fuels, health problems and increased greenhouse gas emissions.
- *Increased usage of railways:* The motorway road network (From Peshawar to Lahore to Karachi to Gwadar) comprises of only around 4 percent of Pakistan's total road network but carries 80 percent of the country's commercial traffic.[35] Significant up gradation and expansion of the railway system is needed for transportation of cargo in a quick, cheap and greater capacity. This will also lead to lower GHG emissions as railways tend to be more efficient in terms of tonnes moved per energy expended.
- *Encouraging efficiency gains* in existing modes of transport through proper vehicle maintenance and improved efficiency of engines as well as enforcing improved engine designs through enforcing vehicle emission standards.

2.1.3 Industrial Processes

The GHG Inventory shows that industrial processes were responsible for 6% of 2008 total GHG emissions[36] but it does account for 23% of the emissions from the energy sector. It makes up more than a quarter of Pakistan's GDP and since Pakistan is still at the lower stages of development, the sector is expected to grow in the future and substantially add to the national GHG emissions. At the moment however the industrial sector's GHG emissions relative to overall GHG emissions remain small and therefore it is not considered a priority for Pakistan's mitigation strategy. Still there are some areas in the industrial sector that provide demand side opportunities for GHG mitigation.

Situational Analysis:

Industries that tend to be the most polluting in Pakistan are cement, brick kiln, metal, textiles, petroleum refining, fertilizer, leather, mining, sugar and chemical industries. In various industries, boilers account for 35% of energy consumed and about 50% of these boilers are imported second-hand

and tend to be highly energy inefficient.[37] Thus, conversely, there exists a considerable potential for carbon mitigation through efficiency enhancement in these boilers

Future Scenario and priority mitigation measures:

By 2050, GHG emissions from Industrial sector are expected to increase to 67 MtCDE or 1.6% of total GHG emissions according to business as usual assumption.[38] This scenario can, however, be further exacerbated if the country's energy mix gets more coal centric, as anticipated, or if the country moves towards rapid industrialisation as its economy expands. A close watch, therefore, needs to be kept on developments in this sector as they have a direct bearing upon the national emissions. Some of the mitigation options for the Industrial sector are listed below:

- *Improving energy efficiency* – Promoting energy efficiency through replacement of inefficient boilers, replacement of inefficient machinery, improving the efficiency of motors and lighting, fuel switching, combined heat and power, renewable energy sources, more efficient electricity use, more efficient use of materials and materials recycling, and carbon capture and storage.

- *Promoting industry specific energy conservation policies* - For example, food and paper industries could be targeted for the use of the bio-energy from waste, turbines could be used to recover the energy discharged from pressurized blast furnace gas, exploring cogeneration options especially in the sugar industry.

- *Energy recovery techniques need to be encouraged*. These can take form of heat (binary), power efficiency and fuel recovery (efficiency of combustion). The potential for recovery of waste heat from process furnaces and liquid effluent streams is largely unused. This is partly due to a scarcity of capital for investment in waste heat recovery systems. In addition, the economies of scale are also not favorable in a number of industries such as steel, glass, and ceramics, where the typical size of an operation is much smaller than the prevailing world standards.

2.1.4 Waste Management

Situational Analysis:

The 2008 GHG inventory has determined that some 4,733 thousand tonnes of CO2 equivalents as Methane are discharged from waste management disposal facilities in Pakistan of this 2,832 tonnes are generated from solid wastes and the remainder from the management of waste water.[39] In addition 772 thousand tonnes of N2O, CO2 equivalent is also discharged from these sources.[40]

Pakistan generates 47,920 tonnes of solid waste daily[41] and it is estimated that around 40% of the generated waste remains uncollected in major cities like Karachi while the waste that does get collected is not properly treated. Landfill sites, if any, are often undersigned or designed poorly leading to incomplete decomposition, methane production, and contamination of ground and surface water. Fermentation of organic matter in informal waste dumps and industrial organic effluents also has the potential to generate significant quantities of methane which makes up 45-60% of the landfill gas mixture.

Future Scenario and priority mitigation measures:

Pakistan's population is expected to more than double from current level of 173 million to 350 million in 2050.[42] This will eventually increase the associated waste production in the future and the, subsequent, GHG emissions are expected to rise from 6 to 15 MtCDE.[43]

In order to mitigate its GHG emissions, Pakistan could introduce the following policies in its Waste sector:

- *Making effective use of GHG emitted from landfills* - Some landfills simply burn the methane gas in a controlled way to get rid of it. But the methane can also be used as an energy source. Landfills can collect the methane gas, treat it, and then sell it as a commercial fuel. It can then be burned to generate steam and electricity.
- *Introduction of modern land filling techniques* – these techniques include structural membranes and systems to collect gases produced. Collected gas is either flared to waste by oxidation of the methane to C02 or collected and used for the generation of heat or burned directly to produce electricity.
- *Recycling* – Recycling should be an integral part of any solid waste/refuse and industrial waste management. In our modern society and more importantly in a developing nation such as Pakistan the recycling and reuse of resources can be a major cost saver. For such programmes to work, it is important that there be a reliable end user of the recycled or product to be recycled. Collecting what might be useful can and had lead to the gathering of materials that can create in some cases greater environmental issues
- *Energy from solid wastes* - Coupled with a recycling reuse programme to mitigate the generation of more harmful GHG are waste to energy programmes where waste, untreated timber, n non-recyclable paper, and other organic, biodegradable material can be burned in a controlled environment. Wastes such as the smaller material from the maintenance of parks and gardens, trees, clippings and organic wastes can be composted to sequester carbon for integration into the soils in and around the metropolises and/or applied to cropping land to increase the fertility.
- *Municipal liquid waste management* - The contribution of GHGs such as methane and nitrous oxide from the sewer systems of Pakistan and animal feed lots, such as the Karachi cattle lot, seem to be unaccounted for presently. They present significant opportunity for climate mitigation as the methane collected could be utilised for the generation of power for the facilities and exported to the grid for cost recovery. There is currently a CDM project proposed for the Karachi Cattle mandi which leads to capturing of the methane and fires it to produce grid electricity as well as organic fertiliser as a by-product. Such as project could be replicated across the country.

2.1.5 Agriculture and Livestock

The Agriculture and Livestock sector is one of the most important sectors of economy in Pakistan. It is responsible for 21% of the GDP, employs 45% of labour force, and earns valuable foreign exchange for the country.[44]. Moreover, in 2010, the livestock sector contributed 53.2% of total agricultural earnings, more than 10% of exports, and 11.4% of GDP.[45] Over recent years, share of livestock has increased in agricultural value-addition while share of crops has gradually declined. Livestock population has also increased dramatically in recent years. This could be attributed to population growth, increase in per capita income and increased revenue from exports. The Table-5 below details the rapid rise in livestock population.

Pakistan Livestock Population 1996-2006									
	Cattle	Buffaloes	Sheep	Goats	Camels	Horses	Mules	Asses	Total
1996	20,424,458	20,272,873	23,543,973	41,169,309	815,290	333,944	131,848	3,559,011	110,250,706
2006	29,558,812	27,334,985	26,487,741	53,786,988	920,868	344,253	155,698	4,268,472	142,857,817
Percentage Increase	44.72%	34.84%	12.50%	30.65%	12.95%	3.09%	18.09%	19.93%	29.58%

*Data used from 2006 Livestock Census

Table-5 : Pakistan Livestock Population (1996-2006)

The Agriculture and Livestock sector is responsible for second largest GHG emissions after the energy sector.

Situation Analysis:

In 2008, the agriculture and livestock sector was responsible for 39% of Pakistan's GHG emissions.[46] The mix of GHG emissions in 2008 in the agriculture and livestock sector were in the form of methane (79%) and nitrous oxide (21%)[47] as shown in Figure-2 below. These GHGs have a Global Warming Potential (GWP) higher (24 and 310 times, respectively) than carbon dioxide and thus are a greater threat to the climate. Breakdown of GHG emissions from the agriculture and livestock sector, originating mainly from four main sub-sectors, in 2008 is shown in the chart below:

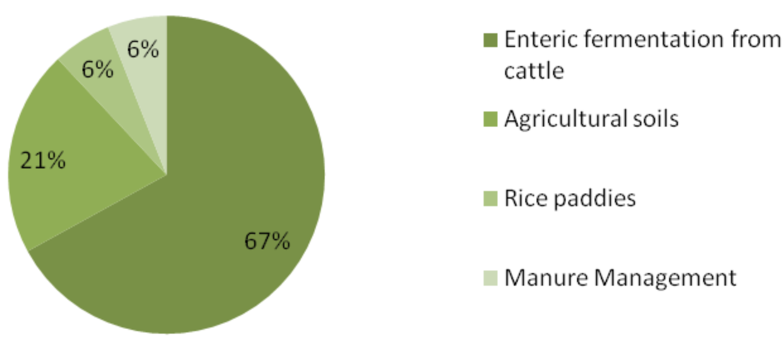


Figure – 2 : Mix of GHGs within livestock sector

As shown above, the emissions arise mainly from flooded rice fields and enteric fermentation in domestic livestock.. Enteric fermentation results from the normal digestive process of ruminative animals. The amount of methane produced by an animal varies according to its type, which determines the nature of its digestive system and its feed intake. The amount of emissions increases proportionally with the size of the food intake. Also, methane is produced from rice paddies during anaerobic decomposition of organic material in flooded rice fields. The gas escapes to the atmosphere by diffusive transport through the rice plants during the growing season.

Livestock is the largest contributor in terms of GHG emissions to the agriculture sector. Enteric fermentation is said to contribute 67% to agriculture-livestock emissions while manure management is said to contribute 6%. Majority of these emissions are in the form of methane.

Within the agricultural sector, the major crops produced in Pakistan are wheat, rice, cotton, and sugarcane. Other important crops produced by this sector are maize, bajra, jowar, tobacco, barley, mustard, and a variety of pulses. Wheat, rice, cotton, and sugarcane, on average, contribute 33.1 percent to the value added in overall agriculture and 7.1 percent to GDP.[48] Wheat is the leading food grain of Pakistan and contributes 14.4 percent to the value added in agriculture and 3.1 percent to GDP.[49] Cotton contributes significantly to exports and is responsible for a large share of foreign exchange earnings. Pakistan grows some of the highest quality rice in the world. This meets domestic demand and is an important export item for the country. Rice accounts for 6.4 percent of value added in agriculture and 1.4 percent in GDP.[50] Rice paddies contribute 6% of GHG emissions of total GHG emissions produced by the agricultural and livestock sector. These emissions are largely in form of methane. In addition, GHG emissions are produced by agricultural soils mainly in the form of nitrous oxide. These are responsible for 21% of GHG emissions produced by the agriculture and livestock sector. Imbalanced and inefficient fertilizer use, mismanagement of water, and various other agricultural practices exacerbate nitrous oxide emissions from the soil.

Future Scenario and priority mitigation measures:

By 2050, Pakistan's population is expected to rise to 350 million.[51] If higher economic growth rates also accompany the increase in population by 2050, the demand for agricultural and livestock produce should rise multiple fold. This will require intensive agricultural practices as more food will need to be produced with the same amount of land available. Intensive land use practices and policies will increase reliance upon fertilizers and this could increase nitrous oxide emissions from the soil. A higher population on higher consumption patterns would also require a higher stock of livestock for protein sources such as diet of eggs, dairy products, and meat. In addition to that rice is one of the major agriculture exports of Pakistan from agriculture. Farmers can also increase production of rice to have higher returns from international market. A higher number of livestock and rice production will also drastically increase Pakistan's methane and nitrous oxide emissions.

GHG emissions from agriculture and livestock in Pakistan have previously grown at a rate of about 3% per annum and this could go up if the above mentioned factors are accounted for in the future. Thus, there is a pressing need to contain these emissions or at least slow down their growth rate. There are a number of areas that could be targeted in the agriculture and livestock sector in order to mitigate Pakistan's GHG emissions. These are listed below:

- *Cattle feed improvements* – Enteric fermentation occurs in livestock when they cannot digest their food properly. Emissions from this source can thus be reduced through a strategy to improve the digestibility of livestock feed. This can be done by introducing a feed supplement such as multi-nutrient feed blocks (MNB). Use of such feed supplements is expected to reduce CH_4 emissions by an average of 23 percent per animal. Also, raising confined cattle on concentrated high-protein feed consisting of corn and soybeans can cause range of illnesses, lead cattle to emit 40% more GHGs, and consume 85% more energy than raising cattle organically on grass and other forages.[52] The use of appropriate feedstock mixes and additives can reduce methane production from enteric fermentation/digestion in cattle and needs to be encouraged in an informed manner.

- *Cropland management* - Nitrous oxide emissions can be reduced through cropland management. This could be done through better soil, water, and fertilizer management. Practices such as improved drainage, restricted grazing, effluent utilization, avoiding compaction, fertilizer management, waste management, erosion control, crop mix change, grassland conversion, reduction or elimination of fallow periods, and agro-forestry can significantly reduce nitrous oxide emissions.

- *Reducing methane emissions from rice cultivation* – In order to reduce emissions from crops, there is a need for more efficient irrigation techniques, better management of organic fertilizers, plant residue management and better waste management. There is also a need for development of rice varieties that reduce the production of methane.

- *Increasing productivity* - Milk is one of most important commodities from the livestock. Pakistan is one of the largest milk producers in the world yet its milk productivity tends to be a third of that of leading countries such as New Zealand. By focusing on areas such as genetics, technology, animal health services, and nutrition, milk productivity could be increased while reliance would be placed upon fewer ruminants for milk.

- *Efficiency enhancements:* Energy efficiency enhancement in running agricultural tube wells, through audit and retrofits, infrastructure development, capacity building, use of alternates energy technologies and standardization. The uses of locally made laser land levelers will help reduce agriculture water consumption by as much as a third.

Pursuing these policies should be cheaper than other mitigation options available. Implementation of these policies should not only reduce GHG emissions from the agriculture-livestock sector, it should also indirectly benefit Pakistan in the form of increased soil and water quality, better agricultural practices, conservation of water and energy, reduced cost of growing crops, and reduction of illnesses derived from food.

2.1.6 Land use, land-use change, and forestry (LULUCF)

The LULUCF sector in Pakistan is responsible for only 3% of GHG emissions[53] and its share is expected to fall further to just 0.357% by 2050.[54] Yet the importance of LULUCF is significant in Pakistan, owing to the potential for climate mitigation through carbon sequestration via afforestation, reforestation as well as avoiding deforestation.

Situational Analysis:

Pakistan has an area of 3.3 million ha covered by forests and planted trees, which is equivalent to 4.8% of the total land area[55]. This relative *forest cover area is one of the lowest* in the world and dismal even within the context of South Asia. Secondly, the forest resources of Pakistan are deteriorating both qualitatively and quantitatively and the annual change rate during 1990-2000 was -1.8% and during 2000-2005 was - 2.1%, which again ignobly stands out as an *extremely high*[56] deforestation rate (See Table -6 and Figure-3 below).

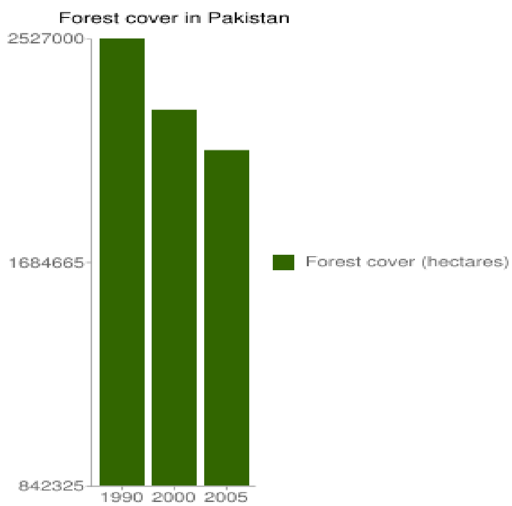


Figure-3: Forest cover in Pakistan, 1990-2005

Classification		**Area**		**Annual change rate**				**Total change**		
Period	1990	2000	2005	1990-2000	1990-2000	2000-2005	2000-2005	1990-2005	1990-2005	1990s vs 2000s
Units	ha	ha	ha	ha	%	ha	%	ha	%	%
Total forest area	2,527,000	2,116,000	1,902,000	-41000	-1.8	-43000	-2.1	-625,000	-24.73	16.67
Other wooded land	1191000	1323000	1389000	13,200	1.11	13,200	1	198,000	16.62	-9.98
Primary forests				-		-		0		
Plantations	234000	296000	318000	6,200	2.65	4,400	1.49	84000	35.9	-43.9

Table-6: Forest Area of Pakistan (1990-2005)[57]

With this backdrop of low forest area coverage and a high deforestation rate, the Government is striving to reverse both of these negative trends and has set an overarching national target, as per the Millennium Development Goals (MDG), to increase the forest cover of Pakistan form 4.8 % in 1990-91 to

6.0 % by 2015. To set the direction, the country is trying to accurately assess the current state of forest cover in Pakistan and utilize this assessment[58] for appropriate policy development.

