

What is Climate Change Adaptation?

In the past centuries and millennia, there have always been warmer or colder periods on earth but never has there been such a fast warming of the planet as we have experienced it in the last 100 years. The rapid warming of our planet is caused by the increase of greenhouse gases in the atmosphere. Since the late 1800's, gases like carbon dioxide and methane have accumulated high up in the atmosphere. Some of the sun light that hits the surface of our earth is transformed into heat that reflects back into space. Before, when there was a low concentration of greenhouse gases in the atmosphere, more of the heat was able to escape into space. But now, the greenhouse gases reflect larger parts of the heat back on earth, thereby increasing the temperature globally. The gases act like glass or plastic cover of a greenhouse that trap heat inside.

As per IPCC, Climate Change refers to a statistically significant variation in either the mean state of the climate or in its variability, persisting for an extended period (typically decades or longer). Climate change may be due to natural internal processes or external forcings, or to persistent anthropogenic changes in the composition of the atmosphere or in land use. The Framework Convention on Climate Change (UNFCCC), in its Article 1, defines climate change as: a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods. The UNFCCC thus makes a distinction between climate change attributable to human activities altering the atmospheric composition, and climate variability attributable to natural causes.

Where do Greenhouse Gases Come From?

Greenhouse gases (GHG) occur naturally, but human activities have caused a high increase in their concentration. Greenhouse gases are those gaseous constituents of the atmosphere, both natural and anthropogenic, that absorb and emit radiation at specific wavelengths within the spectrum of infrared radiation emitted by the Earth's surface, the atmosphere and clouds. This property causes the greenhouse effect. Water vapour (H₂O), carbon dioxide (CO₂), nitrous oxide (N₂O), methane (CH₄) and ozone (O₃) are the primary greenhouse gases in the Earth's atmosphere. Moreover there are a number of entirely human-made greenhouse gases in the atmosphere, such as the halocarbons and other chlorine and bromine containing substances, dealt with under the Montreal Protocol. Beside CO₂, N₂O and CH₄, the Kyoto Protocol deals with the greenhouse gases sulphur hexafluoride (SF₆), hydrofluorocarbons (HFCs) and perfluorocarbons (PFCs).

The main sources of greenhouse gas emissions are:

- **Energy supply:** When producing electricity by burning fossil fuel such as coal, natural gas or oil, GHG are emitted into the atmosphere.
- **Industry:** Many industrial processes require heat or electricity that is taken from fossil fuels.

- **Transport:** Cars, planes and trains usually run on burning of fossil fuels thereby producing greenhouse gases.
- **Deforestation:** Trees and soil store a lot of carbon and hence if trees are burnt or cut down, some of that carbon is released into the atmosphere as carbon dioxide, which is a greenhouse gas.
- **Agriculture:** The production of fertilizers and their use is often greenhouse-gas intense. Intensive animal husbandry significantly contributes to greenhouse gas concentrations as well. Flooded rice fields and the bacterial processes that take place in and above the flooded soil are also a source of greenhouse gases.
- **Waste:** Includes methane emission from solid waste, methane and nitrous oxide from waste water handling and emission from waste incineration.
- **Buildings:** The residential and commercial building are another source of GHGs due to energy and fuel consumption for heating, cooking, lighting, refrigeration etc.

What is the Difference Between Weather and Climate?

Weather is the actual state of atmosphere in a particular area, as perceived daily with a regard to temperature, rainfall, wind etc. Weather is what one sees and experience every day.

Climate can be seen as the average weather condition over a longer period of time. It is the characteristic progression of weather in a given geographical area over a longer term. Climate is the status of the climate system with a statistical description of the weather in the form of average values and the variability of relevant parameters over a period of time. These parameters are mainly surface values, such as temperature, rainfall and wind.

Climate variability refers to the variations in the mean state of the climate. Variability is generally a natural feature of a climate system. This means that sometimes summers will be hotter and sometimes they will be colder. It is projected that the variability of the climate will increase.

An extreme weather event is an event that is rare for a given area during a given time of the year. Single extreme weather events cannot be directly attributed to climate change as their genesis is so complex that it cannot be shown if they were caused by climate change. However, the increase in the number of extreme weather events in recent years can be related to climate change. Extreme weather events are events such as intense rainfalls, heat waves, storms or cyclones. While tsunamis have similar impacts as some extreme weather events (e.g. cause flooding), it cannot be considered a weather event.

