Critical Evaluation of Human Settlements and Encroachment of Waterways/River Beds and its Impact During Recent Floods

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Abstract:

Flood vulnerability in Pakistan, especially in Khyber Pakhtunkhwa, is influenced by both natural factors and human activities. Proximity to rivers, monsoon rains, and glacier melting contribute to flooding, while human-induced issues, such as encroachments on riverbanks, urbanization, and mismanagement, exacerbate the situation. The growing population in floodplains reduces the carrying capacity of rivers, increasing flood risks. In Khyber Pakhtunkhwa, human settlements along rivers like Indus, Kabul, and Swat have disturbed the natural flow of waterways, leading to environmental imbalances. The 2022 floods highlighted the consequences of unchecked encroachment, poor governance, and institutional inefficiencies. Addressing this issue requires a coordinated approach, including stricter enforcement of river protection laws, floodplain zoning, and the integration of advanced technologies such as GIS and satellite mapping. Additionally, a unified body for flood risk management, along with active community involvement, is crucial for long-term flood mitigation and reducing economic and human losses from future disasters.

Key words: *Flood vulnerability, encroachment, urbanization, Khyber Pakhtunkhwa, flood management.*

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Introduction

The vulnerability of floods to any geographical area depends on social, economic, physical, and environmental changes in the context of regional and global phenomena such as climate change. In Pakistan, the causes of floods include the location of affected areas near rivers, monsoon rains, and the heavy melting of snow and glaciers. Additionally, human-intensifying factors such as mismanagement and encroachments are considered major reasons behind the flood's destruction, affecting both plains and fragile mountains. The physical features of floods are highly diversified and largely affect the local climate.

Due to human settlement and encroachment, the following have become major threats to urban flooding:

i. Nullah Lai width reduces to 23-35 meters from 35-50 meters in Rawalpindi.
ii. Kabul River reduces its width by more than 50% near Nowshera city and surrounding areas.
iii. Encroachment in the natural waterways on the left bank of the Indus River in the lower part of Sindh is a major cause of delayed (from 4-5 days to 2-3 months) discharge of flood and storm water.
iv. Gujar Nullah Karachi width reduces to 15 feet from 100 feet.
v. In four nullahs of Karachi, 13,441 houses and 2,948 commercial structures have been built within a decade.
vi. A 60% population growth has been observed in the last decade over the bed of the Ravi River.

Like the rest of the country, the province of Khyber Pakhtunkhwa is also susceptible to floods due to its physiographic and climatic conditions. In Khyber Pakhtunkhwa, water is an extensively available natural resource. The Indus, Kabul, Swat, Panjkora, Kunhar, Chitral, Bara, Kalpani, Kohat Toi, Kurrum, Tochi, and Gomal are prominent rivers flowing in the province, providing ample supply for drinking, irrigation, and power generation. The province's population is growing at a rate of 2.6% per annum. As the population grows, the demand for food, shelter, and other infrastructure increases. Intensive land utilization in active floodplains is a critical issue. The population is continuously encroaching towards rivers for agriculture or infrastructure expansion, reducing the channel's carrying capacity and increasing the risk of floods. During the 2022 flood, human encroachment contributed significantly to intensifying flood characteristics.

The dynamics of poverty, urbanization, and the widening development gap between the rich and poor in a developing country like Pakistan contribute to challenges in structuring social spaces, where encroachments are an ever-present phenomenon. Encroachment is both a cause and consequence of underdevelopment, indicative of low (and even declining) development. Human settlements and growing urbanization in the past few decades in Khyber Pakhtunkhwa, particularly along the banks of the Indus, Kabul, and Swat rivers, have disrupted waterway flow. People are extending their residences into floodplains, disturbing the environment and ecosystem. This imbalance has led to various disasters, such as climate change and floods, resulting in colossal economic loss and threats to human life. In Pakistan, urbanization occurs in two forms: recognized urbanization, where people migrate from rural to urban areas, and unorganized urbanization, which is driven by high population growth rates and ad-hoc settlement patterns in informal systems.

A critical evaluation of government departments reveals the underlying reasons for unchecked encroachment. The government is "paying the price for years of delays in addressing the problem." Corruption, mismanagement of the country's water resources, lack of necessary infrastructure, and weak governance have fueled the crisis, affecting the poorest and middle class the hardest. One of the most glaring institutional failures in the wake of recent flash floods in Khyber Pakhtunkhwa has been the unabated and unchecked encroachment on riverbanks, exacerbated by illegal human settlements. There is no single body responsible for managing flood risk due to legal and institutional gaps, coupled with mismanagement and loose administrative coordination (Kordana & Słyś, 2020). A collaborative and integrative mechanism is laid down in the legal and institutional framework to cope with flood management.

In Swat and Dir Valleys, the locations where people construct their houses pose a challenge and increasing vulnerability. Most houses are built in areas exposed to high flood risk. Through several joint anti-encroachment operations carried out by the Irrigation Department, TMA, and District Administration Swat, most of the encroachments/obstructions have been removed since August 2020, and the floodplain has been vacated for the unobstructed passage of floodwaters.

Community involvement in the planning and design of urban settlement environments is a new alternative for bridging the gap between government, planners, and the community. With the active role of the community, a sense of belonging will be created, leading to increased motivation to maintain and improve the environment.

Problem Statement

Floods are not meant to be stopped; rather, they have to be regulated and channelized. The greatest human civilizations inhabited river basins due to fertile land. With the outburst of population and irregular urbanization, increased demographic pressures and economic activity forced people to move to floodplains, resulting in increased flood damages. A developing country like Pakistan presents a bleak picture of immense damages incurred whenever floods occur. In KP, the communities are facing a trade-off between the benefits and hazards of living in and around floodplains/flood-prone areas. The recent flood of 2022 exposed the illegal encroachments that were criminally neglected by the concerned authorities due to corruption and poor management, resulting in massive losses to life and property. This study will analyze how flood hazards can be reduced through proper management, planned mitigation, and preparedness measures undertaken along riverbanks and waterways.

Scope of Study

The river networks in Khyber Pakhtunkhwa are vulnerable to flooding stress due to the construction of human settlements and encroachments. The scope of the study is to examine the massive destruction caused by the obstruction resulting from illegal settlements in the river network. The impact of such phenomena is expected to worsen due to climate change. This study will help policymakers reduce human and economic vulnerabilities caused by encroachment and identify the most appropriate course of action.

