

**The 2nd APEIS Capacity Building Workshop on Integrated
Environmental Monitoring of Asia-Pacific Region**

**METHODOLOGY
FOR ENVIRONMENTAL DEGRADATION
AND DISASTER**

BY

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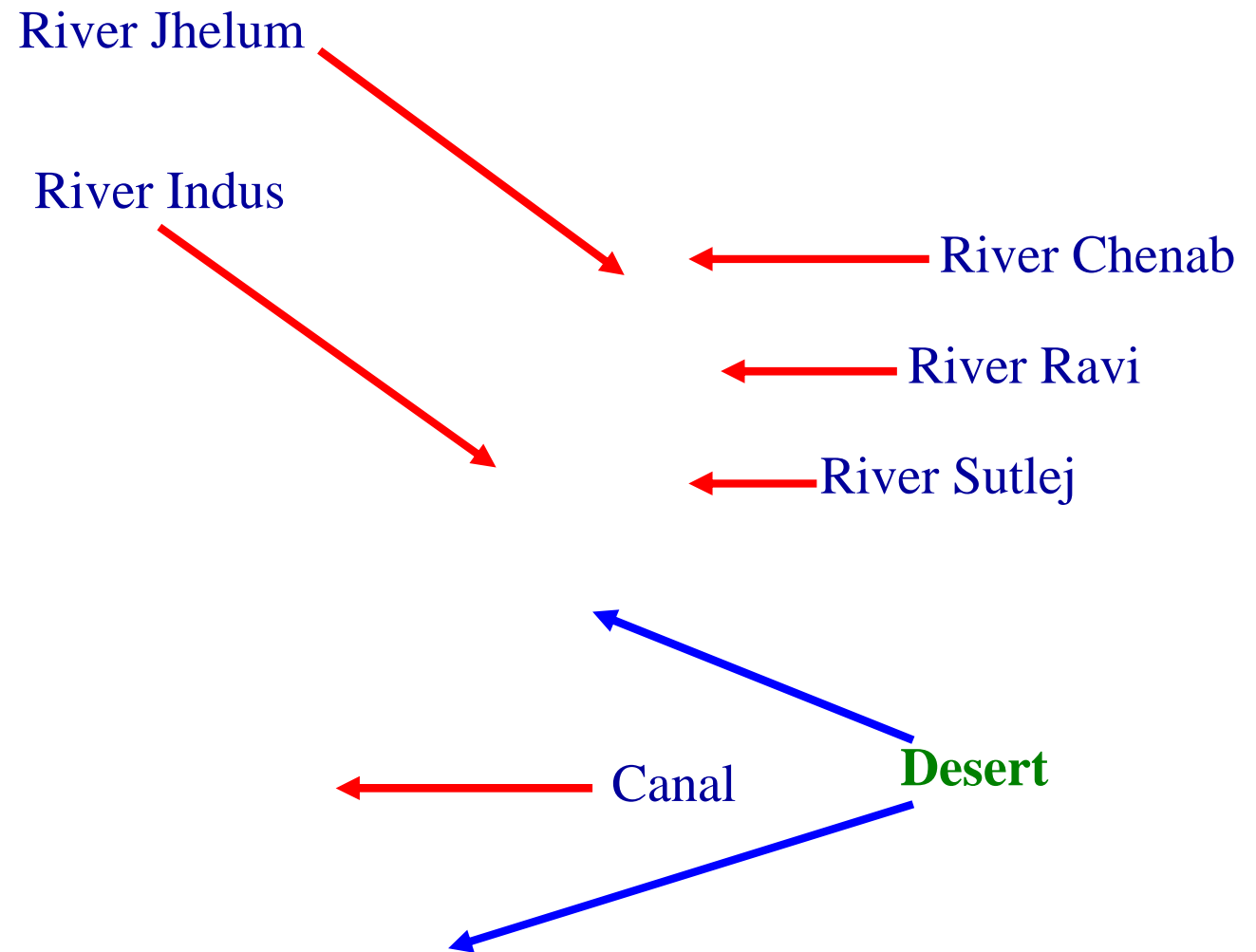
(HYDROLOGICAL ADVISOR OF PAKISTAN WITH WMO)