What is Climate Change Mitigation and Adaptation?

There are two key terms related to climate change, viz. adaptation and mitigation. The difference between climate change mitigation and climate change adaptation is described below.

- **Adaptation:** Adjustments in natural or human systems in response to actual or expected climate change impacts, which cause moderate harm or exploit beneficial opportunities, i.e. activities that enable businesses and communities to become more resilient to the impacts of climate change (such as developing new water-treatment technologies for drought-prone areas, installing flood defences, conducting a supply chain vulnerability assessment, etc.).

Adaptation is defined as the adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities (IPCC). Adaptation is the process through which people reduce the adverse effects of climate and adaptation measures are meant to protect a community against projected climate change impacts.

- **Mitigation:** A human intervention to reduce the sources or enhance the sinks of greenhouse gases, for example, reducing the carbon footprint of business operations by cleaner fuels, reducing electricity consumption, etc.

Adaptation to climate change at the needed scale and scope requires a coordinated, multi-sectoral, global effort. So far, governments and civil society organizations have been largely leading such effort. The private sector will be a pivotal player in this process.

The private sector is relatively a newcomer when it comes to climate change adaptation, although many companies have been active in the field of environmental management and climate change mitigation. Businesses that are concerned about climate change have been more focused on reducing their GHG emissions to mitigate climate change rather than responding to current and evolving climate change risks and impacts.

Most companies have not yet begun to understand how climate change will affect their operations and profitability. It is likely to affect all companies - large and small - and some will be affected more than others. It is thus beneficial in the business interest of the companies to engage themselves on the issue of climate change adaptation.

Industries and business houses should recognize that the physical, economic and social impacts of climate change translate into concrete business risks that must be assessed and managed through targeted adaptation measures. Moreover, healthy and resilient environment and workforce has a direct effect on the businesses and its profitability.

Why is Climate Change Adaptation Necessary?

Global temperatures are rising with serious implications for other physical and biological systems. The human impact on climate change is comparatively a subject of recent attention. Most of the climate change science is focusing on the long-term physical effects.

People across the nations will be affected by climate change in one way or other. It will have disproportionate impacts on poor communities in developing countries due to their higher reliance on natural resources and living close to natural setting. Further, poor communities lack access to crucial assets and financial savings that provide a necessary buffer when faced with these crises. The problem is added due to hazards risks from geographical disadvantages and lack of adequate infrastructure.

The challenges that communities in developing countries face as a result of climate change such as more frequent and intense storms, water scarcity, declining agricultural productivity and deprived health, will also present serious challenges for businesses. Community risks are inevitably the risks for business. Both local and global companies depend on community members as suppliers, customers and employees. Businesses also depend on local resources, services and infrastructure for their operations. It is difficult to separate community well-being from business' viability and in turn the overall economic growth of a nation.

Anticipated impacts on communities include:

- Water shortages and droughts.
- Increased frequency and severity of floods.
- More unpredictable weather patterns.
- More frequent and intense storms and weather-related disasters.
- Decreased agricultural productivity and rising food insecurity.
- Public health problems.

While there is some uncertainty about the exact nature, timing, location and magnitude of climate impacts, many of them have already started happening, and they will be worsened and accompanied by new threats. Such impacts affect not only the human well being but also obstruct sustainable economic development.

Projected climate variability in directly climate-sensitive sectors that cater to basic needs like agriculture, water management and energy provision will impact both the economy and the entire population. These and other sectors that directly affect the livelihoods of the population, including housing, waste and sanitation and healthcare. These sectors need to integrate climate change adaptation considerations into their further development. This includes the physical infrastructure, their location, processes and value chains, as well as products and services offered and their price structure.

Impacts on Industries

Climate change impacts on businesses can be classified into direct impacts, e.g. through weather events and change of temperatures, and indirect impacts, for example due to changed inputs and market demand. Climate change impacts on businesses include those related to reduced water and energy supply, impacts on infrastructure such as roads, which affect supply chain logistics and the accessibility and cost of resources. Such impacts are not only relevant for the viability and continuity of businesses, but also affect direct and indirect stakeholders, such as employees and communities.