Research Methodology

This study reviews the case studies, policies, current status, barriers, opportunities and operational data available at online and with different department of Khyber Pakhtunkhwa, i.e Irrigation Department, EPA, DC Swat and Mansehra related to policy formulation and planning on encroachment and human settlement on river beds and waterways. This study relies on exploratory research methods like secondary data available with various stakeholders.

The quantitative data collected in this study is analyzed using in-depth critical approach to extract answers and propositions.

Research Questions:

This study intends to:

1. Assess the impacts of flooding due to encroachment and human settlement.
2. Investigate the economic vulnerability in the province of Khyber Pakhtunkhwa before and after flood 2022.
3. To identify the quantum of role that unplanned urbanization has in the river encroachment. Narrow down the data gap that exists for generation of a global sustainable developmental plan.

Encroachment:

According to the Khyber Pakhtunkhwa River Protection Ordinance 2002, Encroachment means;

i. construction of any structures or buildings, permanent or temporary, within the area specified in clause (a) of sub-section (1) of section 3, and includes such structures or buildings, existing in the said area, the owners whereof do not provide proper septic tanks and a soaking pit or an alternate arrangement acceptable to the Authorized Officer; or

ii. construction of building, house, hotel or any other permanent structure within the area specified in subsection (2) of section 4 without making the arrangement referred to in clause (i) above;

Types of human settlement in Pakistan

1. Human settlement on the bed of seasonal rivers and waterways specially in big cities.
2. Culture of Kachi Abadi's to grab govt.
3. No proactive approach of highway's project consultants. Inadequate capacity of crossing bridges of Local, Provincial and national High ways major reason of agricultural and Abadi's loss. Bridge crossing for river located between Peshawar and Mardan at motorway M-1 is an example.

Critical Evaluation

Flood Commission Inquiry Report 2010

The Flood Commission was formalized under the directions of the suo-motu of the Supreme Court of Pakistan in 2010 to investigate the matter of breaches in dykes and unauthorized diversion of floodwaters by influential people to protect their lands. The Flood Inquiry Commission submitted its 200-page final report to the Supreme Court. Some of the key points of that report are (PDNA, 2022):

Key Points:

a. The negligence of the Irrigation departments of Sindh and Balochistan caused a colossal loss of Rs 855 billion to the national economy during the devastating floods of 2010.
b. 1,600 people lost their lives, and thousands were injured. Almost 4.5 million people lost their jobs, mostly in the farming sector. An estimated 20 million people became internally displaced persons (IDPs), and 7 million students were deprived of their academic sessions.
c. Encroachments contributed to obstructions in the flow of water, resulting in flooding in many areas.
d. Illegal encroachments, including thousands of 'katcha' lands by local influential, were leased out at nominal charges, resulting in the erection of private bunds. Local and provincial governments were involved in encouraging illegal acts that promoted encroachments.
e. Major damages were caused due to the lack of maintenance and repair of river embankments, canals, and obstructions created by major highways/motorways constructed by the Irrigation department and the National Highway Authority (NHA) across the country.
f. The delay in the Munda Dam caused damages downstream in Charsadda, Peshawar, and Nowshera districts, as well as at Munda Headwork's.
g. Encroachments in riverbeds and areas around irrigation facilities caused major havoc in Swat and other parts of the country.

Concluding Remarks:

(i) No pre-disaster structural framework or administrative network was adopted.
(ii) The 2010 flood fully exposed the illegal encroachments, which had been allowed to go unchecked by the concerned authorities due to negligence, corruption, and poor management, resulting in massive losses to life and property. Extensive encroachments in the floodplain were identified by most as one of the key factors responsible for obstructing the natural river flows. These issues are as follows:

a. Thousands of acres of "Katcha" lands were illegally encroached upon by local influentials or leased out at nominal charges, resulting in the erection of private bunds. Construction of houses and other built-up properties was allowed along riverbanks and canals. Similarly, encroachments on acquired lands in pond areas of barrages have aggravated flood hazards.
b. The major reason for the inundation of agricultural lands and abadis on the northern side of the Peshawar-Islamabad Motorway (M1) was the inadequate capacity of crossing bridges meant for the drainage of flood flows in rivers located between Peshawar and Mardan. The natural flow of water has been blocked due to numerous encroachments in most waterways caused by unplanned and illegal constructions.
c. In the Commission's view, this is a symptom of policy failure, not a disease: successive governments have failed to develop and implement town planning as an integral and unavoidable instrument of state policy, under which need-oriented provisions should have been made to meet the residential requirements of the growing population, rather than promoting affordability-driven expansions.

(iii) The Commission recommended that all illegally constructed structures on government lands, which had been destroyed by the recent floods, should not be allowed to be re-erected.

Types of Floods:

1. **Flash Flood:** Fast-moving waters that sweep everything in their path. They are caused by heavy rainfall or rapid snow thaw (Kunhar River, Chitral River, Hill torrents).

2. **Riverine Flood:** Caused by gradual riverbank overflows resulting from extensive rainfall over an extended period of time. These floods rarely result in loss of life but cause immense economic damage (Kabul River, Swat River (lower reaches), Kurram River).
3. **Urban Floods:** Occur when the drainage system fails to absorb the water from heavy rain (lower reaches of Bara River and Budni River).