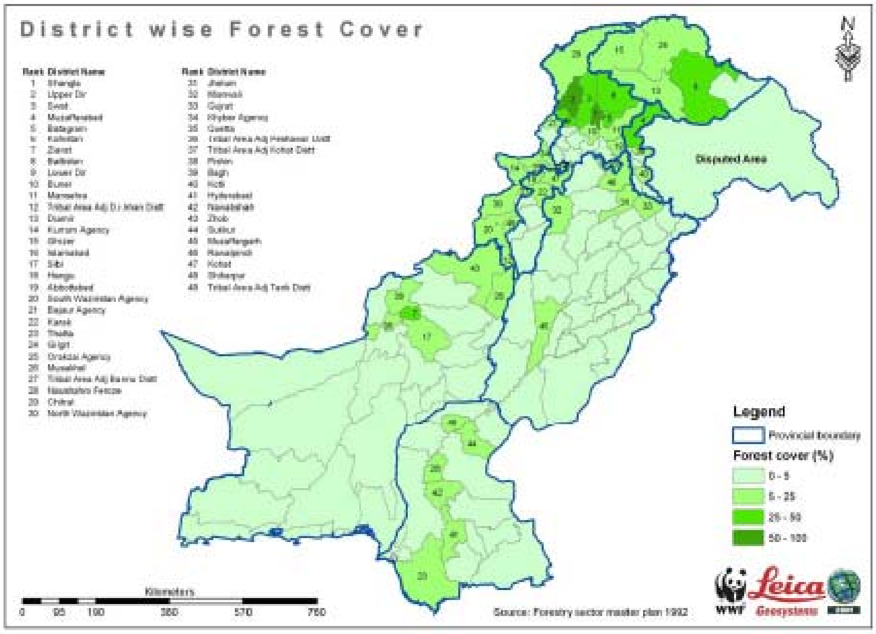


Figure 4: District Wise Forest Cover in Pakistan[59]

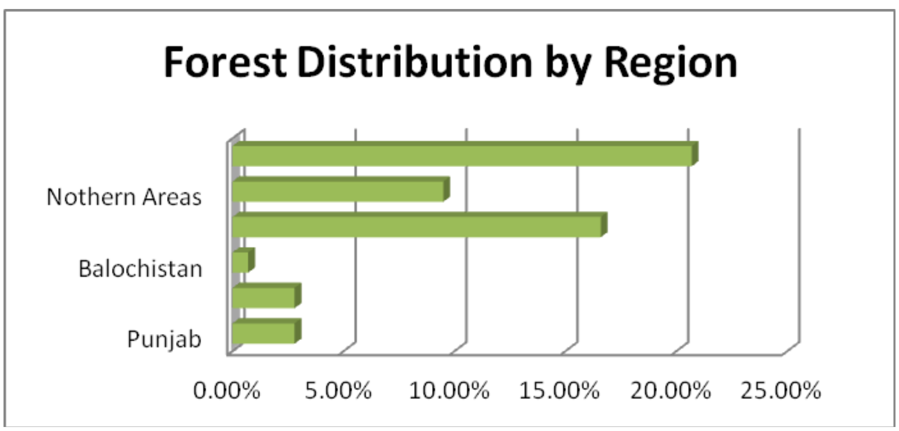


Figure 5 : Forest Distribution by Region in Pakistan

Low level of public awareness and education, excessive exploitation of forest resources for commercial and subsistence purposes, encroachment and fire, a growing population, insecure land tenure, unplanned urban and industrial expansions, inequity, unemployment and poverty are some of the main reasons why Pakistan continues to have a high deforestation rate today. Pakistan is already suffering from some of the effects from low forest cover in the form of desertification, decreased water quality, and decreased water availability, decreased quality of air, siltation, landslides, and lower capacity of land to hold water.

Future Scenario and priority mitigation measures:

Forests can not only be a cause for climate change, through rapid deforestation, they can also be affected by climate change as rainfall and temperature patterns shift. Climate change, through higher temperatures and changes in precipitation and humidity levels, is expected to cause changes in species composition and reduction of forest area. Pakistan already has a low forest cover and these problems are expected to exacerbate deforestation leading to a further depletion of the existing forest cover unless remedial measures are undertaken to arrest and reverse the situation. Listed below are some options that Pakistan can pursue in the LULUCF sector in order to decrease its GHG emissions along with the least cost ranking of the options given in Figure-7:

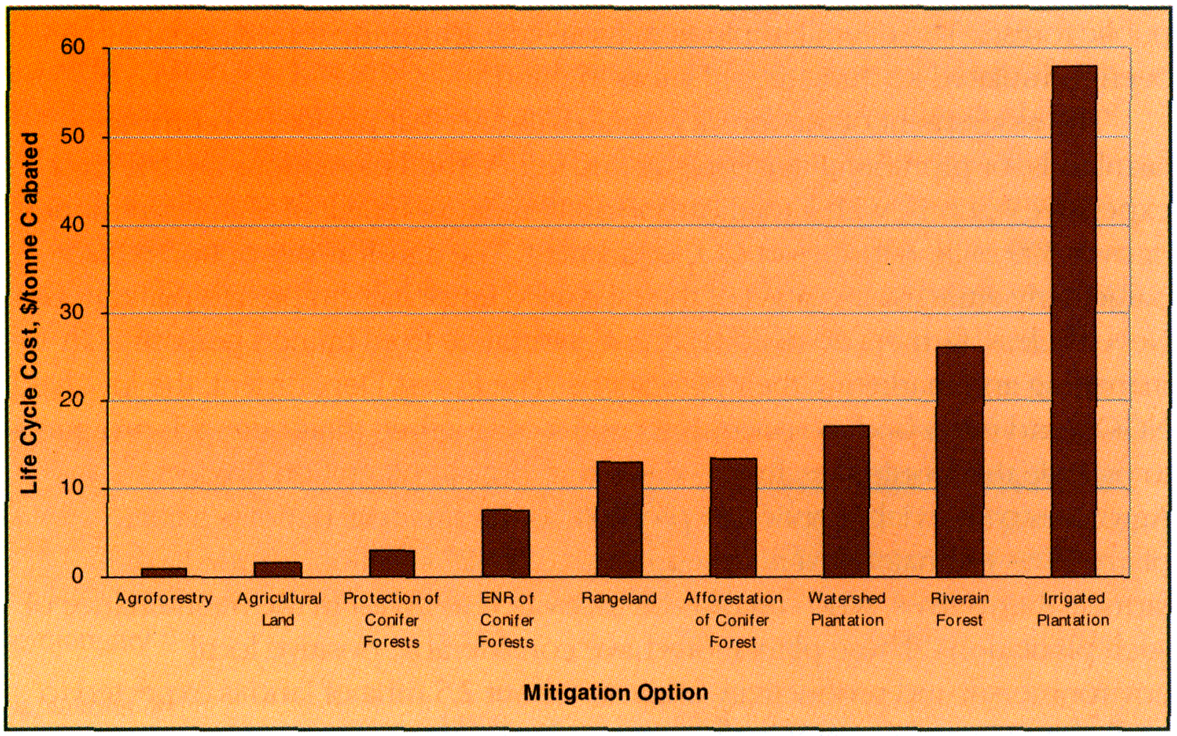


Figure 7 - Least Cost ranking of mitigation options in the Forestry Sector (ALGAS Study)

- *Afforestation and reforestation* - There is considerable potential in the forestry sector for carbon sequestration which can offset the national emissions in other sectors. Moreover, the sequestered carbon can now be capitalised through the carbon market mechanisms such as the CDM. The cost of various options for afforestation varies with agro-forestry as the most economical and irrigated or riverine forestation demanding more life cycle costs.

- Along with natural forests, steps should be taken for promotion of *public-private and farm forestry* initiatives along with urban greening.

- *Education and awareness* raising amongst stakeholders about the national and globally important value of forests

- Engagement in the REDD+ regime to recognise the carbon value of the forests in Pakistan and gain benefit for *avoiding deforestation*.

2.2 Costing Mitigation Options in Pakistan

In order to cost possible future mitigation options it is first appropriate to deduce future projections of greenhouse gas emissions in Pakistan based upon future economic projections for the country. Also, the resultant economic and emissions modelling is applied over the 2011-2050 time frame to firstly construct a BAU or business-as-usual emissions scenario and then subject it to specified assumptions projecting two separate clean development scenarios. The mitigation investment needs are, subsequently deduced through applying a reverse algorithm based upon the emission reductions.

2.2.1 Future GHG emissions outlook 2011 - 50

The economic growth in Pakistan slowed down substantially after the 2007-08 fiscal crises which worsened in the wake of rising global food and fuel prices in 2008 and later by the slowdown in global economy. The recent floods have dampened the chances of early recovery. At the start of the current fiscal year it was envisaged that Pakistan economy will grow by 4.5 percent in 2010-11, however due to the devastating floods situation this growth rate has been revised to 2.8 percent. The external debt levels have reached alarming levels and are bound to further go higher given the need to procure loans for post-flood reconstruction. As Pakistan has already resorted to an IMF program in November 2008 in order to avoid a balance of payments crisis, therefore the economic managers are under the conditionality not to let fiscal deficit increase beyond the limits decided with the IMF authorities. This in turn implies that public sector investment cannot be increased in the discretionary manner seen at the start of this decade.

In order to provide an assessment of GHG emissions in Pakistan, the first step is to furnish a macroeconomic framework that guides us over a longer term horizon (2011-15) regarding the pattern of major macroeconomic variables. This working will also act as the initial set of assumptions for projecting the energy demand (given later). In Table the average GDP growth rate target between the years 2011 and 2015 is the same as being the latest one being used by the Government of Pakistan and as communicated to its development partners[60] in the post-2010 flood scenario.

A forward scenario is constructed assuming 6 percent GDP growth between 2016 and 2020 exhibiting a consolidation[61] and the period thereafter is considered one of sustained growth going up to an average of 7.1 % in the period between 2041 and 2050. Thus, the average GDP growth for the period 2011 – 15 comes to 6.5 percent. For purposes of comparison, in *ex post* terms Pakistan's GDP growth during 1972 to 2010 was approximately 5.2 percent.

	2011-15	2016-20	2021-30	2031-40	2041-50
GDP % Growth	4.7	6.0	6.5	6.9	7.1
Agriculture (%)	3.6	4.6	4.5	4.5	4.7
Industry (%)	5.1	7.0	6.3	6.3	6.7
Services (%)	4.8	6.2	7.2	7.8	7.6
Investment & Savings Requirements					
Capital formation to GDP Ratio	18.6	24.1	26.0	26.0	25.5
National Savings to GDP Ratio	15.3	20.1	21.8	21.9	21.8
Current Account Deficit to GDP Ratio	3.3	4.0	4.2	4.1	3.7

**The data presents annual average*

Table-7: Pakistan: Macroeconomic Framework 2011 – 50*

During the period 2011 – 15 the GDP growth will be contributed by average growth of agriculture at 3.6 percent, industry at 5.1 percent and services at 4.8 percent. The future scenario takes into account the current rise of the services sector in Pakistan which now contributes around 53 percent of GDP. The fixed investment requirement for achieving the economic growth targets mentioned above will increase from an average of 18.6 percent of GDP in 2011-15 to 25.5 percent in 2041 – 50. Pakistan may achieve the envisaged growth levels even with lesser investment if productivity in labour and capital usage is nurtured. The foreign savings (current account deficit of balance of payments account) as percentage of GDP is projected to remain above 3 percent owing to greater import needs of a growing economy. A higher growth path can also be envisaged if national savings levels improve which in turn can be channelled in to productive investments.

	2011-15	2016-20	2021-30	2031-40	2041-50
Energy Consumption (% Growth)	3.7	4.8	5.2	5.6	5.7
% Share by Source					
Gas	43.9	45.4	45.4	42.3	32.9
Oil	27.5	24.3	19.5	14.9	14.1
Electricity Sources	15.7	16.2	17.5	17.9	16.9
Coal	11.3	12.4	15.7	22.8	33.6
Other (incl. LPG)	1.6	1.7	1.9	2.2	2.6

*The data presents annual average

Table 8- Energy Consumption by Source*

The economy in order to recover and consolidate will require a buoyant effort on the part of commodity producing sectors, which in turn will demand higher energy. The overall energy consumption is envisaged to rise from an average growth of 3.7 percent in 2011 – 15 to 5.7 in 2041 – 50 (Table-8). The average growth between the time period 2011-50 comes to around 5.2 percent. This energy consumption scenario takes in to account the changing shares by sources of energy with declining oil and gas and increasing reliance on coal.

- Pakistan may soon take steps towards conserving its fast declining reserves of gas or at least curtailing the use of gas by providing substitutes. This in our scenario translates into a reduction in the share of gas from around 44 percent to 33 percent in the last decade.
- The country in order to lessen its exposure to global price shocks and also protect its foreign exchange reserves is assumed to follow a policy of moving away from imported oil in future. The share of oil therefore reduces to 14.1 percent in the final decade.
- The radical shift may be seen in coal for which Pakistan carries still unexploited reserves and may be Pakistan's only option in a global scenario of rising energy prices. The share of coal in our counter-factual increases from 11.3 percent in 2011-15 to 33.6 percent in 2041-50. Several recent studies have indicated the substantial potential of coal reserves in Pakistan[62]. While

incorporating coal as a possible substitute, it has been assumed that underground coal is converted in to coal gas without bringing coal out of the ground thus implying lesser hazard to the environment.

	2011	2020	2030	2040	2050
Total GHG Emissions (Mt CO_2 eq.)	347	557	1046	2156	4621
Energy	176	295	560	1250	2730
% Share	50.6	52.9	53.5	58.0	59.1
Agriculture	134	210	408	812	1765
% Share	38.7	37.7	39.0	37.7	38.2
Industry	20	30	52	61	75
% Share	5.8	5.4	5.0	2.8	1.6
LULUCF	10	13	15	20	35
% Share	2.9	2.3	1.4	0.9	0.8
Waste	7	9	11	13	16
% Share	1.9	1.6	1.1	0.6	0.3

Table 9- Sector-wise GHG Emissions 2011 - 2050

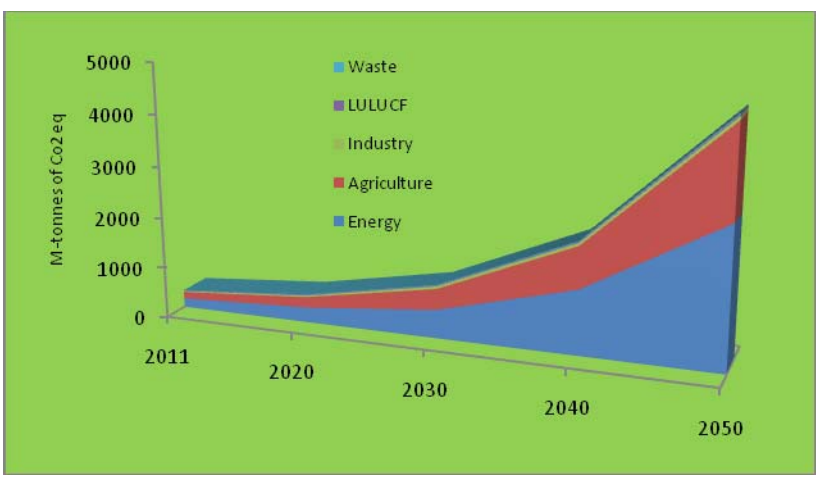


Figure 6 - Total GHG Emissions 2011-50

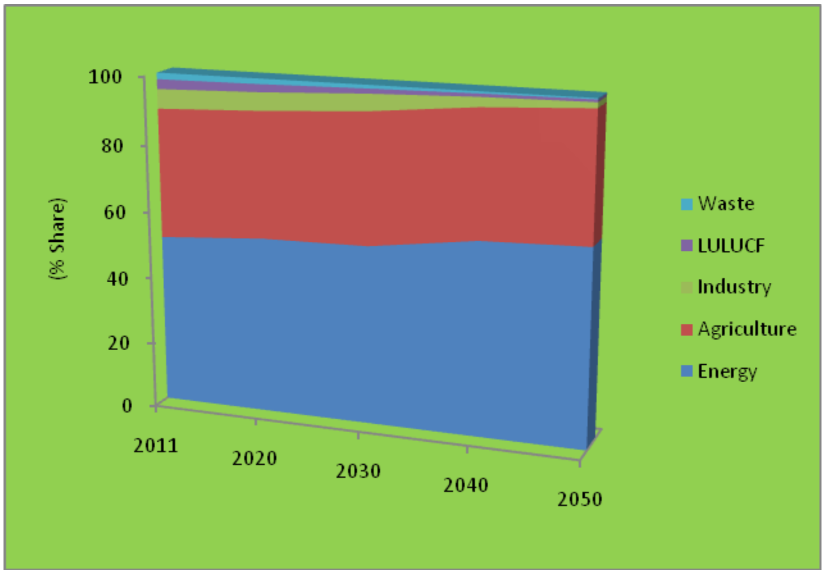


Figure 7 -Share in Emissions

The projected growth in agriculture, industry and energy consumption gives rise to the concerns of increases in GHG emissions. These concerns are more aggravated in a scenario that sees Pakistan's energy future being driven by coal. We see in Table 9 that overall GHG Emissions (Mt CO_2 eq.) are projected to increase from 347 in 2011 to 4621 in 2050 under this *BAU scenario*. These emissions are linked with and based upon the earlier projected sectoral GDP estimates of agriculture, large-scale manufacturing, energy and transport. The usual long run emission-output elasticities for projections and the share of respective sectors has been derived from the general equilibrium model documented in economic research in Pakistan[63].

The results show that wwithin this projected BAU scenario for overall emissions, energy sector will *remain the highest* contributor. Its share goes high as much as 59 percent in 2050. The agriculture sector is going to *maintain a constant* share however the share of industry in GHG emissions will see a *decrease* perhaps due to our underlying assumption of efficiency in production techniques and availability of greener technologies.