Climate Change Risks in Various Industry Sectors

Business sector	Expected Risks	Concerns
Agriculture, Food & Beverage	<ul style="list-style-type: none"> • Water scarcity • Crop damage due to weather extremes • Increased exposure to new pests and disease • Transportation problems 	<ul style="list-style-type: none"> • Water scarcity is primary vulnerability • Impact of climate change on agricultural products is increasing
Agriculture, Food & Beverage	<ul style="list-style-type: none"> • Reputational risk • Physical risk due to extreme weather events • Peak demand could outstrip capacity • Hot weather may reduce efficiency of extraction 	<ul style="list-style-type: none"> • Climate change risk includes potential physical damage to personnel and equipment, and potential disruption of the production activities of offshore installations • Significant climate from one year to another can cause substantial variations in the balance of supply and demand for electricity and gas • Water shortages can reduce hydroelectric power production

Business sector	Expected Risks	Concerns
Manufacturing & Consumer Goods	Higher prices of raw materials Higher energy prices Anticipated changes in customer preferences Supply chain disruptions	<ul style="list-style-type: none"> • Dramatically rising energy prices will have a negative impact on the operating costs of companies • Reduced availability, supply and quality of raw materials is a concern • Industry could face a production bottleneck due to a functional failure in supply chain
Banking & Finance	<ul style="list-style-type: none"> • Macroeconomic downturn hurts volume • Customer defaults in retail sector • Uninsured damage to project assets • Exposure to indirect risks through investment portfolio 	<ul style="list-style-type: none"> • Certain agricultural products might be affected by the intensification of droughts...it is necessary to put climate impacts into monetary terms to "wake up" the banking system • Climate change changes our risk profile for certain sectors that we lend to and thus our lending "appetite" within those sectors
Construction & Building Materials	<ul style="list-style-type: none"> • Changes in building codes and regulations • Reduced worker productivity due to heat • Disruptions in delivery of materials • Disruptions due to extreme weather events 	<ul style="list-style-type: none"> • Certain agricultural products might be affected by the intensification of droughts...it is necessary to put climate impacts into monetary terms to "wake up" the banking system • Climate change changes our risk profile for certain sectors that we lend to and thus our lending "appetite" within those sectors
Health care & Pharmaceuticals	<ul style="list-style-type: none"> • Changing disease vectors • Increased waterborne illness • Higher health insurance costs 	<ul style="list-style-type: none"> • Potential and actual drought situations present a risk • Water availability in several manufacturing regions is a concern
Mining & Industrial Metals	<ul style="list-style-type: none"> • Regulatory risks • Vulnerable to energy and water shortages due to intensity of use • Rainfall and flooding creates risk of overflow of storage reservoirs containing contaminants 	<ul style="list-style-type: none"> • Increasing regulatory pressure will impact the steel industry in terms of impacts on the process, location of facilities and availability of raw materials • Main concern is energy and water security (energy intensive sector)
Insurance	<ul style="list-style-type: none"> • Increased volume of claims • Historical loss information less reliable • Risk modelling and product pricing more complex • Some risks may be uninsurable 	<ul style="list-style-type: none"> • Changing weather patterns and an increase in insured losses in some geographical areas already experienced

Source : Adapting for a Green Economy: Companies, Communities and Climate Change - Report by the UN Global Compact, UNEP, Oxfam, and World Resources Institute (WRI), 2011

Business Opportunities and Climate Change Adaptation

In addition to the risks associated with climate change impacts for business continuity, there are also business opportunities arising from the change of circumstances. New products, processes and services need to be developed that cater to changed needs, especially in fields like climate resilient materials and products, climate resilient value chains, microfinance and micro-insurance.

Furthermore, government schemes will come up which seek to minimize climate change impacts on the population and strengthen the resilience of the society. Opportunities potentially exist for companies to implement or support government adaptation efforts. For example, companies could act as contractors providing products and services in the field of adaptation, including large-scale infrastructural projects but also locally implemented initiatives. In India, adaptation measures are predominantly carried out on a state level, including the state-level implementation of the eight National Missions of the NAPCC.