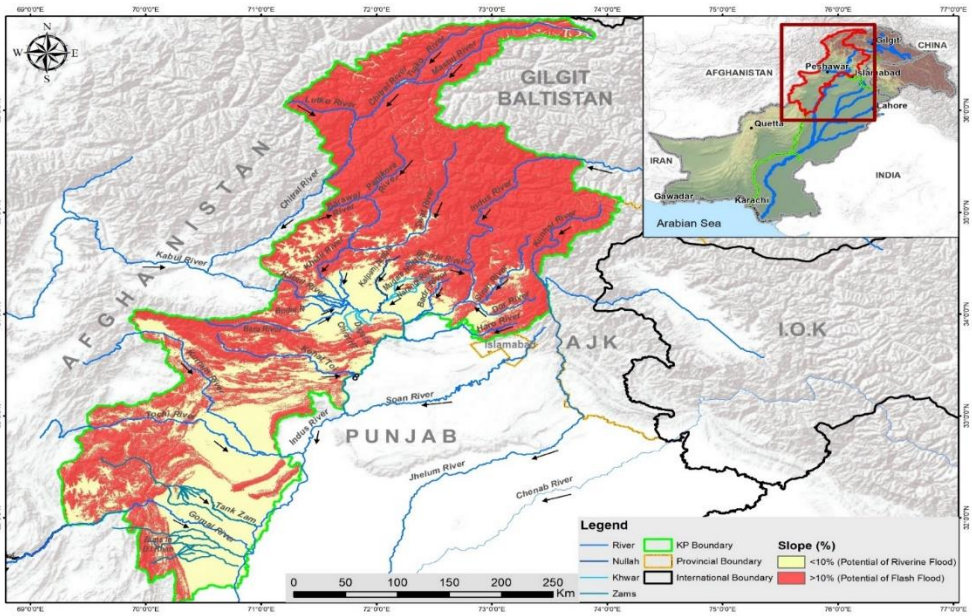


Figure: Flash and Riverine Flood Hazard Map

Legal Framework of Different Departments

The institutions responsible to check the encroachments and illegal human settlements are knitted with a set of different legal framework. The main features of these Acts *khyber pakhtunkhwa river protection ordinance, 2002*) are highlighted as under;

The KP River Protection Ordinance, 2002, Amendment Act, 2014

Keys Features of the Act:

1. It covers land use and zoning plans and building control regulations for catchment area of rivers (Clause 3, 4 and 5 of the Act).

2. Proper arrangements for the construction in 200 feet area along the river have been given. Powers to seal any building given to the authorized officers Section 16 provides for the bar of jurisdiction to civil courts.

3. NOC from irrigation department in the Amended Act.

4. Environmental protection Agency is constituted under the aegis of this act. Section 11, 12, 13 and 15 pertain to Prohibition of certain discharge or emissions, strategic environmental assessment, environmental examination and impact assessment and handling of hazardous substances respectively.
5. Under the Act, Rivers like Shalam, Naguman, Kabul and Bara have been notified.

Critical Analysis:

1. No minimum limits for prohibition of constructions have been specified.
2. Powers of trial and punishment thereof given to civil courts instead of civil magistrate.
3. Except Dalas Drain, all other Nullahs and khwar like Naray khwar, budhni nullah, shahi khwar, sheena, sufaid sand and Malankandeer, janjali, arabanoo, peer bala and achini not notified.
4. The act also does not cover the infrastructure built before the said act.
5. River beds mostly fall in private properties of Malakand and Hazara region, wherein this Act is silent about such arrangements.

The KP Removal of Anti Encroachment Act 1977

1. It covers identification and removal of encroachments on all kinds of public properties (Section 3 to 8 of the Act).
2. Summery trial and non-cognizance by any court
3. Exclusive jurisdiction of tribunal to decide cases of public property having powers of a civil court.

Environmental protection Agency Act 2014

1. Section 11, 12, 13 and 15 pertain to Prohibition of certain discharge or emissions, strategic environmental assessment, environmental examination and impact assessment and handling of hazardous substances(*Khyber-Pakhtunkhwa-Environmental Protection-Act, 2014*).

KP Land-use and Building Control Act, 2021

1. The DG of the Authority to ensure development of master plans, district land use plans of all districts and to ensure their implementation.

2. The District land-use planning and management committee headed by DC is to make district development master plan and to conduct a survey for categorization of land classes into:

    a. Residential, commercial, industrial, forest, mining, agriculture.

    b. Water bodies, area prone to natural hazards, mixed land etc.

3. Enforcement and penalties include:

    a. Power to seal building/structure and to attach an area for violation of Act, rules and regulations.

    b. Application of code of criminal procedure, 1998.

    c. Offences cognizable and non-bailable.

    d. No cognizance by any other court.

The Punjab Canal & Drainage Act 1873

1. Mainly covers use of water for public purposes.

2. Construction and maintenance of canal system.

3. Water rates and recovery.

4. Section 5 of part II authorizes the provincial government to notify any Nullah, drain, river and stream for public purposes

5. The Cancal inspector has been given magisterial power for demolition of any property under river bed and canal.

6. Canal and river are defined under same category.

Acts of the local Authorities

Different Acts of the local authorities are enacted providing provision to building regulations and having independent boards to tackle issues at their areas in lieu of building code violation. Some of them are GDA Act 2020, KDA Act 2020.

Institutional Framework

Roles and Responsibilities of Various Departments in Khyber Pakhtunkhwa:

Flood management is a multifunctional process involving a number of organizations. The roles and responsibilities of various departments/organizations are crucial in the overall management. This section provides information on the existing roles and responsibilities of various departments in addressing encroachment and human settlement issues in riverbeds and waterways:

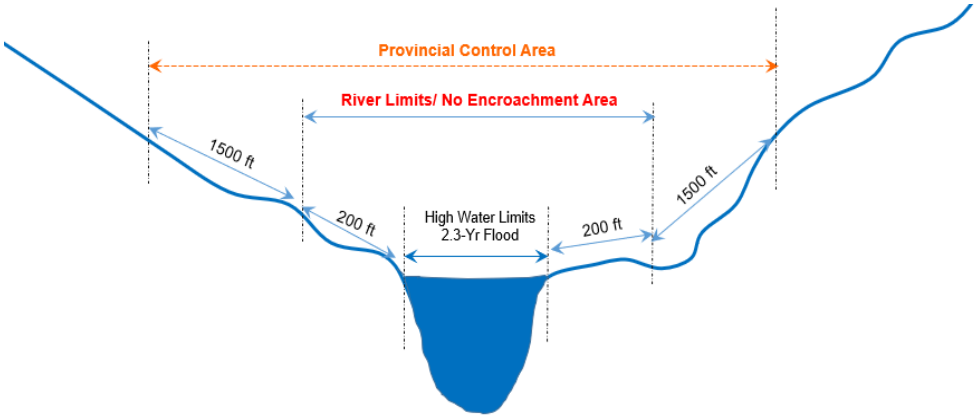
1. **Provincial Irrigation Department, Khyber Pakhtunkhwa**
   i. The Provincial Irrigation Department plays a vital role in pre- and post-flood situations. The department, in close liaison with Provincial Disaster Management Authorities, provides information about the flood situation in the rivers flowing in KP Province.
   ii. The Irrigation Department of Khyber Pakhtunkhwa is responsible for monitoring structures present in riverbeds under provincial control. All planned development must consider its implications on flood/risk.
   iii. The role of the Irrigation Department is primary in protecting, maintaining, and preserving the waterways, canals, and riversides. An NOC from the Irrigation Department is mandatory if any construction is to take place in the area adjoining the riverside.
2. **Provincial Revenue Department (through Deputy Commissioner), Khyber Pakhtunkhwa**: The Revenue Department has the mandate to take action based on the intimation from the Irrigation Department under The Khyber Pakhtunkhwa Anti-Encroachment Act of 1977.
   ii. It enforces the law to eliminate encroachment and any illegal activities taking place in the vicinity of water channels or riversides.
3. **Provincial Environment Department, Khyber Pakhtunkhwa**
   i. The Department of Environment, Forests, and Wildlife is responsible for checking the feasibility of any construction, keeping in view the protection and conservation of the habitat.
   ii. It is also responsible for the prevention and control of pollution in the water-adjacent areas.
4. **Provincial Local Area Authorities/TMAs, Khyber Pakhtunkhwa**
   i. The local municipal body assumes primacy in evaluating construction projects.
   ii. It assesses feasibility from both technical and sanitation perspectives.