2.2.2 Exploring choices - future energy requirements in Pakistan

2.2.2.1 ***BAU Scenario :*** As earlier mentioned, the business as usual scenario indicates that overall energy sector GHG emissions will rise from 176 MT CO2 eq. in 2011 to 2730 in 2050 (Figure 88). This implies an annual average compound growth rate of 11 percent per annum. The break up indicates that the share of energy industries will rise from 28 to 34.5 percent in 2050 while the share of manufacturing and transport sectors in overall energy sector emissions will rise from 27 to 32 percent and 21 to 25 percent respectively during the same time period (The model used is detailed in Annex-1).

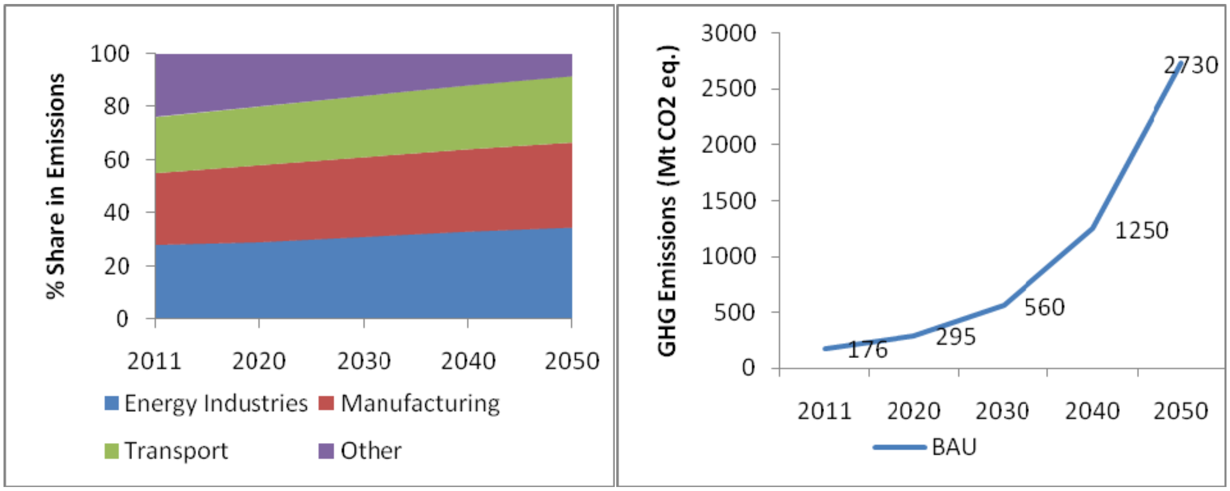


Figure 8 Energy Sector Emissions 2011 – 50 [Business as Usual Scenario]

2.2.2.2 ***Scenario-2 (Clean Energy Development-1):*** We construct here a second scenario where cleaner coal and cleaner transport sector fuels are incorporated. By cleaner coal we imply here an improvement in quality that at least renders a 15 percent reduction in coal emissions compared with business as usual scenario. For the consideration of simplicity in interpretation the same percentage reduction in emissions is retained for transport sector fuels. In this scenario we also allow for a 5 percent possibility of energy provision from renewable sources.

The results indicate that in the terminal year 2050 the emissions will be in the vicinity of 2321 Mt CO2 eq (Figure) which implies a reduction in annual average compound growth rate of 1 percentage point. The break up indicates that emissions share of energy industries will decrease from 28 to 24 percent. The contribution of manufacturing sub-sector increases from 27 to 31 percent (a lower increase if compared to business as usual scenario). The contribution of transport sub-sector decreases from 21 to 17.5 percent due to the availability of cleaner technologies with transport sector.

Using broad investment quotients[64], this reduction from 2730 to 2321 Mt CO2 eq. will require an annual growth in fixed investment of around 13 percent until 2050. *In 2010 prices the additional or differential investments (as compared to BAU), including conservatively estimated fixed as well as variable/maintenance costs comes to around **$8 billion**.* This investment figure is calculated backwards by using an algorithm which basically uses the incremental capital output ratio (ICOR[65]) of 3.404 to derive investment rates for the output that produces emissions worth 2321 mceq. (The model used is detailed in Annex-1)[66]. Kindly note all prices are in 2010 dollar terms and not using a discount figure.

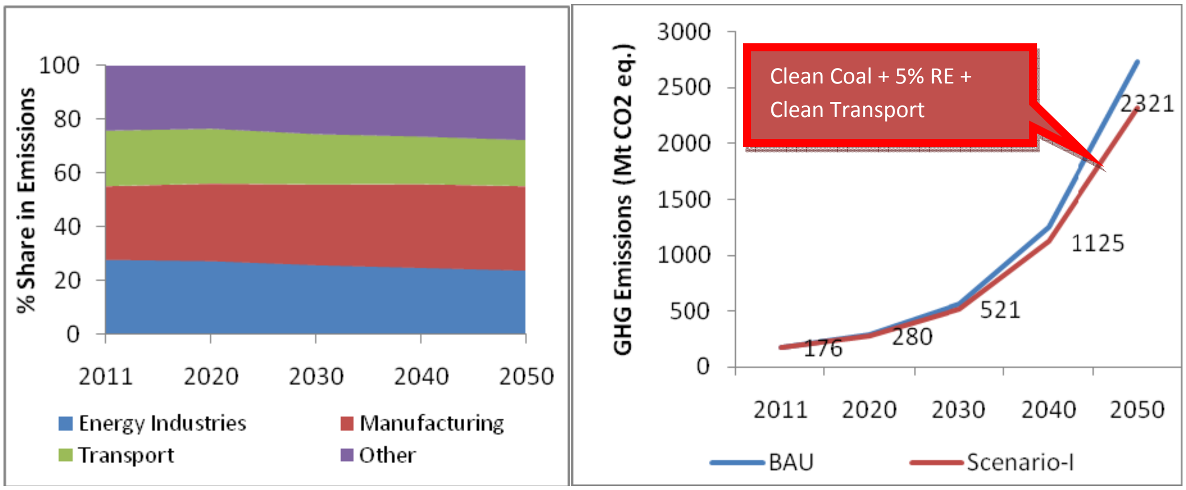


Figure 9 Energy Sector Emissions 2011 – 50 [Scenario-I]

2.2.2.2 ***Scenario -3 (Clean Energy Development-2):*** Finally we construct a third scenario where it is envisaged that the potential process of coal gasification may reduce the coal emissions up to 30 percent. The assumptions about the transport sector's emissions remain the same (as seen for scenario-I). However it is envisaged that 15 percent of energy needs may come through renewable sources.

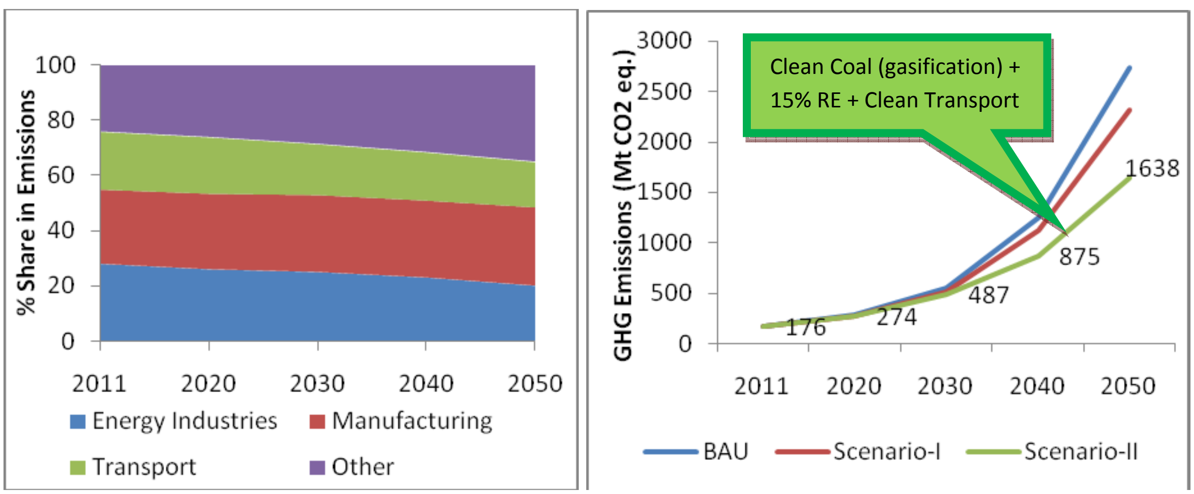


Figure 10 Energy Sector Emissions 2011 – 50 [Scenario-II]

Figure here exhibits the results from this scenario, which renders total emissions of 1638 Mt CO2 eq. by 2050 - *a reduction of 40 percent from the business as usual scenario.* The break up indicates that due to the availability of possible renewable sources the contribution of energy industries will decline to 20 percent by 2050. The contribution of manufacturing sub-sector increases by a smaller margin (if compared with earlier scenarios) to 28.5 percent in 2050. Similarly the contribution of transport sector declines to 16.5 percent in the terminal year. *The total "additional" investment requirement for this scenario in 2010 prices comes to **$17 billion*** utilizing the same algorithm of utilizing the incremental capital output ratio (ICOR) of 3.408 to derive investment rates for the output that produces emissions worth 1638 Mceq (The model used is detailed in Annex-1).

The contribution of sub-sector labeled as *others,* increases in this scenario from 24 percent in 2011 to 35 percent in 2050. This strongly indicates that simultaneous efforts would be required to find greener solutions in agriculture sector and fugitive emissions. However, for the sake of the present study, only the energy sector is considered. Further data and analysis can refine these indicative figures.

An interesting offshoot of this analysis is that in terms of a simple cost-benefit analysis, this "clean energy" investment of U$ 17 billion is resulting in carbon emissions reduction of 1092 MtCO2eq which, if priced at U$ 25/tC[67] provides a value of U$ 27.3 billion which clearly provides a financial benefit far outweighing the costs of mitigation. The question of access and availability of the requisite climate finance to make this low carbon transition, however, remains unaddressed.

2.2.3 Energy Gap Analysis:

The energy shortfall in Pakistan is currently estimated to lie in the 2500-5000 MW range[68] (with 5000 MW being during peak hour timing) and, according to estimates, this energy crisis cost the country $6 billion in 2008[69] while causing losses upwards of 2% of GDP in 2009-10[70].

We show here a brief estimation of how this need may be bridged through harnessing coal and its related financial and environmental costs. The incremental cost[71] of producing 1 Mw-hr from coal is approximately $66[72] which, in turn, implies that the daily cost of producing 5000 MW from coal will be $7.9 million. The annual increase in GHG emissions from (incremental) coal will be 4309 CO_2MT[73].

Item(s)	Requirements
Current Electricity Short Shortfall	5000MW
Coal $/Mw-hr	66
Cost of Incremental Coal Per Hour ($)	330,000
Daily Cost of Incremental Coal ($)	79,20,000
Annual Cost of Incremental Coal ($ billion)	2.89
Annual Increase in GHG Emissions due to incremental Coal (CO_2MT)	4309

Table 10- Bridging Electricity Short Fall through Coal

In terms of future investment in coal this scenario has the following implications:

- In order to use coal to bridge the energy gap in Pakistan one would require an **annual variable cost[74] of $2.89 billion in 2010** prices.

- This will also involve initial investment at the national level in the range of **$5 billion in 2010 prices**.

- This will cause a sudden jump in emissions which may only be countered through increased investment in cleaner technologies, such as coal gasification.

2.2.4 Meeting the energy shortfall through low carbon option

At this point it may be important to explore the choices Pakistan has to bridge the energy gap and what sort of costs may be involved for each choice. Figure 11 indicates that Pakistan's demand for energy may well cross 1500 mtoe by 2050. However given that supply side will not be able to keep pace with the rising consumption levels, there may remain a **gap of around 214 mtoe** that will need to be bridged using own or external resources.

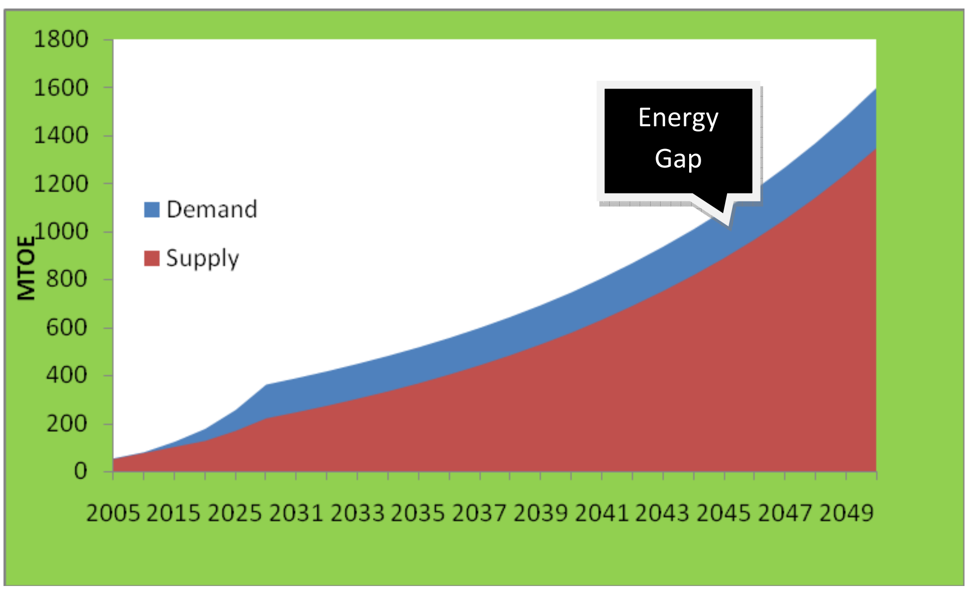


Figure 11 Energy Demand and Supply 2005- 2050

Having observed the rising energy gap **Figure** below indicates the wide variance between the emissions from incremental coal versus incremental renewable :

- Coal has less fixed cost but annual variable cost of U$ 3 billion/year

- Renewable option to fill the energy gap involves high upfront costs amounting to over U$ 10 billion (at 2010 prices) but with, obviously, much lower emissions requires over **$10 billion** in fixed costs.

- The coal emissions also start to decline post 2030 once cleaner coal is adopted at a mass scale with lesser unit costs.

- The investments estimates for employing cleaner renewable energy are, realistically, nowhere near to what Pakistan at the public sector level is able to afford under the national environmental portfolio currently.

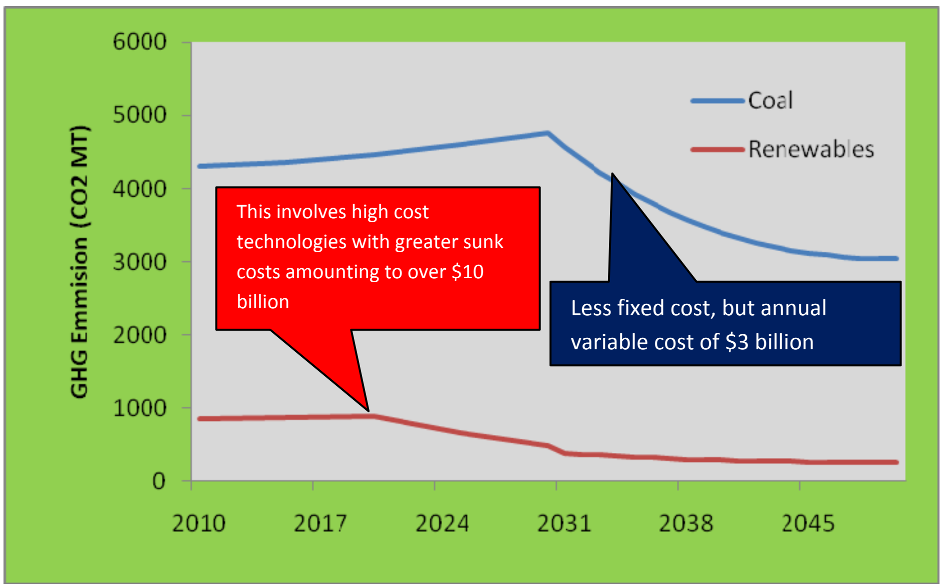


Figure 12: Impact of Incremental Coal versus Incremental Renewable to bridge gap

2.2.5 Conclusions:

The above analysis indicates the following:

- Significant financial needs are required for Pakistan to try to de-link its economic growth from, a corresponding, growth in emissions. The low carbon development scenarios projected for the country estimate "additional" investment costs of mitigation ranging **between $8 billion to $17 billion to 2050**, as progressively cleaner coal and a higher percentage of renewable energy technologies are employed.

- It is possible to reduce emissions by 40% from the BAU scenario by employing cleaner technologies.

- The mitigation costs of U$ 17 billion will result in significant carbon reductions which, if priced at a reasonable value of carbon (U$ 25/tC) provides an estimate of U$ 27.3 bn (which can be potentially capitalized through the carbon market) indicating a positive cost-benefit ratio. The question of access and availability of the requisite climate finance to make this low carbon transition, however, remains unanswered.

- The energy gap analysis shows that the country requires an upfront investment of U$ 10 billion if it wants to meet its current energy gap of 5000 MW through incremental renewable (as compared to meeting it through incremental coal). The current national budgetary spending does not allow this investment "need" figure to be met through own resources.

- The country needs to carry out an extensive "Technology Needs Assessment" to clearly identify the best available technologies that can be employed in the future to make a clean energy transition.

- Access to appropriate GHG reducing technologies and supportive financing is required if Pakistan is to successfully shift the trajectory of its future BAU growth towards a low carbon pathway.

- Considering the long term gestation period for energy sector investments and the fact that today's investments will "lock in" the infrastructure, fuel and technologies for decades to come it is extremely important for Pakistan to generate these additional finances if it has to make the choice towards a low a carbon future.