FLOOD FORECASTING DIVISION

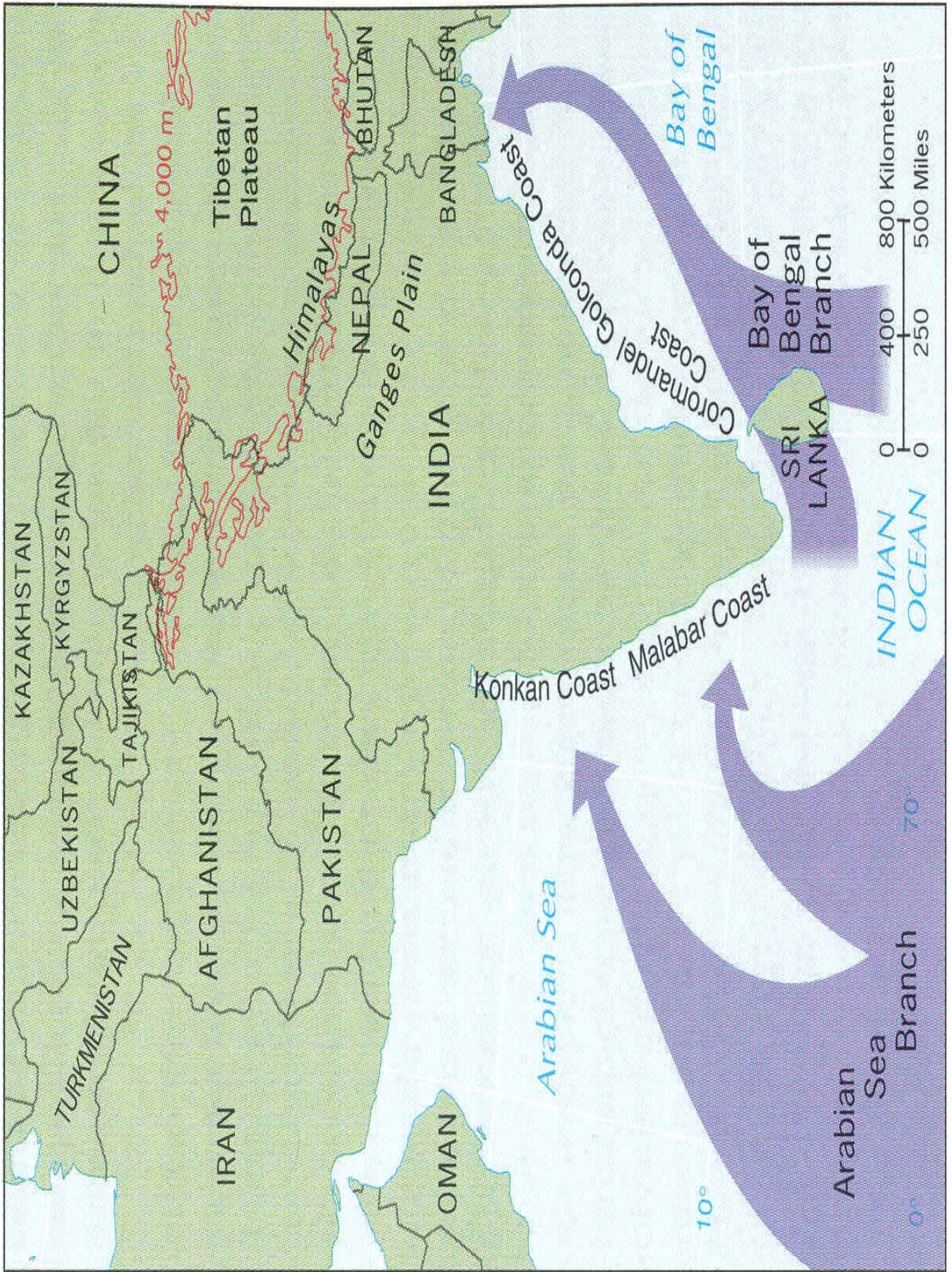
46-JAIL ROAD, LAHORE

PAKISTAN

Pakistan Map



Every year Pakistan is frequented by disaster of varying magnitude from light to moderate & severe flooding due to heavy precipitation both in winters and summers. This fact can be scientifically based on two major weather systems, one in summers i.e. monsoon and the other in winters due to westerly waves. Being located in subtropical region the major amount of rainfall in monsoon season extends from July to September. The monsoon current is responsible for deficient and surplus areas for river flooding/flash flooding in the area bounded by flood plains in between the five natural streams in the Indus river system. This plays greater havoc which causes considerable environmental change and degradation.



The satellite coverage for quick and accurate determination of the area under threat is a prerequisite for initiating any mitigation and environmental restoration activities. The extent and intensity of damage can only be measured by satellite derived products.

In winters westerly waves i.e. mid latitude low pressure systems causes rainfall mostly in upper half of the country and some times can generate land sliding in the mountainous region thus affecting the forests and natural habitat and environment.

14-11-2003
At 0400 UTC

IR Image

15-11-2003
At 0300 UTC

IR Image

14-11-2003
At 0230 UTC

WV Image

The major causes of the environmental degradation and disaster affecting human communities, lives and economy are flooding and slow & creeping phenomena of drought. As a part of flood mitigation and disaster prevention the major activity undertaken on country wide basis is flood forecasting and warning system both in community and government based communication. This was necessitated because of the major flood disaster known till today in the country's history is 1992, which is resulted damages to that time of Rs.50 million loss of life and property washing away of many villages changing the whole landscape and environment of most of the areas spreading from north of the country to south. Some of the major disasters and losses are enumerated in the table:

HISTORICAL FLOOD DAMAGES IN PAKISTAN