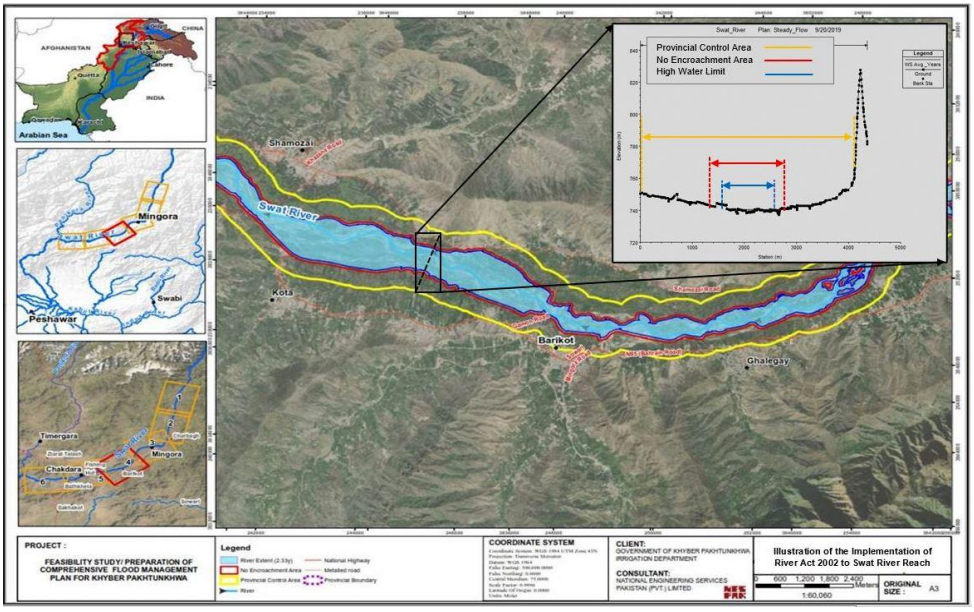
iii. The local municipal body is the authority that approves building plans. No structure can be built without its NOC.

Critical Evaluation of Government Offices in KP

Apart from legal and institutional frameworks, the rampant encroachment on the sides of the Swat River presents a bleak scenario, especially in the context of recent floods. The following points should be considered to identify the loopholes and grey areas in the system that have contributed to mismanagement and weak administration:

- The River Protection Act of 2014 is generalized and lacks specificity regarding the execution body or officer. The term "authorized officer" is not explicitly defined, leaving uncertainty about who will initiate anti-encroachment actions. The Irrigation Department investigates encroachments and informs the Revenue Department, but laxity and delayed action create opportunities for encroachers.
- The zoning plan of the catchment area is not clearly defined. Generalized zoning without specific details enables illegal activities that may lead to encroachment.
- The Act defines the "provincial control area" as being 1,500 feet away from the 200-foot high-water limit. This provision does not account for the presence of private properties within this limit.
- No patrolling mechanism exists along the riverbed, which allows encroachers to carry out illegal activities.
- Despite the immunity provided by the Act, court interventions remain unhindered, delaying the process.
- There is a lack of technology, GIS, and Geo-Mapping of the riverbeds and waterways.
- After the devolution plan, magisterial powers were removed from the DC, hindering forceful action, with thousands of cases pending in lower courts.
- According to the Ordinance Clause, the "high water limit" refers to the uppermost water level attained by rivers during peak flows in the usual flood season, as demarcated on-site and notified. The area up to 1,500 feet, starting from 200 feet, is measured along the slope (layoff land) beyond the high-water limits on either side of the rivers or their tributaries and is known as the Provincial Control Area.

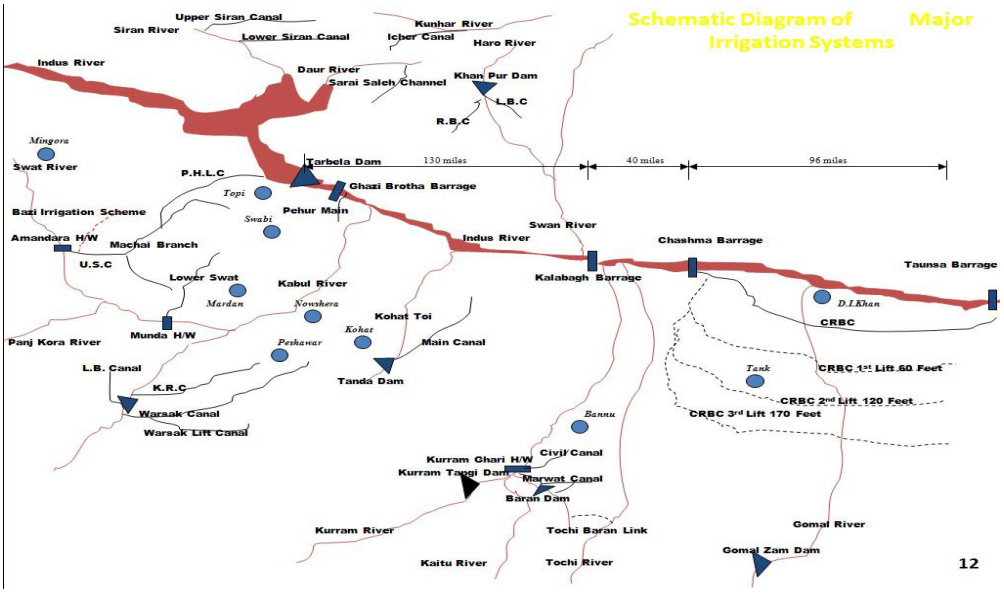

Provincial Control Area
River Limits/ No Encroachment Area
1500 ft
200 ft
High Water Limits
2.3-Yr Flood
200 ft
1500 ft