- Kindly note that this analysis has been carried out only for the energy sector which represents the majority of GHG emissions in Pakistan. The other GHG producing sectors of agriculture, livestock and forestry have not been considered due to paucity of reliable data at this point. The mitigation needs would be considerably enhanced by addition of the remaining GHG emitting sectors to this analysis.

ADAPTATION SECTION

3.1 Adaptation Assessment

As earlier outlined, Pakistan is a very small contributor to the issue of climate change having not only one of the lowest emissions of greenhouse gases per capita in the world but also contributing only 0.5% to the cumulative global emissions. Yet the country is turning out to be one of the worst casualties of climate change being consistently placed in the extreme vulnerable category by a host of climate change impact indices - including the Maple Croft index and the Columbia University vulnerability index. It is categorized as a country prone to "extreme climate risks" and Table-11 shows a comparison of the most vulnerable Asian countries (according to the Maple-croft World 2010/11 rankings) which indicates that Pakistan is, ominously, moving up this vulnerability ranking. Pakistan can, thus definitely be termed as prime victim of global "climate injustice" - bearing the burden of the impacts with a minimal contribution to this global problem.

Maplecroft Ranking 2010 : Extreme Risk Asian Countries

Country	Rank 2010/11	Rank 2009/10
Bangladesh	1	12
India	2	56
Philippines	6	44
Pakistan	16	29
Nepal	4	11
Afghanistan	8	3

Source: Maplecroft website October 2010

Table-11 : Maplecroft Climate Vulnerability Ranking

The country's extreme vulnerability to climate change is not a scientific secret but is, in fact, a logical certainty owing to its geographic location, elevation as well as demographics. Pakistan lies on a steep incline, dropping sharply from almost 8500 meters down to sea level within a distance of less than 3000 km. This situation is augmented by the presence of huge glacial reserves in the north of the country which melt and flow through the country, supplying more than 70% of the river flows. This frozen "blue gold" is the country's most precious reserve and sustains the agro based economy aided by the unpredictable monsoon rains of the summer. The glacial melt and the monsoon rains overlap in the three month summer period providing the irrigation water needed for the arid country but also, ironically, dangerously raising the risk of flash floods in the rivers. The dense population base which resides along these flood plains and is, subsequently, directly impacted multiplies the country's vulnerability. All this is established scientific knowledge. Climate Change is now beginning to add a new erratic and volatile ingredient into this water cocktail as it is not only augmenting the melting of the glaciers in the north but also enhancing the unpredictability of the monsoons.

A recent reminder of what climate change impacts mean for Pakistan was seen in the form of most devastating 2010 floods that have wiped off 5.8% of the national GDP and have cost the country's, already, fragile developing economy a whopping U$ 8.74-10.85 billions[75] (an average of U$ 9.7 billions is used for this report) in damage and reconstruction costs. These floods have changed the very perspective of all stakeholders on the seriousness to address climate change. It is a clear reminder that climate change is turning out to be, an unfortunate but stark, reality for Pakistan. The issue is now confronting the country head on while demonstrating the strength and ferocity of its impact in terms of human, economic and environmental costs.

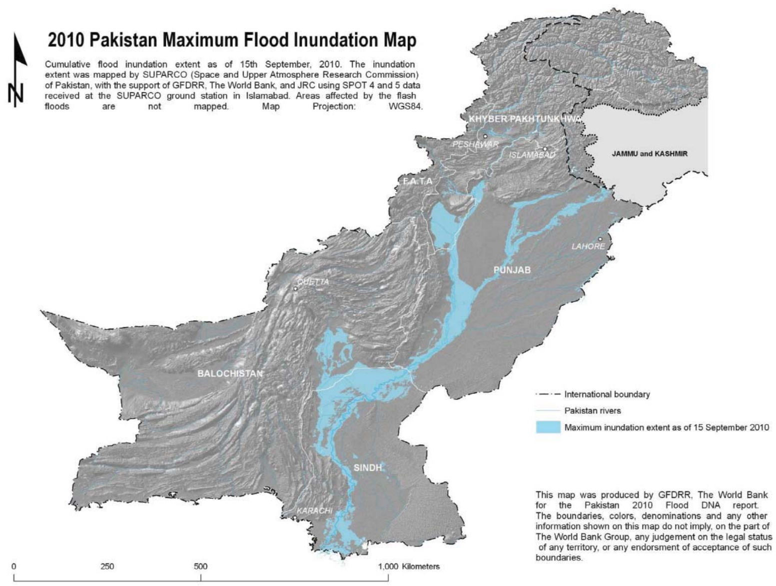


Figure 13: Pakistan's 2010 flood inundation map

This high vulnerability and the need for adaptation have been highlighted in all major studies on climate change. Pakistan's initial national communication, submitted in 2003, recognizes the need to adapt to adverse impacts of climate change particularly for the water and agriculture sectors. This was reaffirmed recently by the report of the Planning Commission entitled "Task Force on Climate Change" (2010) which assesses key areas in which adaptation is required. The most vulnerable areas for climate adaptation are identified as Water Resources, Agriculture and Livestock, Coastal and Indus Deltaic regions, Forest and other vulnerable eco-systems, Health and Extreme events. In light of the available research and focus priorities, the section below outlines the major sectors impacted by climate change as well as recommending priority adaptation measures.

3.1.1 Water Resources

The water sector is the most important sector that is directly impacted by any changes in climate in Pakistan. The country's fresh water supply is primarily fed by the river flows (140 MAF) which supply 70% of the water in the country followed by rainfall which supplies the rest through the monsoons as well as westerly winds. Furthermore, the river flows are largely fed by glacial and snow-melt from the

Hindukush-Karakoram-Himalayan mountain ranges in the north of the country. They feed directly into the Indus river system which is shaped like a funnel linked to the five main rivers (Indus: 44%, Chenab: 19%, Jhelum: 16%, Kabul: 16% and Others: 5%). The country's water security is, thus, considered to be under serious threat as both the country's glaciers as well as rainfall supplies are highly sensitive to any changes in climate.

Any such changes in the water availability have extremely serious implications for Pakistan which is already a water stressed country (per capita water availability less than 1800 cubic meters per year) and is now heading towards becoming a water scarce country (per capita availability less than 1000m3/year by 2035)[76]. The recent floods (2010) in Pakistan have provided a clear example of the potential for damage due to climate change in Pakistan. Triggered by two climate driven events, the rapid melting of northern glaciers as well as erratic monsoon rains in the northern areas, dangerously coupled to produce the unprecedented floods in Pakistan which wiped off 5% of the national GDP through massive losses to human lives and infrastructure. Climate change is predicted to cause more such floods followed by periods of drought as the northern glaciers rapidly melt and eventually vanish.

The country thus needs to urgently undertake measures to not only cope with this situation but also adapt to the unavoidable future events. In this regards, a mix of policy and institutional measures are required to enhance water storage, encourage water conservation and efficient management as well as create the requisite research and early warning capabilities to respond to future climate disasters.

Likely impacts:

- Enhanced melting of glaciers and reduction of snow cover leading to alterations in the seasonal flow patter of the Indus River system
- Increased flooding in the rivers for a few years followed by declining river flows.
- Increased chances of formation of glacial lakes with risk of GLOFs or glacial lake outburst flows.
- Higher frequency and intensity of extreme climate events coupled with erratic monsoon rains could cause high floods followed by droughts.
- Increased water demand due to high evaporation rates at elevated temperatures
- Increased chances of water stress of the shared water resource potentially leading to cross border conflict

Priority measures:

- Highest priority needs to be to enhance water security through construction of large dams and employing all available water storage capacity in the country. This will ensure capacity for water regulation, hydropower production as well as irrigation and flood control in the country.
- Employing water conservation strategies such as canal water lining, reduction in irrigation system losses and use of optimum irrigation techniques to help save water

- Ensure the most efficient water management practices such as recycling waste water, protection of catchment areas, ensure rational groundwater usage, protect against sea water intrusion in the Indus delta

- Appropriate institutional and legislative support should be extended to ensuring water storage, conservation and efficient management in the country.

- Employ the latest early warning systems to monitor weather as well as water patterns and provide advance warnings about potential flooding.

- Flood plain management along the flood corridor to ensure minimum damage to human lives and infrastructure during floods.

- Climate proofing of future infrastructure investments to cater to the threats of climate induced disasters such as floods.

3.1.2 Agriculture and Livestock

The agriculture sector contributes 24% to Pakistan's GDP, employs 48.4% of the labor force and contributes 70% of the export earnings and, thereby, forms the backbone of the country's economy. Any shifts in this sector have multiple effects on the economy. Climate Change could be a major factor contributing to such shifts in agriculture owing to changes in rainfall patterns, water availability, seasonal weather and temperature shifts across the country. These factors, in turn, are predicted to alter crop growth cycles, hydrological cycles and alter the productivity of crops as well as livestock fodder. There is, thus, an undeniable need for the agriculture sector in Pakistan to adapt to climate change.

The food security in Pakistan is inextricably linked with the water and agriculture sectors and, as such, the need to adapt to climate change is duly acknowledged as an intrinsic element of Pakistan's future development. This is evident as "Vision 2030" document as well as the medium term strategic plans also recognize and encourage adaptation strategies and this has been identified as a major thrust area in the Initial National Communication of Pakistan. The country needs to prepare on this front by firstly scientifically assessing the shifts expected in agriculture and then respond to it through research, technological innovations and appropriate risk management measures.

Likely impacts:

- Reduced crop productivity and failure to timely respond to shifting crop calendars/rotations

- Changing insect, pest and pathogen populations

- Undermining of national food security

- Changes in livestock productivity (meat and milk) due to temperature stress and other climate related diseases.

Priority Measures:

- Establish an enabling institutional capacity to respond to the climate change such as setting up climate change Cells in Ministry of Agriculture to devise adaptive strategies for project impacts on agriculture and with extension arms at the local level to timely transmit the information to farmers.

- Develop digital simulation models to assess climate change impacts on physical, chemical, biological and financial aspects of agriculture production systems in all agro ecological zones of the country. These should be synced in with advanced and reliable predictions of climatic parameters and water flows.

- Develop new crop varieties which have stronger resilience to heat stress, water shortage, heavy rains and which are more drought tolerant.

- Develop better indigenous breeds of livestock with higher milk productivity and less prone to heat stress and drought tolerant.

- Use feed conservation techniques and fodder banks to respond to stress periods

- An effective mechanism to transmit information about expected changes in crop growth cycles, new crop varieties and other adaptation techniques to the farmers at the ground level should be established.

- Develop a risk management system to safe guard against crop failure and extreme event (i.e. floods, droughts). Introducing an extensive crop insurance scheme can be one such effective technique.

- Formulate an agriculture policy for the country in the context of climate change

3.1.3 Forestry and Biodiversity

Pakistan has very low forest cover, but these forests are very diverse in nature and of significant importance for the livelihood security of millions of rural people who live in and around these forests. The major factors contributing to deforestation include logging for timber, cutting of fuel wood, land-use changes such as crop cultivation, and overgrazing of livestock. Unless alternative fuels, such as kerosene and natural gas, can be provided the growing demand for fuel-wood is likely to contribute to soil erosion, damage watersheds, reservoir silting, desertification, and sea encroachment. Such changes could exacerbate the impacts of climate change which could include varying forest productivity, changes in composition of species, reduced forest area and unfavorable conditions for biodiversity enhancement.

Temperature and precipitation are the two most important elements of climate, and together they have a number of first-order effects on forest distribution, composition and growth. The first order effects of climate change and an increase in temperature on Pakistan’s forest could be many, including the timberline moving up the Himalayan mountain slopes, the disappearance of alpine grasslands in those areas where mountain tops are just above the timberline, and changes in plant composition, cover, and location. The future area of different biomes could be significantly different than at present. An increased frequency and intensity of drought, storms, erosion, and landslides, could have the greatest impact over the next century. Increased temperature could affect plant distribution, photosynthetic rates, plant growth, soil organic decomposition rates, incidence of fires, pest outbreaks, diseases and ultimately regeneration success, mortality and growth/yield of trees. Thus adaptation in this sector is aimed at the need to restore, sustain and enhance the country's forests and biodiversity while preparing it to withstand the present and future possible impacts of climate change.

Some model predictions[77] indicate that there will be potential for an expansion in the forested area in Pakistan under climate change scenarios. However, the actual change in forest area depends mostly on the ability of species to migrate to new areas, as well as on the activities of humans in forested areas. A greater number of fire outbreaks, erratic rainfall, and the pressure of human activities may not allow some species to move to new locations. Physical barriers such as croplands, orchards, and topographic features may also hinder migration.

Likely Impacts:

- Varying forest productivity as well as changes in growth/yield of tress with shifting of biomes
- Changes in composition of species as well as forest migrations due to changes in temperature and precipitation levels.
- Pressure on forest resources due to weather extremes
- Increase in forest pests, insects, pathogens and disease due to increased temperatures

Priority Measures:

- Promote research on the climate impacts on forests including any predicted biome shifts as well as composition of species within biomes.
- Research and establish gene banks and see banks to conserve the biological diversity of valuable species of flora and fauna residing in the country's forests
- Remove barriers to accommodate the "natural" migration of forests due to climate change.
- Promotion of compensatory farm forestry based upon developed climate resilient tree species.
- Reduction of forest fires through timely warning systems, creating fire lines and involvement of local communities.
- Biological control of forest pests by maintaining viable population of predatory birds and insects

3.1.4 Extreme Events and Coastal Zones:

The frequency of climate induced extreme events in Pakistan is increasing and the effects can be felt across the diverse country – starting from the 1050 km stretch of coastal areas that have been prone to more frequent cyclones to the plains of the country which are subjected to a high possible incidence of floods and moving all the way up to Northern areas where likelihood of GLOF related catastrophic happenings is now considered a very real possibility. Adapting to such diverse events over 9 different ecologies is a formidable challenge, especially with a support infrastructure for rescue and relief which is just beginning to take shape.

Climate Change is likely to increase climate-related natural disasters. With the projected increase in the frequency and intensity of extreme climate events, including floods, droughts, cyclones, landslides triggered by heavy rains and urban flooding due to congestion on storm drainage. Climate change projections are scenario based, hence, contain some degree of uncertainties. But in spite of this there are strong indications that in South Asia, particularly in Pakistan, climate change is intensifying the above mentioned hazards. Pakistan is already experiencing the climate change impacts that are too visible to ignore. Most disasters or hazards that lead to destruction cannot be prevented; their impacts however, can be minimized by adaptive and preparedness measures.

Likely Impacts:

- Increased frequency and intensity of cyclonic activity along the coastal zones.
- Incidence of catastrophic Glacial Lake Outburst Flows (GLOFs) in the northern areas of the country.
- Increased frequency and intensity of floods across the country.

Priority Measures:

- Strengthening flood and cyclone forecasting and “early warning” system in the country;
- Allocate adequate financial and other resources to implement “National Disaster Risk Management Framework” formulated by NDMA;
- Undertake GIS mapping of all existing irrigation infrastructure/flood embankments as well as sea embankments for efficient monitoring and disaster management;
- Redesigned and upgrade storm drainage capacity of major cities especially Karachi and Lahore keeping in view climate change related likely increase in short duration intense rainfall or cyclonic events;
- Ensure establishment of local flash flood forecasting & warning system in vulnerable mountainous areas;

- Undertake flood plain mapping/zoning to various level of vulnerability and develop a flood vulnerability map based on future projected climate change.

3.1.5 Energy and Industry:

As already outlined in the mitigation section, the energy sector emissions account for 50.7% of total emissions in 2008 and are not only the fastest growing since the previous inventory in 1994 (have almost doubled) but are also predicted to rise exponentially by 2050. The reason for this is two fold – an increasing dependence on coal to fuel this energy and an increasing demand for energy by a growing population and expanding industrial and transport needs.

Impacts:

a. Changes in water availability and the timing of such water availability will impact hydropower generation and thermal power plant cooling. Likewise sedimentation built-up in existing dams will reduce hydropower generation capacity.

b. Impacts of sea level rise on seashore energy infrastructure. Likewise potential hazards to infrastructure from floods e.g. Kot Addu damage from 2010 floods.

c. As predicted temperatures increase a reduction in thermal power efficiency is expected.

d. Likelihood of increase in transmission/distribution lines losses due to temperature increases

e. Indirect impacts include greater reliance on fossil fuels or alternate energy as river flows exhibit cyclical changes due to glacier melt, rising temperature and changing precipitation patterns. Higher temperatures would also result in increased evapo-transpiration losses raising demand and cost of pumped water.

Priority Measures

- Changes in Infrastructure/household design to make it more energy efficient

- Promotion of renewable energy options such as wind, solar and small hydro as an alternate source of energy

- Life style changes to inculcate energy conservation e.g. car pooling.

3.2 Costing Adaptation needs

Costing of adaptation is an area where a globally established and recognized methodology does not presently exist. Nevertheless a number of innovative techniques are being regularly injected into the debate to streamline this challenging process. However, the figures being quoted for the costs of adaptation have excessively wide ranges reflecting the variability and uncertain nature of economic predictions linked with future climate change. The various studies done on the subject of adaptation assessments suggest that adaptation to climate change at the global level will cost several USD billion per year. While potentially relevant for the international discussion on adaptation and its financing, these existing global multi-sectoral estimates face serious limitations. In particular, these estimates are quite sensitive to the assumptions made with regard to the climate risk exposure, the costs of "climate-proofing", the issue of double counting and scaling up to global levels from a very limited (and often very local) basis. Thus, the global adaptation cost numbers can be seriously misleading if adequate attention is not paid to the assumptions that underlie particular empirical estimates[78]. Moreover, most figures are only aimed at capturing the direct costs whereas in many instances the indirect costs exceed the direct costs of adaptation[79].