Perspectives & Case Examples

Global experiences from proactive industrial and business houses offer several useful insights, but perhaps the most important one is that though many companies have well-established strategies for reducing greenhouse gas emissions, relatively few have comprehensively tackled the challenge of adapting to changing climate conditions. Among large and medium sized industrial houses and based on captive interest the small industries can focus on several aspects of adaptation, such as:

- building internal awareness about climate adaptation and how it differs from mitigation,
- incorporating climate impact exposure into existing risk management systems,
- building business value by providing climate-resilient goods and services, and
- finding mutual benefit in helping communities, customers and suppliers adapt to the impacts of climate change.

Climate Change Adaptation in India

The climate-sensitive regions in India would be highly vulnerable to climate change impacts, mainly because of:

- **Resource dependency:** India is natural resources based economy. The projected climate variability in such regions will impact both population and industrial economy.
- **High exposure:** Many communities and industrial clusters are often situated in the low lying areas or close to the shore or surrounded by wetlands. Such regions are prone to flooding and periodically suffer from cyclones, coastal erosion, heat waves and droughts.
- **Limited adaptive capacity:** To deal with the climate related challenges for a large country like India, substantial efforts are required for assessment, planning measures, implementing them and maintaining them. Many regions with communities and industrial zones remain vulnerable

to climate change impacts, as they have exposure to the risks while there is only limited adaptive capacity.

Proactive measures focusing on preparedness for climate variability and climate change related disasters will enhance proofing of industries and thus contribute to environment security and economic developments.

There is a need for building knowledge and strengthen the capacities of local authorities and that of the industry stakeholders and relevant associations to assess, plan and respond to climate change related threats.

National Action Plan on Climate Change

India's national action plan on climate change is a consolidated account of the country's position on climate change mitigation and adaptation efforts. There are eight different national missions which form the core of the plan and dictate the direction of future action. The missions are:

1.	National Solar Mission
2.	National Mission for Enhanced Energy Efficiency
3.	National Mission on Sustainable Habitat
4.	National Water Mission
5.	National Mission for Sustaining the Himalayan Ecosystem
6.	National Mission for a Green India
7.	National Mission for Sustainable Agriculture
8.	National Mission on Strategic Knowledge for Climate Change

“In dealing with the challenge of climate change, we must act on several fronts in a focused manner... There are eight National Missions which form the core of the National Action Plan, representing multi-pronged, long term and integrated strategies for achievable key goals in the context of climate change.”

- Prime Minister's Council on Climate Change, National Action Plan on Climate Change

Perspectives of Climate Change Adaptation in Gujarat

Gujarat, with its long coastline of 1,663 Km and an already warmer climate is even more sensitive to impacts due to climate change. With nearly 13 districts extending from Lakhpad in the north to Valsad in the south, the state of Gujarat lies exposed to the likely sea level rise and changes in sea surface temperatures, which would increase storm surge occurrence and cyclonic activity in the Arabian sea. The changes in rainfall patterns will lead to reduced surface flow in Luni, Mahi, Sabarmati and Narmada rivers which could affect both domestic and agriculture water availability. This in turn, along with temperature variations, could reduce crop productivity. The state of Gujarat is but gearing up to deal with Climate Change.

The Government of Gujarat has thus taken a pioneering step in the whole of Asia by establishing the first ever full-fledged Climate Change Department within the State Government. On 17th September 2009, a separate Department of Climate Change was set-up in Gujarat. It is the first of its kind in India.

This department is created with a vision to act as a bridge between Government and society to address the issues related to global warming. Gujarat is the first and only State in India, first in Asia and fourth State/Province in the world to form a separate Department on Climate Change. In Gujarat, steps have been taken both on adaptation and mitigation front through forward looking policies and actions.

The Department of Climate Change proposes to undertake a few innovative initiatives in addition to furtherance of existing renewable programmes of the State. The thrust would be Climate Change capacity building in various departments of the Government so as to integrate the Climate Change perspective in long term planning, creation of mechanism for promotion of clean technologies and generation of widespread consciousness on Climate Change amongst people at large so as to achieve desirable lifestyle changes. Outreaching activities that are related to Information, Education, National and International Seminars, Symposia, Workshops, training programmes, demonstrations, exhibitions, communication and training related to promotion and popularization of Climate Change Consciousness and renewable energy proposed to be under taken by the department.