Provincial Control Area
No Encroachment Area
High Water Limit
Shamozai
Swat River
Kotkay
Barikot
Ghalegay
Mingora
Swabi
Peshawar
Timergara
Chakdara
PROJECT :
FEASIBILITY STUDY/ PREPARATION OF COMPREHENSIVE FLOOD MANAGEMENT PLAN FOR KHYBER PAKHTUNKHWA
Legend
COORDINATE SYSTEM
CLIENT:
GOVERNMENT OF KHYBER PAKHTUNKHWA
IRRIGATION DEPARTMENT
CONSULTANT:
NATIONAL ENGINEERING SERVICES
PAKISTAN (PVT.) LIMITED
Illustration of the Implementation of River Act 2002 to Swat River Reach
1:60,060
ORIGINAL SIZE : A3

Situational Analysis

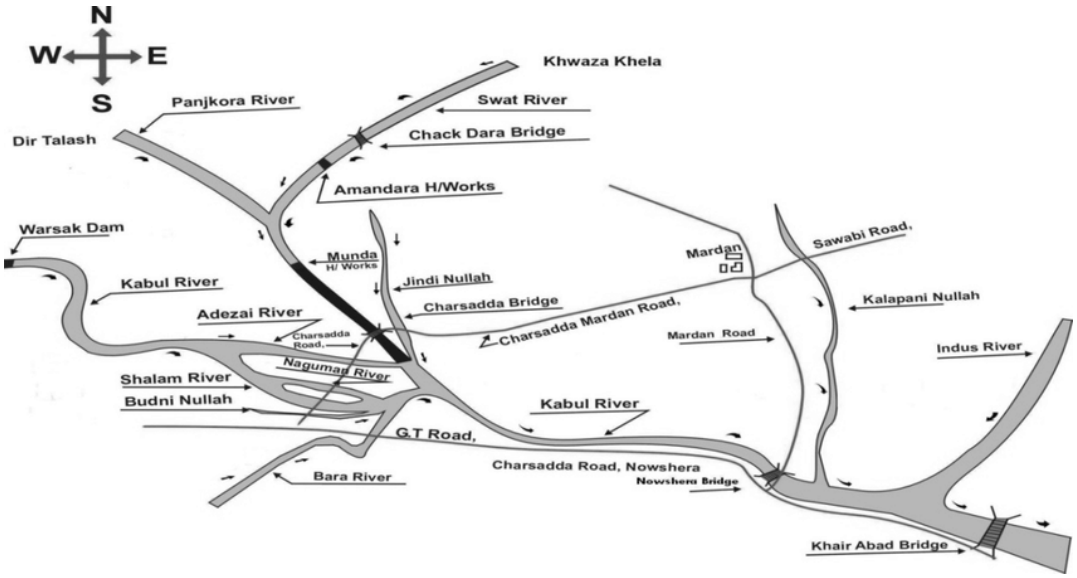
Many of the rivers in Khyber Pakhtunkhwa are fed by numerous small waterways and streams. The tributary valleys of the Swat, Kabul, and Kunhar rivers form significant physical features of the Indus River. A large number of streams are snow-fed and flow from higher elevations. The Swat and Kunhar rivers were already flowing in their courses before the mountains assumed their present form. In other words, the rivers are older than the mountains they traverse. As the mountains began to form through folding, contortion, and upheaval of the rock beds, the old rivers maintained their channels with greater erosional force, resulting in deep transverse gorges.

In the Swat and Dir Valleys, the locations where people construct their houses present a challenge and increase vulnerability. Most houses are constructed in areas exposed to high flood risk. The floodplains of the Swat and Panjkora Rivers have been illegally encroached upon, either by the local population or by government infrastructure, with the justification of low-cost land.



The Swat River starts from the Kalam Valley in Swat Kohistan, at the confluence of two main tributaries: Ushu (Mahodand Lake, 38 km from Kalam) and Utror (or Gabral, 17 kilometers north of Kalam). The confluence of the Ushu and Gabral rivers at Kalam Bazar forms the Swat River. It then runs downstream in a narrow gorge up to Baghdheri, then to Babozai, Barikot, and all the way to Chakdara, covering a length of about 160 km.

Main Tributaries of the Swat River: Jalband, Utror, Dahmaka, Shahoo, Matiltan, Kando Kadam, Chamgarai, Torwal, Ramait, Mankyal, Daral, Gurnai, Najva, Beshigram, Chail, Dabargay, Shagram, Shankoo, Tirat, Darilai, Barwai Khwar, Haroonai Khwar, Hazara Khwar, Malooch Khwargai, Sigram Khwar, Kanju Khwar, Kotlai Khwar, Ningwalai, and Dherai Khwar.



Encroachment in Water Ways & River Beds- KP Province					
S.No	**District**	**No of Waterway**	**Total Areas (Kanals)**	**Area Encroached (Kanals**	**Percentage %**
1	Abbotabad	1283	17553	125	0.7
2	Swat	42	33599	148	0.4
3	Kohat	38	4258	4258	100
4	Mansehra	02	9084	17	0.2
5	Malakand	02	5.7	5.7	100
6	Hangu	52	2662	1992	74.8

Identification of Encroachments and Their Removal

i. Using the available revenue record, 99 encroachments were identified in July 2019 along the Swat River.
ii. In several joint anti-encroachment operations carried out by the Irrigation Department, TMA, and District Administration Swat, most of the encroachments/obstructions have been removed from August 2020 to date, and the floodplain has been vacated for the passage of unobstructed floodwater.
iii. Some of the encroachments could not be removed due to litigation cases, which are under trial in various courts.