The Table-12, given below, provides a listing of the leading global research on this subject while also drawing out the cost of adaptation in South Asia. In the widely acclaimed Stern[80] review the cost of climate change impacts is estimated at ranging between 5-20% of global GDP annually - in the absence of adaptation. The World Bank[81] estimates that up to 10% of domestic and foreign direct investment (FDI) flows in developing countries, and up to 40% of ODA and concessionary finances might be at risk from climate-related damages. Similarly, UNDP estimates that 24.9 % of all estimated global costs of adaptation would have to be just spent in Asian developing countries. Although varying in absolute values, the present research on the subject does unequivocally suggest that cost-effective and timely adaptation strategies which are fully compatible with development objectives are crucial to both coping with as well as lowering future climate impacts. In the absence of appropriate measures, countries will be forced to implement reactive unplanned adaptations, which will prove much more costly.

Study	Estimate	Period	Comment
NCAR	97.5	2010-2050	South Asia 17.1
CSIRO	84.5	2010-2050	South Asia 18.7
Stern Report (2006)	5-20% annual Global GDP		
UNFCCC (2007)	28-67		
World Bank (2010)	70-100 billion per year in developing countries or about 0.2% of projected GDP of all developing countries	2010-2050	
Oxfam (2007)	>50 per annum		World bank plus extrapolation of costs from NAPA's and NGO's project
UNDP	86-109		Takes into account better disaster response

Table 12: Adaptation Cost[82] Estimates from Different Studies (Billion US Dollars)

TABLE 1. Annual Adaptation Costs in Developing Countries

Assessment	Annual Cost	Year
UNDP 2007	$86 billion	2015
UNFCCC 2007	$28–67 billion	2030
World Bank 2006	$9–41 billion	present
Oxfam 2007	$50 billion +	present
Stern Review 2006	$4–37 billion	present

Sources: UNDP (2007, p. 192-194); Agrawala and Fankhauser (2008, p. 69)

Table 13: Annual Adaptation Costs in Developing Countries (UNDP analysis)

The UNFCCC (2007) study further gives a break-up by sector of additional annual investment need and financial flow needed by 2030 to cover costs of adaptation to climate change (billion dollars per year in present day values) (Billion US $) given in Table-14 below:

Sector	Global	Developed Country	Developing Country
Agriculture	14	7	7
Water	11	2	8
Human Health	5		5
Coastal Zones	11	7	4
Infrastructure	8-130	6-88	22-66
Total	49-171	22-105	27-66

Table-14: Sector wise adaptation costs - Source: UNFCCC, 2007

The above mentioned estimates do, however, lead towards certain useful deductions which include the following:

1. The global annual costs for adapting to climate change are in the range of billions of U$ with estimates ranging them approximately between U$ 50 to U$ 100 billion. These climate “need” figures has been selectively acknowledged under the Copenhagen Accord (2009) and the Cancun Agreements (2010) which have both collectively formalized the climate finance figures of U$ 30 billion as fast track finance (covering three years from 2009-2012) and U$100 billion/year as long term finance from 2020 onwards. Although providing a basis for garnering climate finance in the future, these figures which encompass both mitigation and adaptation funding do suggest that the climate finance needs of developing countries have been under-estimated.

2. The South Asian region is consistently bracketed as a highly vulnerable region with average costs of adaptation ranging between 15-20% of the global adaptation figures.

3. The infrastructure sector is threatened the most by climate impacts with high associated climate impact costs.

4. These global costs have not, so far, been apportioned on country basis which should be the basis for further research on the subject.

3.3 Costing Adaptation in Pakistan

In this section an attempt is made to provide estimates of adaptation costs for Pakistan using a variety of different methods while keeping into account the limitations of global adaptation cost methodologies and variability, as outlined in previous sub-section. Also, owing to paucity of country specific data on adaptation, especially individual sectoral aggregation, the analysis is a top-down analysis undertaken using macro indicators and other relevant data to derive country cost estimates.

In the case of Pakistan we take an approach to derive adaptation costs based on different criteria to arrive at a reasonable range of estimates for national adaptation costs:

i. Derivation based upon projected GDP

ii. Per capita basis deriving from existing research

iii. Estimates using disaster modeling based on historical event and their costs.

These approaches allow estimation of adaptation costs under different set of assumptions which are elaborated under each section. The following assumptions, however, have been consistently applied to the three approaches:

a. Provisional costs are projected for 2010 (base period) and in some cases 2030 and 2050.

b. All costs are in current dollars

c. No discount factors are used to keep the analysis simple and consistent.

d. It is relatively inexpensive to avoid some impacts but prohibitively expensive to avoid others (See Figures 14 and 15 below) and that there will be some "residual damage" which will not be adapted to over the longer term, because adaptation is either not economic or not feasible. According to recent research on the subject, this "residual damage" could be as high as 66% of total damages for all sectors.

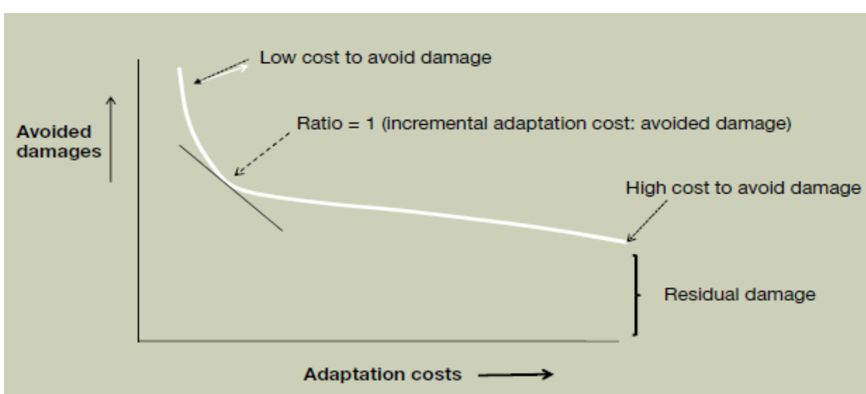


Figure-14: – A generalized adaptation cost curve[83]

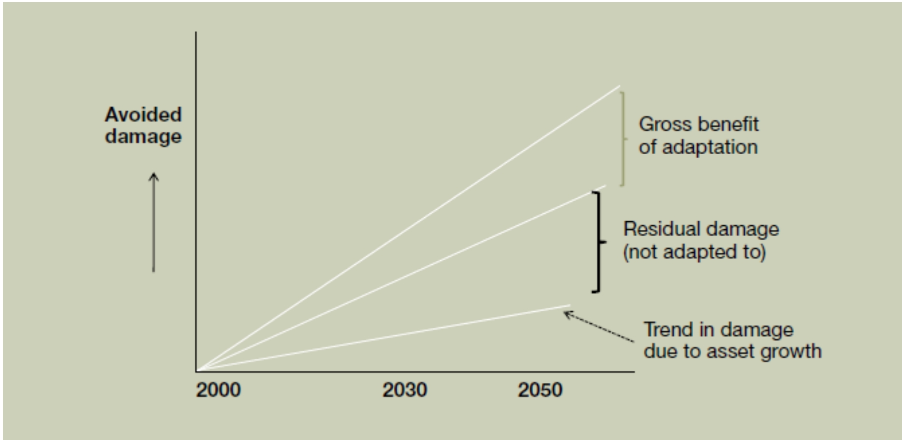


Figure-15: A generalized adaptation cost curve[84]

3.3.1 Derivations based upon projected GDP:

There have been some recent reports which have aimed to categorize adaptation costs as a percentage of national GDP. In this regards, the Stern report has estimated a range of 5-20% of global GDP to address adaptation whereas a recent World Bank[85] study employs a regional range for adaptation costs which varies between 1.5% to almost 7% of GDP (Figure-16). Also, the adaptation costs logically go down over time with a higher level of economic development as well as increase of absolute GDPs which leads to an enhanced national ability to cope with climate change. In this regards, the developing South Asian range is projected to have adaptations costs at 2.25% (2010-2019) and going down to 1.75% of GDP (2020-2030) as the region develops.

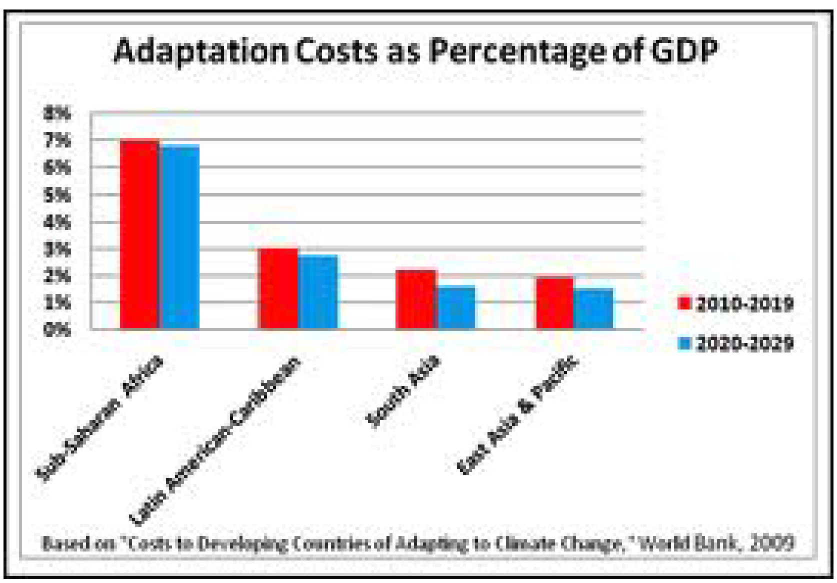


Figure-16: Adaptation Costs as a % of GDP (World Bank 2009)

For the case of Pakistan, we realistically estimate adaptation costs as a sliding percentage of GDP values as given in Table-15 below - starting at 4% of GDP value (2010) which are brought down to 1.5% of GDP in 2040-2050. This sliding value is based upon the following:

- Pakistan's 2010 climate triggered floods caused a damage of 5% of GDP in just one year[86] which is a real time cost and does not account for other climate exposures in the year such as glacial bursts and the cost of the drought of early 2010. Thus, 4% of GDP as a start value for 2010-2015 is actually a conservative figure.
- Within the South Asian region the country suffers from extreme (and rising) climate vulnerability so its adaptation costs would lie at the high end of the average.
- Pakistan has a relatively smaller size of national GDP as compared to India - who's high GDP value skews overall average adaptation cost estimates towards a lower % of GDP in South Asia. Hence, although the World Bank estimated South Asian average adaptation costs as a percentage of GDP are assumed at 2.25%, Pakistan's costs within this context should be logically much higher thus further justifying the figure of 4% of GDP to start with.

Years	GDP Growth Assumptions (As per Pakistan Planning Data)	Adaptation Cost (% of GDP)
2010-2015	4.7	4%
2015-2020	6	3%
2021-2030	6.5	2%
2031-2040	6.9	1.5%
2041-2050	7.1	1.5%

Table-15: Adaptation as a % of GDP – sliding scale

The subsequent values for adaptation costs in respective years are derived by projecting the 2010 GDP to the future and are given in Table-16 below which indicate that the costs keep on rising but along a declining trend as the absolute GDP value grows and the country's capacity to cope with climate change enhances (all values are in 2010 nominal terms):

Year	Adaptation Cost Value (In billions $)
2010	5.75
2020	7.26
2030	9.09
2040	13.26
2050	26.38
Average Value for 40 year period	**10.70**

Table-16: Adaptation Costs / annum in Pakistan (U$ billions)

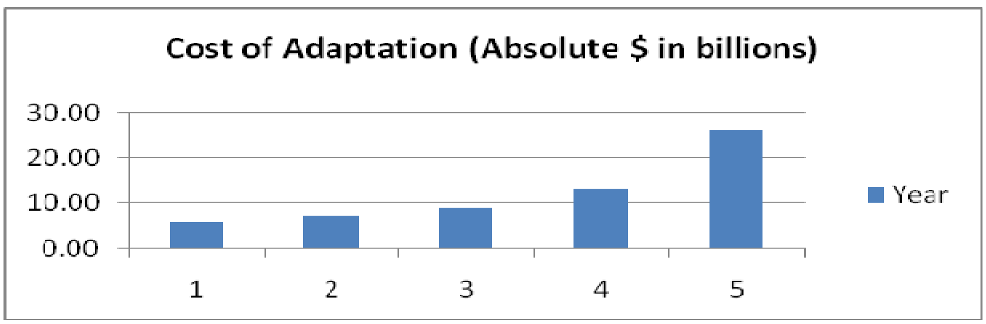


Figure-17 : Costs of Adaptation (2010-2050)

The average value for **annual adaptation costs** that can be reasonably anticipated from this inference amounts to **U$10.70 bn/annum** over the next 40 year time period. It is worth noting that, for this analysis, we start with an adaptation cost figure of U$5.75 billion in 2010 which is significantly less than the U$9.7 billion that Pakistan has actually had to face owing to the unprecedented flood loss damage which, in the absence of adaptation measures, can be equated to be the climate impact cost.

3.3.2 Per Capita based adaptation:

In the simplest form, per capita implies "a number divided equally between a certain number of individuals" or a common denominator which seeks to "equally" apportion a finite resource amongst a finite population. It is most widely used as an indicator to represent the economic or social well being of each individual in a particular country. Thus by dividing the national productivity (GDP / GNP), income, national debt, number of schools or hospitals by the total national population it provides an "equitable" framework which is used as a comparative performance gauge amongst countries and utilized for a variety of purposes. Within the environmental sector, it has been applied for indicating the utilization of natural resources such as freshwater and energy.

In the context of climate change, the "per capita" indicator has been employed in a number of proposals that have gained substantial political attention but these have been focused on the mitigation sector. This report endeavors to provide an initial idea on its possible application to the adaptation sector in trying to derive aggregate adaptation costs.

Countries with large populations, as prevalent in South Asia, would find it useful to derive costs based on per capita basis for adaptation. If food availability, income, water, debt etc are all expressed in terms of per capita—a case can be made to justify adaptation costs on a per capita basis. Also, it should be noted that the expected costs would decline over time as adaptation takes place.

For the case of Pakistan, we start with an indirect estimation by allocating a meager 5% of the per capita GNP of US $ 800 in Pakistan towards adaptation. This provides a reasonably indicative figure amounting to US $ 40 per person which is measured against certain other barometers such as:

- Based on CSIRO annual cost of US 18.7 billion shown in Table 3 and using population estimates provided in the World Bank (2010) report for South Asia[87] we arrive at a total South Asian population near 1.44 billion. Dividing the CSIRO annual cost of US 18.7 and using no discount values we get an *average per capita cost of US $ 13 per person across South Asia*[88]. In this regards, Pakistan which is ranked in the extreme climate risk category as noted earlier will, in all probability, be in the higher range for per-capita adaptation cost.

- A recent report[89] suggests that the overall UNFCC (2007) estimate of total annual adaptation costs of U$ 171 billion/year is “highly underestimated” owing to a host of factors such as underestimating health and infrastructure costs, non inclusion of ecosystem protection costs (potentially in the U$ 65-300 billion/year range) as well as other impacted sectors such as energy, financial and retail sectors of the economy. However, just using the conservative figure of U$ 171 billion gives us *a per capita value of U$ 24* (assuming a global population of 6.88 billion). In Pakistan’s case with an extremely high vulnerability, a value of U$ 40/capita seems quite reasonable.

- The health costs associated with avoidance of climate induced diseases e.g. Cholera, malaria, diarrhea have been estimated at US $ 81-104.3 per capita in 2030 and these are not one time costs and recurrence is annual or more than once[90]. Additionally, the cost of Malaria[91] is reported to around US $ 0.08-5.3 dollars (see www.malaria.htm). Moreover, the South Asian region is at high health risk owing to a rise in “endemic morbidity and mortality due to diarrhea diseases primarily associated with floods and droughts[92]” and is thus expected to be on the high end of health costs associated with climate induced diseases. Given such estimations driven by health costs alone, the *figure of U$ 40/capita for adaptation* seems a conservative underestimation given the fact that adaptation costs like disaster management, water, agriculture and all other sectors requiring adaptation provides a more realistic investment horizon for a country like Pakistan.

Working with the assumption of the range of $13 to $40 per capita for adaptation in Pakistan, we use the model shown in Table-17 below to project it through the anticipated population increase in the future scenario to get a range of adaptation costs of U$ 2.3 to U$ 14 billion/annum as adaptation costs.

Year	Population Projections		Total Adaptation Costs (billion $/annum)	
		Per Capita Adaptation Values	*U$ 13*	*U$ 40*
2010	180		**2.34**	**7.2**
2030	280		**3.64**	**11.2**
2050	350		**4.55**	**14**

Table 17– Estimates of adaptation costs on a per-capita basis

Given the recent devastation caused by floods in Pakistan where estimates for direct cost are reportedly US $ 9.7 billion for a single event it makes economic sense to initiate adaptation activities in line with the development agenda. Moreover, as evident from the figures in Table, the flood loss and damage costs are within a reasonable range of the costs of adaptation (U$ 7.2 billion) deduced from the per capita figure of U$40/annum in the year 2010. This also shows that the U$ 40/annum is a reasonable, though conservatively under-estimated, figure for per capita adaptation in Pakistan.