Climate Change is now a scientifically established fact. And whether or not there are enough predictions and accurate forecasting done by the scientific community, it is well known that our path of development has to be sustainable. There has to be a harmony in mankind's relationship with nature and what we do today about Climate Change will determine how we are going to be able to deal with future risks and how we are going to leave a better earth for generations to come. This is the philosophy with which Climate Change Initiatives in Gujarat are being taken forward.

Source: Department of Climate Change, Government of Gujarat

Case Study of “Climate Change Vulnerability Assessment in Industries” from Gujarat

Supported by GIZ, under the Indo German Development Cooperation, the Gujarat Cleaner Production Centre¹ (GCPC) took up pilot study on “*Climate Change Vulnerability Assessments in Industries*” during October/November 2011 under technical guidance from Adelphi, Germany. The expertise of GCPC, which is actively engaged in promotional activities of cleaner production and sustainable industrial development came handy in undertaking the pilot study.

The purpose of the study undertaken for identified industries in the Naroda Industrial Estate near Ahmedabad in the state of Gujarat was to assess vulnerability of industries to climate change so as to establish the relevance to industries, as well as test and establish a methodology for further replication in other industrial areas.

The study carried out by GCPC included the following main steps:

- Training to GCPC team by GIZ experts on climate change adaption and mitigation, vulnerability assessment grid, past and future impact assessment in industries
- Identification of volunteering climate sensitive industries (upto 5 nos.)
- Undertaking assessment in the identified industries
- Report preparation
- Stakeholder dialogue

The potential direct and indirect losses to industries are summarised in Table below.

Potential Direct and Indirect Losses to Industries from Climate Change

Direct Losses	Indirect Losses
Primary Direct Losses	Primary Indirect Losses
Physical damage to buildings	Loss of production due to direct damages
Physical damage to production equipments	Loss of production due to infrastructure disruptions
Physical damage to raw material	Loss of production due to supply chain disruptions
Physical damage to product in stock	
Physical damage to semi-finished products	
Physical damage to control installations	
Physical damage to service installations	
Secondary Direct Losses	Secondary Indirect Losses
Secondary hazards and damages (e.g. due to explosions)	Market disturbances (e.g. from higher prices for raw materials)
Costs for remediation and emergency measures	Decreased competitiveness
	Damage to company's image
	Extra labour for process recovery

¹ GCPC established in August 1998 by Industries and Mines Department of the Government of Gujarat with the technical support of UNIDO (United Nations Industrial Development Organization)

On assessing the data collected, the following reactive adaptation measures were identified :

Vulnerable sources	Reactive Adaptations	Anticipatory Adaptations
Water Resources	<ul style="list-style-type: none"> • Protection of groundwater resources • Improved management and maintenance of existing water supply systems • Protection of water catchment areas • Improved water supply • Groundwater and rainwater 	<ul style="list-style-type: none"> • Better use of recycled water • Conservation of water catchment areas • Improved system of water management • Water policy reform including pricing and irrigation policies • Development of flood controls and drought monitoring
Energy Resources	<ul style="list-style-type: none"> • Improved energy supply • Increasing energy efficiency by proper measures like putting machine on invertors 	<ul style="list-style-type: none"> • Better use of recycled energy • Developing the efficiency of machines • Use of renewable sources at maximum extent
Human health	<ul style="list-style-type: none"> • Public health management reform • Improved housing and living conditions • Improved emergency response 	<ul style="list-style-type: none"> • Development of early warning system • Better and / or improved disease / vector surveillance and monitoring • Improvement of environmental quality • Changes in urban and housing design
Transportation	<ul style="list-style-type: none"> • Use of Electric or Compressed Natural Gas based vehicle or Hybrid • Implementation of vehicle emission standard • Executive employees use public transportation 	<ul style="list-style-type: none"> • Focusing on mode switching and other behaviors affecting transportation • Encourage the use of Cleaner alternative fuel

For further information, contact:

Mr. Bharat Jain
 Member Secretary
 Gujarat Cleaner Production Center
 3rd Floor, Block 11 & 12,
 Udyog Bhavan,
 Gandhinagar, Gujarat, India
 Phone: +91-79-23244147
 Email: gcpc11@yahoo.com

Case Study of “Preparation of Climate Change Adaptation Plan for Industrial Areas” from Gujarat

The Naroda Industrial Estate, established in 1964 is located in the north-east part of the Ahmedabad. The Naroda Industrial Estate - the first industrial estate promoted by the Gujarat, today an agglomeration of several sectors industries and technologies at one location is a result of the advanced IE planning exercise by the Gujarat Industrial Development Corporation. It accommodates more than 600 industries employing more than 30,000 persons directly and a further 40,000 people indirectly. While the Naroda Industrial Estate has predominantly chemical industries (26%) of dyestuffs and dye-intermediates type, which generally falls under the red category of Gujarat State Pollution Control Board. The other types of productions are plastics (5%), pharmaceuticals (3%), and pesticides (1%). Engineering (24%), textiles (5%) and trading companies (9%).