Before Flood 2022

1. The River Protection Act of 2014 deals with encroachments along the riverbanks.
2. Riverbank demarcation and identification of encroachments are done by the Irrigation Department.
3. In compliance with the Chief Justice's directives, the Irrigation Department hired the services of NESPAK to identify river boundaries based on flood modeling.
   a. The NESPAK survey is currently ongoing along the Swat River. According to XEN Irrigation Mr. Suleman, the riverbed survey from Ayub Bridge to Landakay is complete. However, some areas in Upper Swat and image processing are pending and are expected to be completed by the end of December 2022.
4. The District Administration has provided complete support to the Irrigation Department and their survey teams.
5. During the past two and a half years, more than 120 permanent encroachments have been removed along the riverbed.
6. The District Judiciary has issued stay orders in 16 anti-encroachment court cases.

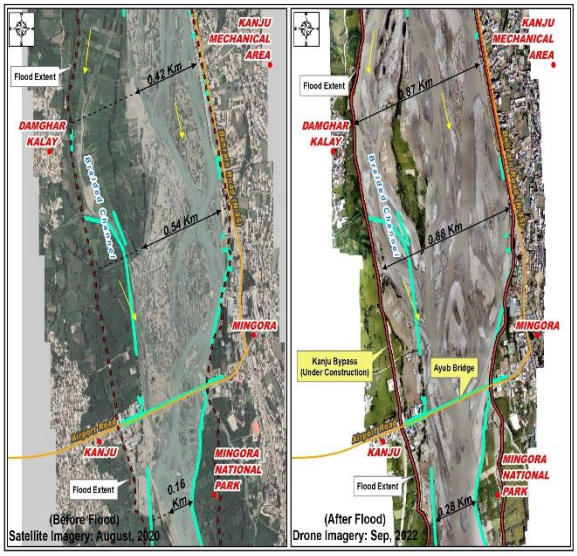
The removal of encroachments is carried out in phases by the committee constituted by the Commissioner of Malakand Division, headed by the Deputy Commissioner of Swat. The updated status of the anti-encroachment operations is as follows:
a. In the first phase, 30 encroachments/obstructions were removed from the floodplain of the Swat River in the Kalam area of District Swat. The operation was carried out from 12th to 14th August 2020.
b. In the second phase, 12 encroachments/obstructions were removed from the floodplain of the Swat River in the Madyan and Bahrain areas of District Swat.

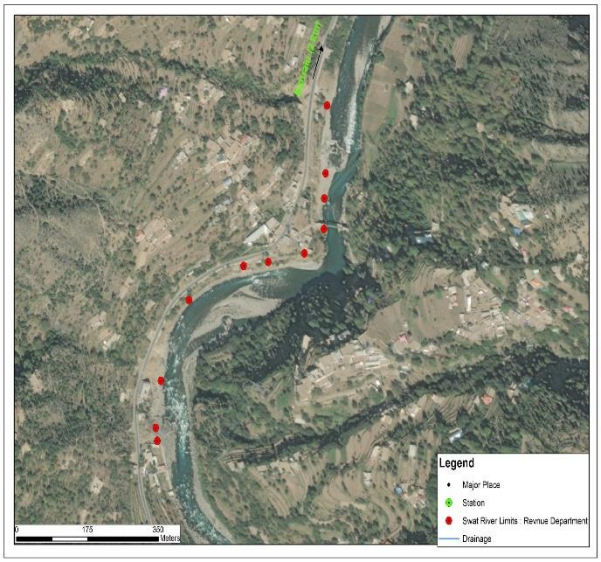
c. In the third phase, identified encroachments from Fizaghatt to Landakay were removed from the floodplain. The operation took place on 14th June 2021, and 27 encroachments/obstructions were demolished.

After Flood 2022

1. After the flood of 2022, most of the encroached infrastructure around the riverbed has been washed away.
2. The future of the Bahrain Bazaar, Madyan Bazaar hotels, and Kalam hotels needs to be decided, along with the possible political backlash.
3. Some important government sector infrastructures that fall under the category of river encroachment are:
   i. Daral Khwar Power House, residential accommodations, offices, and hospital
   ii. Bahrain Masjid
   iii. Police Rest House, Fizagat
   iv. Tableeghi Markaz, Barikot
   v. Police Training Institute
   vi. Shamshan Ghat, Barikot
4. **Detailed Design and Construction Supervision of Flood Mitigation Structures Leading to the Rehabilitation of Swat River**
   i. River geometry and flood modeling activities were at an advanced stage from Kalam to Landakay before the flood of 2022.
   ii. The flood on 26th August 2022 changed the river morphology, and a fresh survey and modeling need to be carried out for the updated river state.
   iii. The flood in the Swat River in 2022 reached 246,000 ft^3/sec at Khazakhela. The flood of 2010 was 175,000 ft^3/sec.
   iv. River slope of the Swat River: Kalam to Khazakhela (1:70), Khazakhela to Ayub Bridge (1:175), and Ayub Bridge to Chakdara/Batkhela (1:300).
   v. Data acquisition through drone from Khazakhela to Ayub Bridge is in progress; data processing is ongoing.
   vi. Marking of high-water limits, demarcation of floodplains, and the 200-ft limits from the high-water mark of the Swat and Panjkora Rivers are in progress under NESPAK consultants.
   vii. In the Swat and Dir Valleys, the locations where people construct their houses present a challenge and increase vulnerability. Most houses are constructed in areas exposed to high flood risk. The floodplains of the Swat and Panjkora Rivers have been illegally encroached upon, either by the local population or by government infrastructure, with the justification of low-cost land.

Course of River Bed Changes by Flood 2022





Swat River, of extents at upstream of Ayub Bridge, Mingora

PESTEL Analysis

The strategic analysis helps understand how the different government offices in Khyber Pakhtunkhwa can be affected by external factors, which are then used to develop strategies to mitigate or eliminate their impact on operations. This framework analyzes only external factors influencing the different departments involved in carrying out activities related to riverbed and waterways protection. It will ensure that all external influences are factored into the revised strategy. This analysis helps develop procedures for future strategies. The PESTLE (Political, Economic, Social, Technological, Legal, and Environmental) analysis would be applied to identify the key issues for the implementation of sustainable systems. A list of issues included in the PESTLE analysis is as follows:

Political Issues

1. The culture of Kachi Abadis (informal settlements) to grab government land.
2. Provincial and national highways are major reasons for agricultural and settlement losses. For example, the bridge crossing the river located between Peshawar and Mardan on the motorway M-1.
3. Negligence of the Irrigation Departments of Sindh and Balochistan caused a colossal loss of Rs. 855 billion to the national economy during the devastating floods of 2010.