3.3.3 Estimates Based on Disaster Modeling

In this section an attempt is made to derive an estimate of adaptation costs from past climate related disasters like floods and droughts. Pakistan has a history of extreme events which, triggered by climate change, are becoming more frequent in the past decade. This fact is in line with the IPCC (2007) future scenarios that project increased incidence of floods and droughts in the South Asian region and is also evident from Table- 18 which enlists the top ten disasters of Pakistan over the past 40 year horizon.

	Disaster	Date	Damage (000 US$)
1	**Flood**	2010	9500000
2	**Earthquake**	2005	5200000
3	**Storm**	2007	1620000
4	**Flood**	1992	1000000
5	**Flood**	1973	661500
6	**Flood**	1976	505000
7	**Flood**	2007	327118
8	**Drought**	1999	247000
9	**Flood**	2001	246000
10	**Flood**	2008	103000

Table -18: Top Ten Disasters in Pakistan (past 40 years)[93]

The history of major natural disasters in Pakistan clearly, as evident from the above table, points towards the following deductions:

- Maximum natural disasters (90% in the Table) are climate related
- The damage costs of these natural disasters is going up with the top three disasters occurring in the past three years
- The frequency of these natural disasters is going up with 60% occurring in the past 10 years.

The World Bank (2009) records a damage estimate of US $ 3.57 billion for natural disasters (1990-2008) to which can be added the most recent climate triggered flood that cost roughly US $ 9.7 billion, as earlier mentioned. The total damage costs for climate related events in the 1990-2008 thus amounts to an estimate of US $ 13.27 billion. However, this figure would be an underestimation as it is flood specific and many other climate induced events (like the recent glacial lake outburst in Hunza and the 2010 drought) are not factored into the disaster damage estimates and also it relates to a period with low climate impacts.

Thus, given the high probability of climate induced natural disasters occurring in the future it is useful to carry out a simulation exercise to estimate future adaptation costs based on this fact. In this regards, we use the following analysis model as shown in Table-19:

- Construct three probable scenarios – assuming a high, medium and low frequency of floods in the future 40 year horizon (2010-2050).
- This is then matrixed against possible damage costs in the high, medium and low ranges while assuming the 2010 flood damage costs in the high range (Using actual flood damage costs of U$ 9.7 billion for the super flood of 2010 in Pakistan) and iteratively deducing medium and low damage cost figures.
- No discount factors are used and all costs are in current dollar terms.
- The analysis is *only* for flood related damage and does not account for any other climate induced disasters or impact costs so its value will be under-estimated as far as total adaptation costs are concerned.
- For the calculation 2/3rd or 66% of the total damages is taken as “residual damage” or damage for which adaptation is not possible and the full impacts will have to be borne as “forced adaptation”. This is in line with the most recent research on the subject[94].
- The remaining 33% of “adaptable” damages are subjected to a “planned” adaptation cost of 20% which is also a figure taken from the recent research on the subject.
- The total adaptation cost is equal to the forced adaptation plus the planned adaptation costs.

Climate Disaster Costing (Flood scenarios) (All costs in U$ billions)							
		Low Frequency		Medium Frequency		High Frequency	
Damage	**Cost**	***Number of Events***	***Cost Incurred***	***Number of Events***	***Cost Incurred***	***Number of Events***	***Cost Incurred***
High	**9.7**	7	67.9	8	77.6	12	116.4
Medium	**5**	6	30	9	45	11	55
Low	**2.75**	5	13.75	10	27.5	13	35.75
Total Events in 40 Years		18	-	27	-	36	-
Total Cost of Damage		-	111.65	-	150.1	-	207.15
Damage costs/annum		**-**	2.79	-	3.75	-	5.18
Average adaptation Costs/annum (2010-2050)			**2.03**		**2.72**		**3.76**

Table 19: Adaptation Cost Estimation based on Floods over 40 year period

The results show that the average cost of adaptation over the 2010-2050 time horizon would range between U$ 2 billion to U$ 3.8 billion/year depending on the frequency and intensity of floods over the next 40 year time period. This analysis, however, is not the full adaptation cost as it does not account for the costs associated with other impacted sectors such as coastal zones, energy, agriculture, forestry, health and other climate induced disasters such as droughts and cyclones.

3.3.4 Conclusions of adaptation costing for Pakistan

The above analysis has endeavored to estimate the adaptation costs through a variety of approaches in order to come to some reasonable range relevant to Pakistan's situation. The results are summarized in Table-20 below and the following are the main deductions:

Methodology	Time period	Cost of Adaptation/annum
Actual (2010)	One year (2010)	9.7++
As a percent of GDP	2010-2050	10.71
Per Capita Basis	2010-2050	7.12 to 14.0
Disaster Modeling (Floods only) * Multiplication factor of three.	2010-2050	6.09 to 11.28

Table 20 : Adaptation Cost Estimates from various approached (U$ billions)

- The actual "forced" adaptation costs that Pakistan has had to bear in 2010 owing to the climate triggered floods is U$ 9.7 ++. The total adaptation would be more than this figure as it is just related to the flood damage costs and does not factor in the costs of other climate related impacts that the country has been faced with such as the early drought and glacial lake outburst.

- The calculations which derived adaptation costs as a percent of future GDP projections indicate an annual average adaptation cost of U$ 10.71 over the 2010-2050 time horizon.

- The per-capita based approach was used to inject a new approach into the ongoing debate over estimating adaptation costs and has derived figures of annual adaptation costs for Pakistan at U$ 6 (in 2010) to U$ 14 billion (in 2050) if a per capita figure of U$ 40 is used.

- The disaster based model was developed in light of the high probability of floods for Pakistan in the medium term horizon and has resulted in providing adaptation cost figures ranging between U$ 2 to U$ 3.76 billion over the 2010-2050 time horizon dependent upon the frequency and intensity of future floods. This "flood" adaptation value derived from the disaster model is multiplied by a factor of three to provide figures of U$ 6 to 11.28 billion. This is done for comparative purposes with the other methodologies which are costing total adaptation - which accounts for the costs associated with other impacted sectors such as coastal zones, energy, agriculture, forestry, health and other climate induced disasters such as droughts and cyclones - while this is "only" factoring in the adaptation to "floods" disaster.

- Overall it can be deduced that, for Pakistan, adaptation to climate change is going to be a high value figure running into billions of dollars in the future ranging from between U$ 7 to U$ 14 billion/annum.

- Also, this figure will rise over time, in cumulative terms. The reason for this is that initial adaptation will probably be quite feasible but will get increasingly expensive as it deals with impacts which require high costs or are "unavoidable" and need to be borne by the country and its economy.

- In future, a more detailed exercise will need to ascertain how much the country would be willing to pay to avoid future climate induced damages and which adaptation measures are cost effective and financially feasible within the constraints of available climate finance.

- Finally, it should be noted that the exercise has been a top-down analysis based on contemporary research done on this nascent subject and is aimed at providing a reasonable first approximation that can be refined over time as relevant and reliable local data becomes available to draw conclusions from a "bottoms up" approach to adaptation costing.

FINANCING OPTIONS SECTION

4.1 Financing Options for Climate Change in Pakistan

As indicated in the analysis above, Pakistan needs significant climate finance cater to the needs of inducing a shift towards a low carbon future as well as cope with the needs of adapting to climate change. This section outlines the main options available for financing both, climate mitigation and adaptation, in Pakistan.

In this regards, both local as well as international options are outlined which can allow the country to effectively and feasibly meet its climate finance needs for adapting to unavoidable climate impacts as well as ensuring the optimum utilisation of its indigenous resources with the lowest possible greenhouse gas emissions.

Also, the country needs to be cognisant and actively aware of the international financial and market based instruments, both in the public as well as private sector domain which can be possibly tapped for financing climate mitigation as well as adaptation activities in Pakistan.

In tandem, Pakistan has to establish local capacity and infrastructure which can not only by synced in with any global financing options but also provide a framework to effectively assimilate and utilise the said funding in a transparent and efficient manner while also acting as a conduit for national budgetary funding for such activities.

Thus, to be feasible and effective, the financing options for climate change need a two way linkage between global and local levels. In this regards, the outline below provides some of the available financing sources for facing up to the climate challenge in Pakistan:

4.1.1 Kyoto market based instruments:

The overarching achievement of the Kyoto Protocol, which was globally ratified in 2005, has been the establishment of the Global Carbon Market based upon three market based mechanisms – emissions trading, joint implementation and the Clean Development Mechanism. This market has grown in size exponentially rising from just U$ 10 billion in 2005 to $118 in 2008[95] and it is now predicted to reach the level of U$ 1 trillion/year in the near future. All these figures point towards a progressively increasing momentum in the carbon market (Table-21).

Transaction Volumes and Values, Global Carbon Market, 2007 and 2008

Markets	Volume ($MtCO_2e$)		Value (US$ million)	
	2007	2008	2007	2008
Voluntary OTC	43.1	54.0	262.9	396.7
CCX	22.9	69.2	72.4	306.7
Other exchanges	0	0.2	0	1.3
Total Voluntary Markets	**66.0**	**123.4**	**335.3**	**704.8**
EU ETS	2,061.0	2,982.0	50,097.0	94,971.7
Primary CDM	551.0	400.3	7,426.0	6,118.2
Secondary CDM	240.0	622.4	5,451.0	15,584.5
Joint Implementation	41.0	20.0	499.0	294.0
Kyoto [AAU]	0.0	16.0	0.0	177.1
New South Wales	25.0	30.6	224.0	151.9
RGGI	-	71.5	-	253.5
Alberta's SGER[(a)]	1.5	3.3	13.7	31.3
Total Regulated Markets	**2,919.5**	**4,146.1**	**63,710.7**	**117,582.2**
Total Global Markets	**2,985.5**	**4,269.5**	**64,046.0**	**118,287.0**

Source: Ecosystem Marketplace, New Carbon Finance.

Notes: (a) Assume a CA$10 price for Alberta offsets and Emission Performance Credits based on interviews with market participants. (b) 2008 JI & RGGI numbers in this chart were updated after initial release of this publication. (c) 2008 JI volume and value information provided by the World Bank.

Table-21: The Global Carbon Market[96] (2007/08)

This new market in the carbon commodity provides a strong linkage and opportunity for financing sustainable development and climate mitigation activities in developing countries as well as "cost effective compliance" in the developed or Annex-1 countries. Since its inception, it has managed to be an effective financing vehicle for promotion of projects focused in the clean energy development (renewable, waste to energy, transport) as well as sustainable forestry sectors. In doing so, it has been instrumental in shifting the economic growth of countries towards a low-carbon trajectory in the most cost effective manner. For Pakistan, the Clean Development Mechanism can be utilised for securing funding for low carbon development especially for clean energy projects such as renewable energy.

In this regards, Pakistan has already announced the CDM operational strategy and institutionalised the CDM host country capacity. Although this has, so far, resulted in attracting more than 60 projects so far (which are at different stages of development in Pakistan with more than 20 having got "host" country approval) there is no doubt that this effort needs to be strategically enhanced to realise the full potential of the carbon market in Pakistan. A list of the projects is given in Table 22 below which shows that there is a strong focus on projects fostering clean energy development in Pakistan.

Table SS1.2: Sector Wise CDM Projects (percent)			
		Pakistan	
Sectors	Global	Current Projects	Pipeline Projects
Energy	64.96	57.14	58.33
Waste management	19.45	28.57	16.67
Industrial process	9.63	14.29	16.67
Transportation	0.13	0	0
Land use & forestation	0.08	0	8.33
Agriculture & livestock	5.78	0	0
Source: UNFCC & CDM Cell, MOE , GOP			

Table 22 : Sector wise distribution of Pakistan's CDM project (MoE, 2010)

This avenue for financing is, however, subject to a global competitive environment. Also, with coal deployment being one of the primary strategies in the future energy expansion in the country the CDM's role in the future energy scenario may be limited as it has, so far, not financed clean coal technologies. Moreover, the long gestation period for CDM project development and, associated transaction costs have led to an under-utilisation of this instrument in Pakistan's context. The potential for its enhanced use do, however, exist if the mentioned barriers can be overcome.

4.1.2 REDD+ Mechanism:

Pakistan faces the challenge of arresting the very high deforestation rates along with low and declining forest area coverage. Both these statistics provide a dismal picture of the country's forestry sector. However, ironically, they inherently provide an opportunity to benefit from REDD+ which is globally aimed at financially rewarding a reversal of high deforestation. Like other countries in the tropical belt, it stands to greatly benefit from interventions carried out to arrest the rapid deforestation especially in the forests stocks still left standing. This will not only assist Pakistan in addressing a local environmental issue but also generate global value by contributing to the fight against climate change through preserving a valuable carbon asset.

To realize this, however, the carbon value of the forests in Pakistan needs to be financially identified and quantified in both current as well as future terms in preparation for an international REDD regime which aims to recognize the value of these global assets of sequestered carbon. The REDD regime is currently in a state of flux and no clear international regime has, so far, emerged. However, being a country with an obvious potential to benefit from REDD+, Pakistan needs to adopt a pro-active plan of action on both, the negotiations as well as readiness tracks of REDD+ by carrying out a "REDD Readiness" capacity building exercise to include a national carbon stock assessment and identification of possible REDD+ projects as well as creating the necessary MRV (Measurement, Reporting and Verification) technical capacity in the country.

In terms of availability of funds, a number of developed countries have committed to provide scaled up funding for readiness and capacity strengthening as well as for supporting implementation of REDD+

plans and actions, including demonstration activities and payments for results. In the margins of COP 15, six donor countries dedicated USD 3.5 billion as initial public finance over the 2010 to 2012 period, as a component of their collective commitment of fast start finance under the Copenhagen Accord, to initiate an effort of slowing, halting and eventually reversing deforestation and forest degradation in developing countries, while also expressing their willingness to scale up financing for REDD+ thereafter, as appropriate, in line with opportunities and the delivery of results. Since then, further pledges of support have been made, including at the ministerial meeting on REDD+ in Paris in March 2010 and at the Oslo Climate and Forest conference in May 2010. The total pledges, as of May 2010, stand at 4.0 billion USD[97] which are aimed to be utilized for REDD readiness in the 2010-2012 time frame.

Although the exact methodology for disbursement of these funds is still not clear, considerable progress was recently made by the establishment of a **"REDD+ Partnership"** group in Oslo at a conference in May 2010. This is a voluntary and non-legally binding framework amongst 58 developed and developing countries[98] which have agreed to collaborative REDD+ efforts including knowledge transfer, capacity enhancement, mitigation action and technology transfer. The UN-REDD and WB-Forest Carbon Partnership are jointly acting as the secretariat for this group which is open to all for membership and the administration of the group is through two co-Chairs (developed and developing country). This was positively followed up with inclusion of REDD+ under the **Cancun Agreements** in December 2010

The funds allocated by the donors are going to be, most likely, administered through this partnership either bilaterally or multilaterally depending on the donor preference. There is some doubt, however, as to whether these promises still stand in the absence of a comprehensive climate agreement but the group mentioned above is now providing a fresh impetus and resolve to this announcement. Also, funding for the implementation stage between **2013 and 2020** will require much more money and remains unresolved.

Another projected source of generating REDD+ finance is supposed to be the global carbon market. In this respect a number of carbon funds in the forestry sector have mushroomed which are presently focusing on the voluntary market place and using this as a route to position them for the future REDD market. Such forestry credits are, subsequently, discounted owing to the risk associated with the lack of market clarity and absence of globally agreed rules but still provide a very valuable learning experience in a nascent market. This is expected to change after the international rules for REDD are agreed and could, potentially, trigger the carbon market to serve as a major source for generating REDD+ funding.

4.1.3 The "Green Climate Fund" under the "Cancun Agreements":

One of the silver linings of the outcome agreements at Cancun (COP16) was that it chalked out the architecture for delivering climate finance through creation of a "Green Climate Fund" and announced the setting up of a transitional committee and a standing committee on finance to make this fund operational in a specified time frame The extensive architecture and framework proposed under these agreements hinges upon the availability of climate finance which is based upon the voluntarily announced pledges by developed countries of providing $30 billion in fast track finance and $100 billion in long term finance – announced at Copenhagen and formalized under the Cancun Agreements.

However, the availability, accessibility, adequacy and predictability of this funding remains uncertain but this will hopefully change in the near future making this fund one of the prime sources for securing climate finance.

4.1.4 MDB climate financing:

This includes instruments such as the GEF, the World Bank climate funds as well as the UNDP – MDG funds. Pakistan can benefit from Climate Investment Funds (CIF) of the World Bank which includes the Clean Technology Fund (CTF) and Strategic Climate Fund (SCF). They collectively extend multiple climate funding options including funding for rrenewable energy, clean technology, and efficient mass transit in cities, forest preservation, and climate resilience. At present CIF has a total amount of funds 6.5 Billions US Dollar (CTF 4.6, SCF 1.9).

Another option on this front is to access the Global Environment Facility which provides "incremental" funding for projects in the climate change sector. Pakistan has already benefited from this fund and this option remains open for the future although constrained by the project development complexities as well as issues related to the "resource allocation framework" under which the projects are now being funded. The scope for funding under such globally competitive instruments remains limited and the access to this funding is laden with historical political baggage.

4.1.5 Bilateral country partnerships:

Along with the international avenues for financing the country also needs to focus on bilateral country partnerships for securing climate financing. With the faltering of the multilateral process in Copenhagen (COP15), the issue of climate change is fast becoming a priority issue for extending cooperation at the bilateral and regional levels. In this regards, Pakistan can explore the avenues of cooperation at the SAARC level (South Asian Agreement for Regional Cooperation) as well as bilaterally with countries such as China, Japan, Korea, European Union and the US with which it traditionally enjoys cooperative arrangements. In this regards, the recent agreement reached with China to generate**.** 2,300MW of clean energy[99] through wind turbines and solar panels was one such example which can be replicated with other countries leading to cooperative climate mitigation financing.