Year	Value of Property Damaged (Rs. In Million)	Lives Lost	Villages Affected
1950	11,282	2,190	10,000
1957	7,356	160	11,609
1959	6,958	83	4,498
1973	118,684	474	9,719
1976	80,504	425	18,390
1978	51,489	393	9,199
1988	25,630	508	1,000
1992	69,580	1,008	13,208
1995	8,698	591	6,852
Total	380,181	5,832	84,475

Since 1992 lot of disaster prevention and mitigation strategies are undertaken keeping in view of the environmental assessment through a well coordinated establishment of hydrological and meteorological reporting stations by setting up and elaborate flood management system in Pakistan both from structural and non-structural point of view. The structural measures include the hydrologic structure strengthening and river training works on ground.

The non-structural measures include the establishment of flood forecasting system. Use of satellite related products for accurate and reliable information covering areas over the country and surrounding areas from where the flood generating systems originates.



**A BRIEF DESCRIPTION OF
FLOOD FORECASTING
AND
MANAGEMENT IN PAKISTAN**

The major flooding activity takes place because of cyclones/monsoon depressions, which have a natural track from southeast of the country as depicted below:

MEAN TRACKS OF STROMS & DEPRESSIONS

LEGEND

JULY ———

AUG ———

SEP ———

**TRACKS OF
MONSOON
DEPRESSIONS/LOW
1890-2002**



FLOOD CATEGORIES

In order to combat disaster of enormous proportion, a strategy has developed to categorize it in three categories i.e. Category-I, Category-II & Category-III.



CATEGORY - I
FLOODS

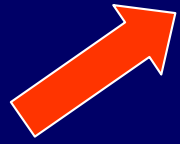
The Category-I comprises of the situation in which the moisture influx converges both from southeast and southwest causing light flooding activity and rainfall mostly below 50 mm in 24 hours. As is evident from pattern given below:

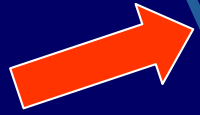
Flooding and reservoir management:

The Category-I generates $8490 \text{ m}^3 \text{ s}^{-1}$ to $14150 \text{ m}^3 \text{ s}^{-1}$ as such when the reservoir is at mean conservation level. Then the above amount can trigger damages both the country and environment in hilly forested area particularly in washing away lands.