4. Illegal encroachment by thousands of 'katcha' (temporary) settlements, often by local influentials, who lease out the land at nominal charges, resulting in the erection of private bunds. The local and provincial governments have been involved in encouraging illegal acts, promoting encroachments. Successive governments have failed to develop and execute town planning as an integral and unavoidable part of state policy.

Economic Issues

1. 1,600 people lost their lives, and thousands were injured. Almost 4.5 million people lost their jobs, mostly in the farming sector. An estimated 20 million people became internally displaced persons (IDPs), and 7 million students were deprived of their academic session.
2. The devastating floods of 2010 caused a loss of Rs. 855 billion to the national economy, mostly in Sindh, due to the non-affordability of housing. Millions of people settled on riverbeds and open areas for decades without regulations.

Social Issues

1. Readiness for cooperation between sectors is poor due to economic and affordability issues, which have driven people to settle in areas not owned by anyone, with the connivance of government departments.
2. The level of awareness concerning the use of sustainable water management systems is rare, where low literacy rates, coupled with lack of awareness, make it easier for people to fall into such traps.

Technological Issues

1. No rules have been made, nor skills developed, to use technologies like GIS and geo-mapping for regular updates.
2. Interlinkages between academia and departments for conducting proper studies in UET and the Disaster Management Department have not been developed.
3. A data bank backed by GIS and geo-mapping, with linkages to all departments, is not available.

Legal Issues

1. The River Protection Act of 2002 contains some ambiguous clauses and does not fix responsibilities either on the EPA or the Irrigation Department.

2. The scope of regulations in the field of cooperation between the Environment Department, Environmental Protection Agency, local governments, district governments, and scientific centers is missing.
3. The cohesion and stability of legal provisions concerning waterways management are weak.
4. The Anti-Encroachment Act of 1977 and its amendments in 2021 are ambiguous regarding the responsibilities of the authorized officer.

Environmental Issues

1. The level of legal protection for the environment and natural resources in the government sector, such as the mandatory NOC from the EPA, is not applied to commercial or private activities.
2. In the River Protection Act, there is no clear mention of the EPA's role before issuing any such NOC.

SWOT Analysis

SWOT analysis focuses on Strengths and Weaknesses in the internal environment and Opportunities and Threats in the external environment. It helps to determine where we stand within the organizations. This tool is applied on irrigation department internal environment and others as external factors.

Strength

1. Act (river & anti-encroachment) promulgated
2. Presence of technical field formation
3. Encroachment ministerial power is with DC under law coverage under the anti-encroachment act

Weakness

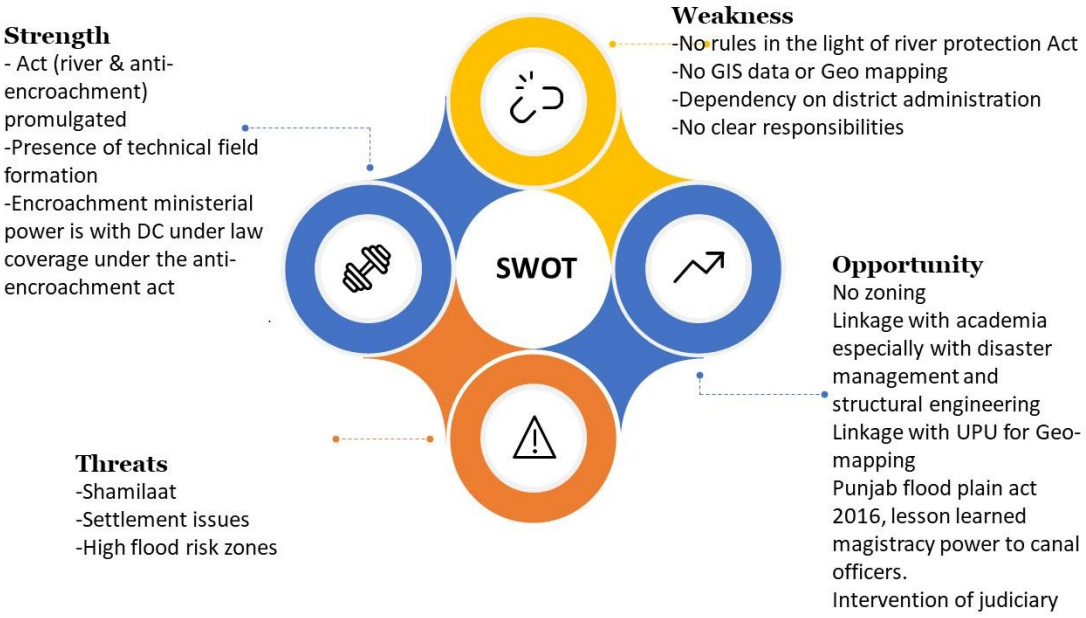
1. No rules in the light of river protection Act
2. -No GIS data or Geo mapping
3. -Dependency on district administration
4. -No clear responsibilities

Opportunity

1. No zoning
2. Linkage with academia especially with disaster management and structural engineering
3. Linkage with UPU for Geo-mapping
4. Punjab flood plain act 2016, lesson learned magistracy power to canal officers.
5. Intervention of judiciary

Threats

1. Shamilaat
2. Settlement issues
3. High flood risk zones



Impact analysis

Pakistan is in the midst of a humanitarian crisis caused by massive flooding in one-third of its territory. Over 33 million people have been displaced, one-seventh has lost their homes and the mortality count is over 1,300. Pakistan is facing an estimated PKR 4.7 trillion ($20 billion) worth of damages and possibly more in a base case scenario, as data continues coming in through organizations involved in rescue and rehabilitation. This amount consists of damages to the crops, houses, livestock and other infrastructure.

The government expects GDP growth to be 2% against a target of 5% and inflation to be around 20% (in August it stood at 27.3 per cent, the highest in 47 years) on an annual average basis. The reduction in river bed and waterways due to the encroachment of the river by constructing houses and other infrastructure has significantly reduced natural water flows through channels and water velocity, resulting in water logging problems during the monsoon season and a water crisis during the summer and winter seasons. A morphological change in the channel resulting from siltation or encroachment will result in changes in the channel's elevation and slope, thus creating havoc in flash floods. Due to these above reasons, the direct and indirect tangible impacts of recent floods at Khyber Pakhtunkhwa are:

Direct Tangible

1. 50 hotels and 150 restaurants and motels were destroyed.
2. 700 hotels, motels, inns and restaurants completely inundated.
3. Road between Bahrain and Kalam worth 10 billion destroyed

Indirect Tangibles

1. 25 billion losses to the infrastructure (river side hotels).
2. 70 billion losses in tourism.
3. 50,000 people lost job (30,000 direct and 20,000 indirect).
4. 65 deaths and 109 injured.
5. 5384 people hospitalized due to water borne diseases.