4.1.6 National Budgetary financing for Climate Change in Pakistan:

Along with the options available for financing through international and/or bilateral avenues, the country also needs to generate national budgetary funds for climate mitigation. This would, not only, evidence a strong national commitment towards low carbon development but also comfort international donors to support nationally prioritised activities.

In this regards, a short analysis[100] of the climate change (both mitigation and adaptation) related financing over the past two fiscal years (2007-2009) shows (Tables 23-25) that Pakistan is already allocating significant budgetary financing towards climate related projects. Collectively, in the two years the country initiated climate related projects amounting to approx. U$ 14.5 billion while allocating funds of U$ 1.5 billion from its national budget matched by foreign assistance of U$ 3 billion towards these projects in the two years. This is a clear evidence of the national commitment to climate change which, however, goes unrecognised at the international level.

Climate Change National Budgetary Financing[101]		
2008-2009		
Total Number of Projects	78	78
Total Cost	1006944.035	11.84 Billion U$
Total Allocation in 2008-2009	73236.611	0.86 Billion U$
Total Foreign Assistance	161305.664	1.89 Billion U$
2007-2008		
Total Number of Projects	68	68
Total Cost	233822.848	2.75 Billion U$
Total Allocation in 2008-2009	57780.514	0.67 Billion U$
Total Foreign Assistance	95337.118	1.12 Billion U$

Table 23: Climate Change National Budgetary Financing – 2007-2009

	Water and Power	Science and Technological Research	Environment	Ka & Na	Interior	Industries, Production & Special Initiatives	Higher Education Commission
Total Number of Projects	45	6	18	6	1	1	1
Total Cost	980527.359	717.212	14757.105	10856.845	7.03	39.68	38.804
Total Allocation in 08-09	70984.05	224.368	1153.896	828.723	1.344	20.01	24.22
Total Foreign Assistance	161301.764	0	3.9	0	0	0	0

Table 24: Sector wise Climate Change related Projects, 2008-2009 (Details in Annex-1)

	Water and Power	Science and Technological Research	Environment	Higher Education	Interior
Total Number of Projects	39	8	19	1	1
Total Cost	29235.116	787.367	20331.237	38.804	7.03
Total Allocation in 08-09	8943.718	257.47	821.589	10	1.137
Total Foreign Assistance	9690.47	0	973	0	0

Table – 25: Sector wise Climate Change related Projects, 2007-2008 (Details in Annex-2)

4.1.7 The Adaptation Fund:

The Adaptation Fund was established by the Parties to the Kyoto Protocol of the UN Framework Convention on Climate Change and remains the primary financial window for seeking financing of adaptation activities in developing countries. The nascent fund which is just beginning to establish its presence in the climate finance arena has got certain unique and innovative features which include the following:

- The vulnerable countries have been given the option of "directly accessing" this fund through specified and approved national institutions charged with implementing the projects (termed "National Implementing Entity or NIE) which are accredited by the Adaptation Fund Board. This allows the benefit of avoiding the usually high processing "fees" charged through the multilateral route. In this regards, the first such body - Le Centre de Suivie Écologique du Sénégal - was approved in April 2010 by the adaptation fund and followed up with awarding a project in Senegal to fight coastal erosion.
- The fund is primarily funded through an innovative source of funding - an adaptation levy on the share of proceeds (2% of CERs) of CDM projects while it is also open to other sources of funding. The fund is expected to raise U$450m by 2012 through this adaptation levy.
- It also has a unique governance structure based upon an "Adaptation Fund Board" with a majority of membership from developing countries. Other than that the Global Environment Facility (GEF) provides secretariat services to the AFB and the World Bank serves as trustee of the Adaptation Fund as interim institutional arrangements which will be reviewed in 2011.

As Pakistan braces to cope with its high and unavoidable climate vulnerability, this fund could serve as a major source for securing its future adaptation financing needs. Already the country has been one of the first to secure a project which addresses the risks of glacial lake outburst floods in Pakistan through the building of technical capacity building and awareness-raising.

However, Pakistan has not yet managed to set up a NIE and, thus, could not benefit from the "direct access" option for this particular project. It would be in the country's interest to fill this capacity void by scoping, identifying and finalizing the setup of an appropriate NIE as soon as possible to enhance the financial efficiency of accessing the adaptation fund.

Looking into the future, this independent adaptation fund could serve as one of the main mechanisms for distributing climate adaptation funding which should be a major part of the U$ 100 bn/year long term climate finance pledge made under the "Cancun Agreements".

Summarizing the above options, the Table-26 below enlists the possible climate finance options for Pakistan :

	Accessibility (Y = Yes / N = No)		
Priority Climate Finance instruments	**Mitigation**	**Adaptation**	**Present**
Clean Development Mechanism	**Y**	***N***	**Y**
REDD+	**Y**	***N***	***N***
Green Climate Fund	**Y**	**Y**	***N***
Bilateral Financing	**Y**	**Y**	**Y**
MDB financing	**Y**	**Y**	**Y**
Adaptation Fund	***N***	**Y**	**Y**
National Budgetary Allocations	**Y**	**Y**	**Y**

Table 26: Climate Finance options in Pakistan

4.2 Creating national assimilative capacity for climate finance:

Securing finance for climate change is a two way process which includes availability and access to finance as well as development of a national enabling environment which can facilitate and attract this financing.

The accessibility to the new climate finance, if and when it is available, will depend greatly upon the availability of assimilative capacity in developing countries like Pakistan. In this regards, the country needs to prepare for this future by creating a specialized **National Climate Change Fund (NCCF)** which can set up an institutional framework to deliver on the following objectives:

- Operate as a national body responsible for overseeing, coordinating and directing all funds for climate change related projects in the country
- Identify and channel all climate related budgetary allocations through a focused and dedicated window. As already indicated, the country is already spending considerable amounts for planned climate change related activities amounting to $4.5 billion (in two years 2007-2009) while also being subjected to forced climate costs such as those related to the U$ 9 billion in flood damages in 2010. The said fund will ensure due global recognition of such costs.
- Ensure that the climate funds are utilized in an efficient, equitable and transparent fashion
- Be tasked with development of projects targeted towards securing climate finance
- Create and oversee national entities required to secure direct access finance (a new mode of financing which by passes the multilateral development bank routes) such as the "National Implementing Entity (NIE)" required to secure funds under the "Adaptation Fund".

- Act as a catalyst in generating requisite resources for financing nationally appropriate mitigation actions as well as adaptation to climate change

This model has already been successfully applied in some developing countries like Indonesia and Bangladesh. In our region, India has managed to attract roughly US $ 2-3 billion of climate change funding. Similarly, Bangladesh has emerged as another important destination of climate change finance after it created a green fund with seed money of only US $ 20 million. The Bangladeshi Fund has now grown to US $ 250 million and expected to grow even further.

Such a platform will allow Pakistan to not only focus its domestic efforts but also demonstrate a national commitment to tackling climate change while, most importantly, acting as a vehicle for catalyzing matched financing from climate donors as well as the new specialized funds being launched at the international level both in the public as well as private sectors.

Announcing of such a fund needs to be on the “high priority” list of the Government of Pakistan and it should rapidly follow up the announcement with a detailed design of the institutional and operational framework of the said fund including elements such as the Board of Governors, appointing a trustee and a national secretariat.

5. Concluding remarks and further work required:

Pakistan is a developing country bracing for significant economic growth and development in the future. In this regards, the country is poised to shift towards an increased reliance upon its indigenous coal reserves to fuel its development in the 2010-2050 time frame. Although this will significantly raise its projected greenhouse gas emissions, the present study has identified numerous measures which can be taken to shift this future development pathway on to a lower carbon and more climate friendly trajectory.

The country, however, requires this shift to be supported through the access and transfer of appropriate technologies and finance. The ensuing “additional” financial needs for mitigation for a cleaner development future range from between U$ 8 billion and U$ 17 billion. These have been identified in this report along with a potential of 18% and 40% reduction of emissions between below “Business As Usual” scenario which is possible with a shift towards cleaner technologies. These clean development investments, however, need to be made in the near future as otherwise the energy future of Pakistan will get locked into the lower cost - higher carbon options.

This mitigation costing estimate will, however, need to be refined and focused further as Pakistan identifies not only the specific technologies that it needs for this low carbon shift (through carrying out the “Technology Needs Assessment”) but also the programmatic, sectoral as well as project specific NAMAs (Nationally Appropriate Mitigation Actions) in the near future.

Pakistan is also highly vulnerable to the impacts of climate change and faces immense associated challenges in coping with its unavoidable effects and economic implications. This study has highlighted the need to treat adaptation to climate change as a primary development issue for Pakistan.

The potential impacts and sectors demanding prioritized adaptation have been identified in this study and the, associated, costs of adaptation have been estimated utilizing three diverse modeling methodologies – using GDP projections, per-capita figures and "flood" disaster modeling. The resulting adaptation cost figures range from between U$ 6 billion to U$ 14 billion/year that Pakistan would have to spend at an average in the 2010-2050 time frame to cope with the effects of climate change while it will be also left to, unavoidably, bear significant "residual damage" costs induced due to climate change. The top-down adaptation costing analysis applied in this report is aimed at providing a reasonable first approximation that can be refined over time as relevant and reliable local data becomes available especially from research focusing on sector specific adaptation costing.

Most significantly the report reinforces the fact that the issue of climate change is, thus, not only an environmental issue challenging the country but an issue which will directly impinge upon the country's economic, financial and development future as it deals with its extreme vulnerability to climate change. The significant climate costs identified in this study inextricably shows that climate change is an issue which Pakistan can ill afford to ignore in the future.

Finally the report has identified the major financing options available for climate change related activities in Pakistan as well as the significant unilateral climate resources, U$ 4.5 billion in 2007-2009 alone, that the country is already committing to climate change without getting any global recognition for its efforts. In future, global financing will need to augment and leverage such national financial commitments. Also, as climate finance becomes increasingly available at the global level, it would be essential to enact appropriate assimilative national capacity in Pakistan to direct this finance towards nationally identified priorities as well as channelize it transparently and efficiently through consolidated financial mechanisms like a National Climate Change Fund which has been proposed through this study.

Summarizing the above, the following work-plan is recommended as a follow up to the current study:

a. Sector based "bottom up" adaptation costing studies

b. Assistance for the establishment of assimilative capacity for climate finance in the country including the following on a priority basis :

    i. Selection and establishment of a National Implementing Entity (NIE) for "direct access" to the Adaptation fund.

    ii. Setting up of a "National Climate Change Fund" in Pakistan

c. Enhancing the local capacity adept at climate relevant data compilation and conversant with the latest carbon accounting procedures for both mitigation as well as adaptation sectors.

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Annexes

Annex-1

Mitigation costing/investment requirements model

Reference, working and assumptions used are given below:

Key Reference: Ghosh, D., P. R. Shukla, A. Garg and P. Venkata (2002) Renewable energy technologies for the Indian power sector: mitigation potential and operational strategies. Renewable and Sustainable Energy Reviews. Volume 6, Issue 6, December 2002, Pages 481-512.

Sector-specific Investment Requirement 2010 prices (Rs. Billion)

	2010	2010..	…..2049	2050
Agriculture	191.3	154	4403	4753
Mining	144.5	117	3326	3590
Manufacturing	356.7	288	8210	8863
Construction	44.1	36	1015	1096
Electricity & Gas	81.1	65	1867	2015
Transport & Communications	370	299	8516	9193
Services	595	480	13690	14778
Total Investment	1782	1439	41027	44288
Investment to GDP Ratio	12	9.5	24.5	24.7
Total GDP Rs Billion	14668	15079	167474	179593
Total GDP Growth	4.1	2.8	7.2	7.2
ICOR	3.4	3.4	3.4	3.4

**For 2010 source is economic survey of Pakistan*

Assumption Scenario 1: Clean coal + 5% RE + clean transport

Technology assumption: Capital per unit of output increases by 4 basis points through out the projected period (Ghosh 2002)

Price of per unit of capital held constant at 2010 prices

Discount factor held constant at 2010 prices

Exchange rate @ Rs. 85

Scenairo 2: Clean coal + 15% RE + clean transport

Technology assumption: Capital per unit of output increases by 8.15 basis points through out the projected period (Ghosh 2002)

Price of per unit of capital held constant at 2010 prices

Discount factor held constant at 2010 prices

Exchange rate @ Rs. 85

ICOR reference and their proportionality with greener technologies in:

1 G20 Conference Proceedings on Sustainable and Equitable Recovery
2 Abanto (2003) Country Chapter on Philipines - Investing towards environmental protection
3 Planning Commission's Material Balancing Reports

Annex-2

Sector wise Climate Change related Projects 2008-2009

	Water and Power	Science and Technological Research	Environment	Ka & Na	Interior	Industries, Production & Special Initiatives	Higher Education Commission
Total Number of Projects	45	6	18	6	1	1	1
Total Cost	980527.359	717.212	14757.105	10856.845	7.03	39.68	38.804
Total Allocation in 08-09	70984.05	224.368	1153.896	828.723	1.344	20.01	24.22
Total Foreign Assistance	161301.764	0	3.9	0	0	0	0

Project	Cost/Investment			Department
	Total Cost	Allocation	Foreign	
1. National Awareness Campaign on Energy Efficiency and Environment Protection	38.97	10.000		Environment Division
2. Strengthening of Forest Products Research at Pakistan Forest Institute, Peshawar	39.250	3.828		Environment Division
3. Environmental Rehabilitation through Improvement/ Promotion of Indigenous Tree Species in south AJK	39.000	8.882		Environment Division
4. Rehabilitation of Denuded Forest Area Through Sowing and Planning and Development of Farm/Social Forestry with Community Participation in Northern Area	125.000	23.695		Environment Division
5. Upgrading and Reconstruction of PFI Field Station Shinkiari for Forestry Research, Education and Training	141.671	14.10	3.900	Environment Division
6. Establishment of CDM Cell	38.935	10.853		Environment Division
7. Development of Forestry Sector Resources for Carbon Sequestration in Punjab (5 years]	3678.660	255.128		Environment Division
8. Development of Forestry Sector Resources for Carbon Sequestration in	1663.043	103.364		Environment Division

AJK (5 years)				
9. Development of Forestry Sector Resources for Carbon Sequestration in Sindh (3 years)	1483.000	150.000		Environment Division
10. Development of Forestry Sector Resources for Carbon Sequestration in Balochistan (5 years)	1664.657	175.000		Environment Division
11. Development of Forestry Sector Resources for Carbon Sequestration in NWFP (6 years)	3003.766	191.000		Environment Division
12. Multi Sectoral Mega Project for Conservation of Juniper Forests [5 years]	493.166	97.000		Environment Division
Project	**Cost/Investment**			**Department**
	Total Cost	**Allocation**	**Foreign**	
13. Conversion of Polythene Bags, Wastes Tyres, Waste Rubbers/Plastics to Light Fuel Oil (Diesel) through Microwave Technology	454.530	10.000		Environment Division
14. Rachna Doab Afforestation (Phase-II)	212.182	52.042		Environment Division
15. Conservation and Rehabilitation of Indus Delta Mangroves for Sustainable Management	39.400	6.120		Environment Division
16. Development of Forest Resources for Carbon Sequestration in FATA	1439.875	39.884		Environment Division
17. Feasibility Study (PC-II) regarding Conversion of Polythene Bags Waste Tyres, Waste Rubbers/ Plastics to Light Fuel Oil (Diesel) through Microwave Technology	2.000	2.000		Environment Division
Project	**Cost/Investment**			**Department**
	Total	**Allocation**	**Foreign**	
18. Media Advertising Campaign on Energy Conservation & Institutional Strengthening / Capacity Building of ENERCON	200.000	1.000		Environment Division
19. Raising of Mangla Dam	62553.000	18000.000		Water and Power
20. Mirani Dam	5861.000	300.000		Water and Power

21. Resettlement Action Plan - Mirani Dam	1243.94	50.000		Water and Power
22. Sabakzai Dam	1576.550	0 120.000		Water and Power
23. Kurram Tangi Dam	17205.266	500.000	5368.22	Water and Power
24. Satpara Multipurpose Dam	2090.431	100.000	195.78	Water and Power
25. Gomal Zam Dam	12829.000	2000.000	4964.000	Water and Power
26. Feasibility Studies of Dams (Naulong, Hingol), Balochistan	161.680		20.00	Water and Power
27. Const. of Delay Action Dams Ground Water recharge of Pishin Quetta Mastung & Mangocher Valleys	1099.833	200.000		Water and Power
28. Construction of 10 Delay Action Dams, Balochistan	2154.000	10.00		Water and Power
29. Construction of 20 small Dams in NWFP	3600.000	500.000		Water and Power
30. Feasibility study of small Dams in NWFP	97.000	29.750	39.250	Water and Power
31. Naigaj Dam, Dadu Sindh	115.02	30.000	84.770	Water and Power
32. Construction of Snam/Pali & Kundal Dam, NWFP	441.02	0 100.000	00 85.00	Water and Power
33. Akhori Dam Project, PC-II, District Attock	817.157	50.000		Water and Power
34. Dams (Small & Large)	15000.000	10000.000		Water and Power
35. Re-construction of Shadi Kour Dam, District Gwadar	300.000	10.00		Water and Power
36. Construction of Porali Dam, District Lasbela, Balochistan	5000.000	5.000		Water and Power