The image features a dark blue background with a complex network of intersecting lines in various shades of blue. Two prominent red arrows with white outlines are positioned on the left and right sides, pointing towards the center. The overall composition is abstract and geometric.

F.F.D LAHORE





F.F.D LAHORE



F.F.D LAHORE



F.F.D LAHORE

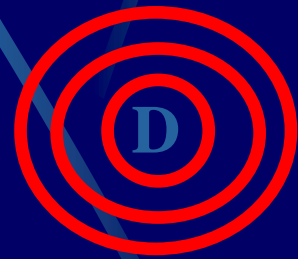


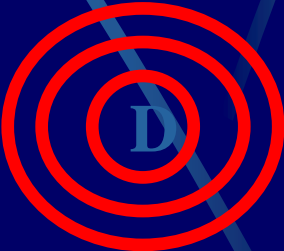


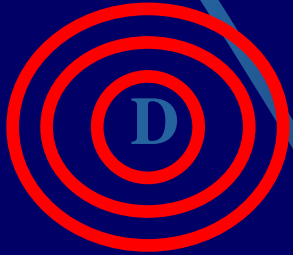
CATEGORY - II

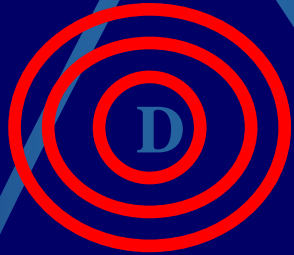
FLOODS

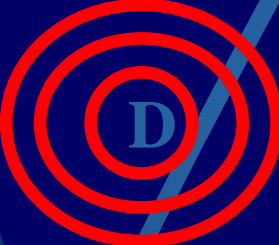
The second condition under which floods in the Mangla catchment occur is when a monsoon low/depression approaches from east/southeast traversing across the Sutlej, Ravi and Chenab catchments. Under this situation, the rain producing capacity of the depression is considerably reduced (by the time it reaches the Mangla catchment) due to extensive moisture shedding (in the form of heavy rains) over the Sutlej, Ravi and Chenab catchments. Consequently, the floods under this condition are generally less than $8490 \text{ m}^3 \text{ s}^{-1}$. Only in an extremely rare case, when the depression happens to be extremely intense, a peak ranging from 16980 to $22640 \text{ m}^3 \text{ s}^{-1}$ may occur. Again no serious flood management problem would arise in this case.