GAP Analysis

S. No	Current state	Desired state	Gap Description	Action required
01	Post event activism of concern Departments Post Crisis Management	Forward looking and risk aware resilience approach	• No flood risk management and preemptive mechanism	• Establishment of FRM authority with the mandate to equip the HR with modern education of FRM and capacity building
02	Fragmented legal framework	Clear and unified legal/operational mechanism	• River Protection Act 2014 identifies encroachment but cannot remove it • No rules formulated • Authorized officer is not defined • Pendency before judicial magistrate • No clear role define in rule of business and Act about jurisdiction	• Single authority of encroachment identification & removal be given to Irrigation Deptt • Rules need to be notified immediately • Authorized officer be clearly defined and be given powers of executive magistrate for enforcement • Appellate Tribunal clause needs to be inserted in Act • Rules of business need to be amended with clear roles & responsibilities
03	No zoning plan /rules on river sides 200 ft flat rule Clear definition of Waterways	Strict demarcation and bifurcation of zones on river sides	• Provincial control area of 1500 ft includes private lands • Katcha is allowed for the land owner in this area which often turns into stable construction	Flood plain zoning explicitly defining: • No development zone • Regulated zone • Free zone for development
04		Integrating flood plain encroachment data with technology	Lack of updated encroachment data on river sides. No GIS and Geo Mapping. • Human surveillance mechanism adopted.	Determining the level of both endogenous and exogenous risk entails the development of set of indicators that can provide reliable information about the level and type of management risk exposure

Conclusion

The human settlement and encroachment on river sides and waterways in Pakistan and especially in Khyber Pakhuntkhwa is decades old issue which is criminally neglected by all concerned Government departments. It requires the integrated public service mechanism with advanced technological tools to avoid the repeated catastrophe posed by floods on regular intervals. Therefore, streamlining the legal framework backed by cohesive institutional harmony at implementation level must be revamped and enforced to safeguard human life and economic losses in Khyber Pakhtunkhwa and provide a window of opportunity for the growing sector of tourism.

Recommendation

1. **Single Body with Powers of Encroachment Identification & Removal on River Sides**

   a. Presently, multiple departments are involved:

   - **Irrigation Department**: Custodian of rivers and waterways in terms of record-keeping and maintenance under the KP River Protection Act 2014.
   - **District Administration**: Empowered to remove encroachments under the KP Anti-Encroachment Act 1977.
   - **River Act**: Mostly pertains to ecology and aquatic life of the river.

   b. What needs to be done:

   - Rules of Business for the Irrigation, Environment, and Revenue Departments in terms of River Protection need to be notified, with clear identification of functions and responsibilities.
   - The authorized officer shall be specifically mentioned in the River Protection Act, with job descriptions.
   - The power to seal and impose fines needs to be mentioned in the Act, along with a schedule of violations.

2. **Rules Need to Be Notified Immediately**

   a. Rules under the KP River Protection Act 2014 should be formulated and notified immediately.

   b. Under these rules, proper regulations should be made, delegating powers to field officers of the Irrigation Department for speedy disposal of business.

   c. Similar to the Punjab Flood Plain Regulations Act 2016, a River/Canal Officer should be notified, with powers of executive magistracy in terms of River Act violations.

3. **Appellate Tribunal Body**

   a. To address civil court, stay issues, an Appellate Tribunal Body should be notified.

4. **Flood Plain Zoning**

   a. Bifurcation of urban and rural flood risk level zones:
   Spatial overlay analysis in GIS software can align the highest-risk and high-risk areas with living spaces in the existing territorial spatial planning zones. The classification of flood prevention levels and structural adjustment of living spaces will help link zoning regulations with human development activities and strengthen the resilience of river-network cities to cope with flood risk.

   b. Human settlement flood resilience spatial zoning should range from low to high:

   - Human settlement control zone
   - Human settlement restriction zone
   - Human settlement buffer zone
   - Human settlement construction zone

   c. Theoretical basis and decision support for the site selection of human settlement construction:

   - Human settlement expansion zone
   - No development zone

5. **EngineeringSolutions**

a. The concept of resilience originated from engineering and indicates an object's ability to return to its original state after being subjected to an external force. In contrast to engineering resilience, ecological resilience emphasizes the ability to survive in any state, allowing for fluctuations in existing mechanisms.

b. Specific building regulations:

- Currently, uniform building bylaws are adopted by local area authorities:
  - In Malakand Region: Upper Swat Development Authority
  - In Hazara Region: GDA, KDA Building Bylaws

c. What needs to be done:

- Specific building bylaws need to be formulated, considering structural and soil investigations.
- Hard Rock, Medium Rock, and Soft Rock classification
- Structure stability testing laboratories
- Piling in mountainous regions with clear seismic and morphological assessments

e. The emerging urban planning technologies, such as big data, cloud computing, artificial intelligence, and mobile internet, are constantly evolving and putting forward new requirements for flood risk management in river-network cities. Therefore, the future of river-network cities should focus on urban public safety technology as the core, through interdisciplinary technology-driven construction.

6. **A Data Bank Backed with GIS and Geo Mapping, with Linkages to All Departments**

   a. Data bank updating on a yearly basis:

   - Sync with Google Inc.
   - Mobile app application with real-time data updates.
   - Construction of a flood risk assessment model for river-network cities: Exploring the natural and social flood risk influencing factors of river-network cities will provide a data basis for improving urban flood resilience, compensate for the lack of disaster prevention topics in traditional urban planning, and offer technical prerequisites for optimal responses to human settlements.

7. **Land Settlement**

   a. Much of the land in the Malakand region along rivers and waterways is disputed.

   b. Land settlement issues, including land computerization and settlement laws, should be resolved.

   c. High-risk areas should be prioritized, with special compensation provided to existing landowners to settle the issue.

8. **Vigilance Cell / Monitoring Mechanism**

   a. Off-the-shelf solutions:

   - Drone technology for river demarcation, as done in India.
   - River and waterway marking using AI and satellite spatial images.

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