The Naroda Industrial Estate faces various concerns ranging from the financial viability of the individual industry, aging infrastructure needing replacement and more recently the adaption for the changing climate. A study was taken up by the Centre for Environmental Planning & Technology (CEPT), with the support of GIZ, for preparation of Climate Change Adaptation Plan and identifying pilot interventions for Naroda Industrial Estate.

The methodology developed through a consultative and multi-disciplinary team includes four major steps, as below:

- Baseline surveys & profiling of the industrial estate
- Vulnerability assessment
- Preparation of climate change adaptation plan
- Detailed planning and designing of pilot interventions

The study components for profiling, assessments and planning focus on:

- Land use vulnerability
- Vulnerability to hazards (erosion, floods, temperature rise etc.)
- Vulnerability of industries
- Environmental vulnerability
- Socio-economic vulnerability

The highlights of some of the key observations are given below:

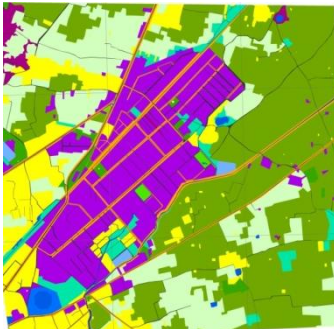
- Industrial plots that are severely flood-prone and may have to close down their operations have been identified. The reasons identified include excessive rains, lack of storm water drainage system and disturbances made to the natural drainage by constructing roads and buildings
- Areas prone to erosion in elevated areas were identified. It was observed that these areas could be protected through simple measures such as plantation.
- The industrial estate has inadequate vegetation, and is unplanned as well as haphazardly and unscientifically developed. It was observed that if properly planned and developed, it could be highly beneficial in adapting to climate change issues such as flooding, ground water recharge and

temperature reduction. Additionally, this would benefit in improving landscape, aesthetics as well as biodiversity.

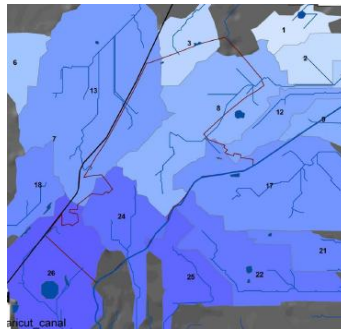
- In the case of individual industries, it was observed that most of them are unaware of the climate change impacts, but are willing to take up adaptative measures if capacities are built. Some of the measures immediately acceptable to industries are changes in design of the industrial building with better ventilation, lighting and energy conservation, water conservation, and improving vegetation inside and outside the industry premises.
- The living areas of workers in and around the industrial estate were identified, the availability of basic amenities and services for drinking water, health etc. were assessed and vulnerability to climate changes were identified. It was observed that some of their living areas are prone to floods, their mode of transportation is by bicycles which are affected by weather variability and they have inadequate incomes and savings to cope with climate change impacts.

For further information, contact:

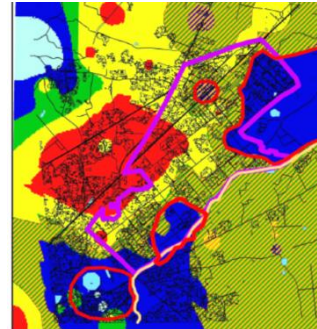
Prof. Ashwani Kumar
Centre for Environment Planning and Technology
Kasturbhai Lalbhai. Campus, University Road
Navrangpura, Ahmedabad 380 009 (Gujarat), India
T : +91 79 2630 2470
E : ashwani@cept.ac.in



Pic: Land Use



Pic: Drainage Pattern



Pic: Flood Hazard Areas