Project	Cost/Investment			Department
	Total	Allocation	Foreign	
37. Engineering Design and Feasibility Study for Munda Dam	652.000	80.00		Water and Power
38. Bhasha Diamer Dam Project Near Chilas District Diamer/Kohistan	1677.420	417.00	98.230	Water and Power

39. Golan Gol Hydro Power Project, Chitral, NWFP	7035.130	700.000	2638.120	Water and Power
40. Khan-Khawar Hydro Power Project, Shangla, Besham, NWFP (Abu Dhabi Fund)	5362.705	1175.00	2644.098	Water and Power
41. Allai Khawar Hydro Power Project, Batagram, Besham, NWFP (Abu Dhabi Fund)	8577.82	2535.00	3453.54	Water and Power
42. Dubir Khawar Hydro Power Project, Kohistan, NWFP (Abu Dhabi Fund)	9754.260	3500.00	4147.510	Water and Power
43. Jinnah Hydro Power Project, Mianwali, Punjab	13546.800	1940.00	6608.221 5	Water and Power
44. Neelum Jhelum Hydropower Project, AJ	84502.260	7500.000	46667.70	Water and Power
45. Bunji Hydro Power Project	832.716	325.00	232.733	Water and Power
46. Phander Hydro Power Project, Northern Area	120.376	80.00		Water and Power
47. Dasu Hydro Power Project, Kohistan NWFP	796.876	132.00	100.000	Water and Power
48. Lawi Hydro Power Project Chitral, NWF	90.585	50.00		Water and Power
49. Keyal Khawar Hydro Power Project, NWF	7066.961	10.00	3032.08	Water and Power
50. Kohala Hydro Power Project	545.732	175.000	209.199	Water and Power
51. Basho Hydro Power Project	91.243	40.000		Water and Power
52. 800 MW Guddu Steam Power Project	44750.460	5000.000	35435.000	Water and Power
53. 330 MW Combined Cycle Dadu Power Project	29038.000	4000.000	18215.570	Water and Power
54. 500 MW Combined Cycle Power Plant	18050.000	5000.000	11921.250	Water and Power
55. 425 MW Combined Cycle Nandipur Power Plant	22335.000	5000.000	14198.000	Water and Power
56. Transmission Arrangements for Power Dispersal of Ghazi Barotha	14127.000	1000.000	6990.000	Water and Power
57. Rehabilitation of Jaban Hydro Electric Power Station	1037.552	275.000	573.714	Water and Power
58. Feasibility Study for Dispersal of Power from Large Hydro Projects	281.000	50.000	73.000	Water and Power

59. Bhasha - Diameer	578000.000	200.000		Water and Power
60. Solar Thermal Power Plants Technologies (Demonstration Units)	39.080	2.350		Water and Power
61. Solar Water Pumping & Desalination Unit	31.810	2.860		Water and Power
62. Pilot Project of Production Plant of Biodiesel	20.190	2.290		Water and Power
63. Pilot Project for Development & Installation of 2 Micro Hydro Kaplan Turbines (Revised)	19.486	7.800		Water and Power
64. Energy Efficiency for Textile Center in Pakistan	39.680	20.010		Industries, Production & Special Initiatives Division
65. Establishment of Forest Nurseries and Block Afforestation in ICT	7.030	1.344		Interior Division
66. 4.8 Battar Hydel Power Project (AJK)	760.403	150.000		Ka & Na Division
67. 1.7 MW Dhannan Hydro Power Project (AJK)	297.254	297.254		Ka & Na Division
68. 43.5MW Jagran Hydro Power Project (AJK)	5356.310	100.000		Ka & Na Division
69. 14.4 Jhing Hydro Power Project (AJK)	1750.689	150.000		Ka & Na Division
70. 16 MW Hydro Power Project, Nultar - III	1279.399	72.217		Ka & Na Division
71. 14 MW Hydro Power Project Nultar - IV	1412.790	59.252		Ka & Na Division
72. Extensive Wind Energy Potential Survey of Northern Areas of the Country, Pak Met Deptt Islamabad	39.100	8.615		Science & Technological Research Division
73. Electrification of Mosques & Schools in Remote Rural Areas through Solar Energy	28.580	3.000		Science & Technological Research Division
74. Up gradation of Facilities to Produce Silicon Solar Modules upto 80 KW, PCRET	262.040	95.214		Science & Technological Research Division
75. Development and Promotion of Biogas Technology for Meeting Domestic Fuel Needs of Rural Areas & Production of Bio-Fertilizer.	89.210	29.210		Science & Technological Research Division

76. Production of Bioenergy from Plant Biomass	260.329	80.329		Science & Technological Research Division
77. Development of Organic Semiconductors and Solar Cells, PCRET.	37.953	8.000		Science & Technological Research Division
78. Establishment of Renewable Energy Research and Development Centre, University of Engg. & Tech; Taxila.	38.804	24.220		Higher Education Commission

Annex-3 :

Sector wise Climate Change related Projects 2007-2008

	Water and Power	Science and Technological Research	Environment	Higher Education	Interior
Total Number of Projects	39	8	19	1	1
Total Cost	29235.116	787.367	20331.237	38.804	7.03
Total Allocation in 08-09	8943.718	257.47	821.589	10	1.137
Total Foreign Assistance	9690.47	0	973	0	0

Project	Cost/Investment			Department
	Total Cost	Allocation	Foreign	
79. Raising of Mangla Dam	62 553.00	20000.00	9678	Water and Power
80. Mirani Dam	5861.0	500.0		Water and Power
81. Sabakzai Dam	1576.55	200.0		Water and Power
82. Kurram Tangi Dam	17205.266	2847.000	5368.222	Water and Power
83. Satpara Multipurpose Dam	2090.431	900.000	195.786	Water and Power
84. Gomal Zam Dam	12829.000	1800.000	4964.000	Water and Power
85. Feasibility Studies of Dams (Naulong, Hingol, Winder & Sukhlegi Rohta), Balochistan	233.745			Water and Power
86. Hydrogeological Investigation in Nowsher	66.617	44.000		Water and Power
87. Construction of 20 small Dams in NWF	3600.0	81.710		Water and Power
88. Restoration of Bolan Dam District Kachhi, Balochista	436.500	170.000		Water and Power
89. Re-construction of Shadi Kour Dam, District Gwadar	300.000	200.000		Water and Power
90. Nawa Bathoza dam District Qilla Saifulla	2351.980	50.000		Water and Power
91. Construction of 10 Delay Action Dams, Balochistan	831.000	160.000		Water and Power
92. Construction of 20 small Dams in NWFP	3600.000	870.000		Water and Power
93. Feasibility study of small Dams in NWFP	97.000	30.000		Water and Power
94. Construction of Snam/Pali & Kundal Dam, NWFP	481.645	440.770	10.000	Water and Power
95. Feasibility Study of Increasing apacity of	25.000	8.000		Water and Power

Baran Dam by raising dam height & construction of Tochi Baran				
96. Bhasha Diamer Dam Project Near Chilas District Diamer/Kohistan (NWFP/ N.	1677.420	500.000	98.230	Water and Power
97. Golan Gol Hydro Power Project, Chitral, NWFP	7035.130	2638.120	450.000	Water and Power
98. Khan-Khawar Hydro Power Project, Shangla, Besham, NWFP (Abu Dhabi Fund)	5362.710	1300.000	2644.10 0	Water and Power
99. Allai Khawar Hydro Power Project, Batagram, Besham, NWFP (Abu Dhabi Fund)	8577.820	1600.000	3453.54 0	Water and Power
100. Dubir Khawar Hydro Power Project, Kohistan, NWFP (Ab	9754.26	2100.000	4147.51 0	Water and Power
101. Jinnah Hydro Power Project, Mianwali, Punjab	13546.800	825.000	6808.22 0	Water and Power
102. Neelum Jhelum Hydropower Project, AJK	84502.260	10000.000	46667.7 0	Water and Power

Project	Cost/Investment			Department
	Total Cost	Allocation	Foreign	
103. Bunji Hydro Power Project	493.690	300.000	88.34	Water and Power
104. Dasu Hydro Power Project, Kohistan NWF	796.880	172.000	100.000	Water and Power
105. Lawi Hydro Power Project Chitral, NWF	90.590	10.000		Water and Power
106. Keyal Khawar Hydro Power Project, NWF	7066.96 0	10.000	3032.080	Water and Power
107. Spat Gah Hydro Power Project Kohistan, NWF	177.770	10.000		Water and Power
108. Kohala Hydro Power Project	545.000	245.000		Water and Power
109. Basho Hydro Power Project	91.243	61.243		Water and Power
110. Feasibility Study for Hydel Power Potential Sites in AJK	100.000	25.000		Water and Power
111. Transmission Arrangements for Power Dispersal of Ghazi Barotha ,(ADB, Kuwait	14127.0 00	6990.000	1679.490	Water and Power
112. Muzaffargarh-Gatti 500 KV	6771.00 0	1500.000	4975.000	Water and Power
113. Solar Homes Programme per P i	50.350	0.745		Water and Power
114. Research on Development of 1 KW Fuel Cell Vehicle in	4.030	1.525		Water and Power
115. Solar Thermal Power Plants Technologies (Demonstration	39.800	12.910		Water and Power
116. Solar Water Pumping & Desalination Unit	33.040	10.260		Water and Power
117. Pilot Project of Production Plant of Biodiesel	21.430	3.560		Water and Power
118. National Awareness Campaign on Energy	39.150	13.112		Environment

Efficiency and Environment Protection				
119. Forestry Sector Research and Development Projet	193.500	27.955		Environment
120. Establishment of Environmental Monitoring System in Pakistan (Japan & GoP).	1098.200	203.824	973.000	Environment
121. Strengthening of Forest Products Research at Pakistan Forest Institute, Peshawar	39.250	3.828		Environment
122. Environmental Rehabilitation through Improvement/ Promotion of Indigenous Trees	39.000	8.536		Environment
123. Improvement of Urban Environment of Rawalpindi through Amenity Forestry	12.200	5.463		Environment
124. Rehabilitation of Denuded Forest Area Through Sowing and Planning and Development of Farm/Social Forestry with Community Participation	125.000	26.230		Environment
125. Upgrading and Reconstruction of PFI Field Station Shinkiari for Forestry Research, Education	141.000	51.057	3.900	Environment
126. Establishment of CDM Cell	38.943	11.189		Environment

Project	Cost/Investment			Department
	Total cost	Allocation	Foreign Loan	
127. Development of Forestry Sector Resources for Carbon Sequestration in Punjab	4362.620	170.000		Environment
128. Development of Forestry Sector Resources for Carbon Sequestration in AJK (5 years)	3949.174	60.000		Environment
129. Development of Forestry Sector Resources for Carbon Sequestration in Sindh (3 years)	1548.384	50.000		Environment
130. Development of Forestry Sector Resources for Carbon Sequestration in Balochistan [5 years]	1404.889	30.000		Environment
131. Development of Forestry Sector Resources for Carbon Sequestration in NWFP [6 years]	3022.766	70.000		Environment
132. Multi Sectoral Mega Project for Conservation of Juniper Forests	1098.486	20.000		Environment
133. Extension in ENERCON Building [2 years]	127.843	72.100		Environment
134. Conversion of Municipal Solid Waste into Energy and Fertilizer (3 years)	2888.480	45.000		Environment
135. Conversion of Polythene Bags, Wastes Tyres, Waste Rubbers/Plastics to Light Fuel Oil (Diesel) through Microwave Technology	381.265	22.24		Environment
136. Electrification of Mosques & Schools in Remote Rural Areas through Solar Energy	28.580	4.530		Environment

137. Development of Low Power High Intensity Solar Lights	6.770	1.140		Science and Technology
138. Upgradation of facilities to produce Silicon Solar Modules upto 80 KW, PCRET	183.989	96.000		Science and Technology
139. Provision of Electricity to Earth quake effected areas through installation 100 Micro Hydel	132.256	46.000		Science and Technology
140. Development and Promotion of Biogas Technology for Meeting Domestic Fuel Needs of Rural Areas & Production of Bio-gas	89.210	50.000		Science and Technology
141. Development & Demonstration of Energy Efficient, Environment Friendly and Earth quake Research Low Cost Houses	2.000	1.330		Science and Technology
142. Production of Bioenergy from Plant Biomass	295.500	50.000		Science and Technology
143. Wind Mapping for Assessing Power Generation Potential for the Province of Balochistan [unapproved]	39.000	5.000		Science and Technology
144. Establishment of Bio Energy Laboratory, PCRET [unapproved]	38.642	8.000		Science and Technology
145. Establishment of Forest Nurseries and Block	7.030	1.137		Interior
146. Establishment of Renewable Energy Research and Development Centre, University	38.804	10.000		Higher Education

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[5] Ibid

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[58] 2009/10, Ministry of Environment/WWF project for “District wise forestry cover assessment of Pakistan.

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[64] Broad investment quotients are those not derived rigorously from any model but reached through focal group discussion with relevant people or any external studies. In our case it is a combination of both. Pakistan has no data/census on sector-wise stock of physical capital. Hence explicit imputation in a model is not possible.

[65] Kindly note that ICOR value changes with type of capital project with a lower ICOR represents higher efficiency in production function. One would assume ICOR getting lower as the future path moves from medium to longer term horizon. However, a constant figure has been used for this analysis.

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[71] "Incremental'' implies the marginal effect or the absolute cost of coal (fuel) per hour.

[72]This working comes from the portal: "Carbon dioxide emissions from the generation of electric power in the united states" given at http://www.eia.doe.gov/electricity/page/co2_report/co2report.html

[73] The detailed algorithm for the said calculation is given below:

a. 5000mw * monetary value of coal /mw-hr ($66)= $ 330,000
b. $330,000 * daily run time (24 hours) = $7920000
c. $7920000 * annual run time (365 days) = $$2.89 billion
d. If plant is coal fired then 1900 pounds emission per mw-hr, emissions for the total deficit of 5000 mw = 9500000
e. Emission for 5000 mw in co2mt = 4309.2

[74] This is a variable cost as it does not include the fixed cost of machinery

[75] "Pakistan Floods, Preliminary Damage and Needs Assessment", ADB / Government of Pakistan document, November 2010, Islamabad, Pakistan. Note that overall costs are presented as a range since reconstruction cost has multiple options

[76] World Bank (2006)

[77] CICERO Report 2000:2, "Developing Strategies for Climate Change: The UNEP Country Studies on Climate Change Impacts and Adaptations Assessment "Karen O'Brien, editor, July 2000. UNEP publication.

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[83] Parry, Martin etc, "Assessing the costs of adaptation to climate change", IIED publication, 2009, United Kingdom.

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[87] Afghanistan 12m; BD 156 m; Bhutan .649 million, Maldives .30 m, Pakistan 159 million and India 1.1 billion

[88] CDKN Policy Brief" Regional Implications for Latin American and Carribbean " quotes per capita cost of adaptation based on World Bank study of 2009.

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[91] World Bank , 2009 estimates that cost of addressing Malaria and Diarrhea in South Asia to be around US $ 850 million.

[92] IPCC (2007) (Afghanistan 12m; BD 156 m; Bhutan .649 million, Maldives .30 m, Pakistan 159 million and India 1.1 billion)

[93] Source: "EM-DAT: The OFDA/CRED International Disaster Database at www.em-dat.net - Université Catholique de Louvain - Brussels - Belgium", November 2010

[94] Parry, Martin etc, "Assessing the costs of adaptation to climate change", IIED publication, 2009, United Kingdom.

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[97] These come from Australia (USD 120m), Denmark (USD 10m (2010 only)), Finland (USD 21m), France (USD 330m), Germany (at least USD 438m), Japan (USD 500m), Norway (at least USD 1,000m), Slovenia (USD 2.5m), Spain (USD 27m), Sweden (USD 63m), United Kingdom (USD 450m) and the United States (USD 1,000m). An exchange rate of 1.24 USD/EUR has been used. Some of these pledges include loans as well as grants. More details will be made available through the emerging REDD+ database

[98] Angola, Argentina, Australia, Belgium, Brazil, Burundi, Cambodia, Cameroon, Canada, Central African Republic, Chad, China, Colombia, Costa Rica, Democratic Republic of Congo, Denmark, Dominican Republic, Ecuador, Equatorial Guinea, Finland, France, Gabon, Germany, Ghana, Guyana, India, Indonesia, Italy, Japan, Kenya, Laos, Malaysia, Mali, Mexico, Nepal, the Netherlands, Nigeria, Norway, Panama, Papua New Guinea, Peru, Philippines, Republic of Congo, Rwanda, Sao Tomé and Principe, Singapore, Slovenia, South Africa, South Korea, Spain, Sweden, Switzerland, Thailand, Togo, Uganda, United Kingdom, United States and Vietnam.

[99] The project would involve an investment of $6.5 billion and wind power projects of 1,000MW each would be set up in Punjab and Sindh. A 200MW solar power project would be set up in Punjab and another of 100MW in Sindh. MOU signed during visit of Chinese premier Wen Jiabao's visit to Pakistan in December 2010. www.dawn.com/2010/12/21/china-to-transfer-solar-power-technology-2.html

[100] This is an indicative but conservative figure which may be under-estimated as the actual national climate change related funding will also need to consider provincial budgetary allocations as well as the forced adaptation costs for climate disaster events (such as the 2010 flood damage assessment) have not been considered in this figure.

[101] Kindly note that all figures are in million rupees and allocation entails the budget allocated for that project in that year alone. Source : PSDP (Public Sector Development Program) documents available at Planning Commission of Pakistan's website