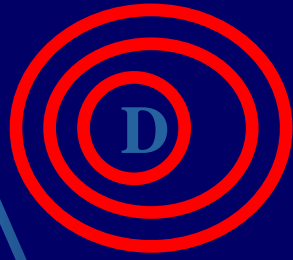


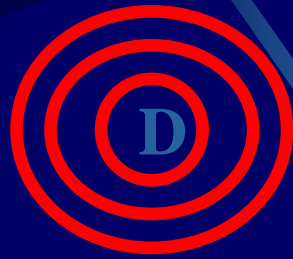


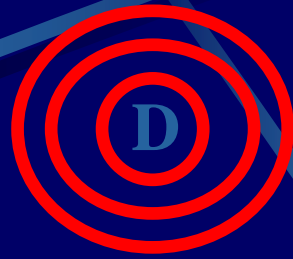


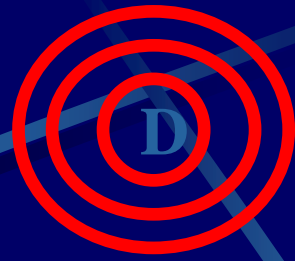








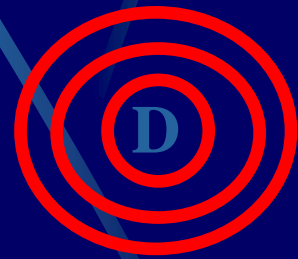




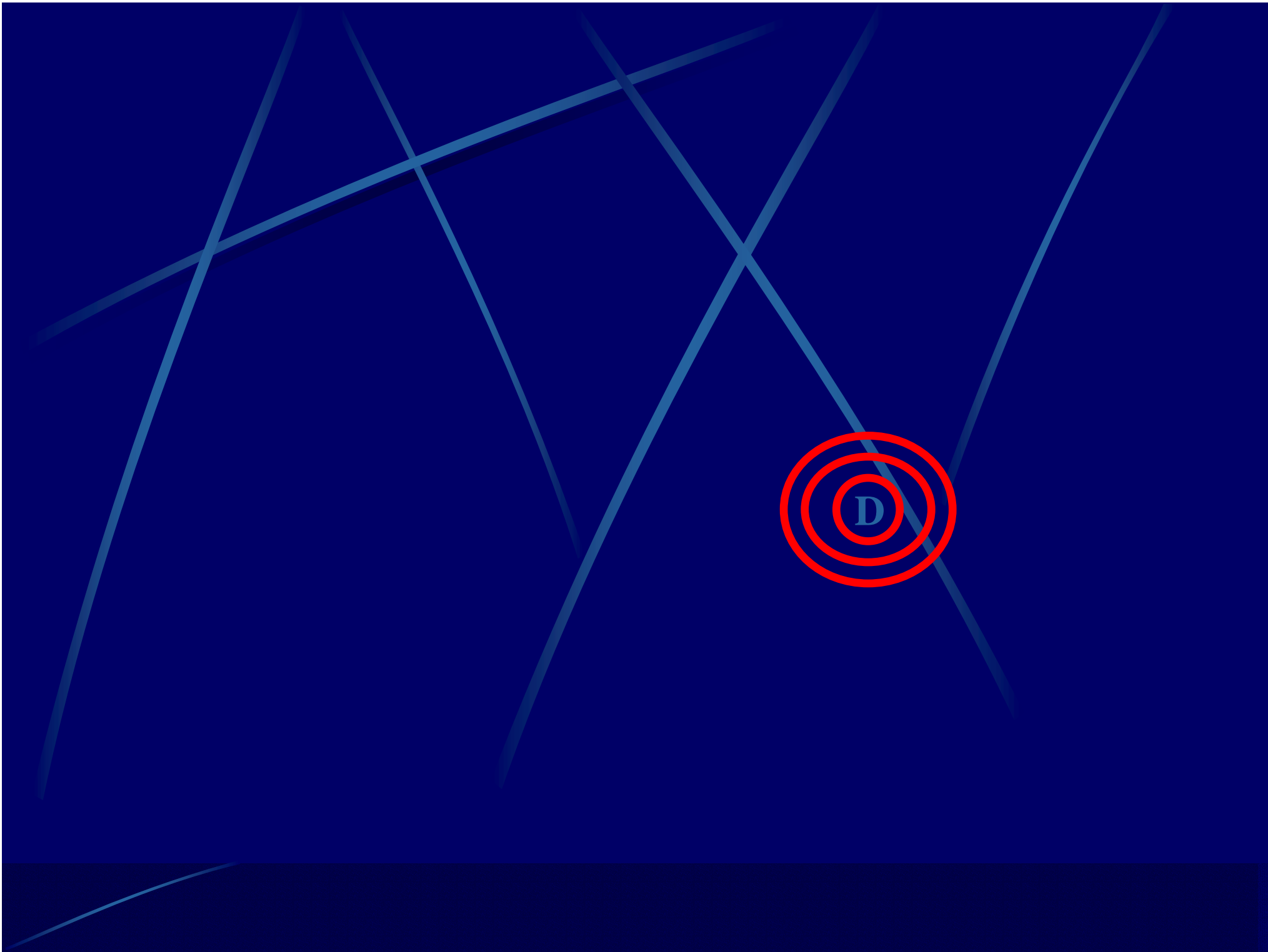


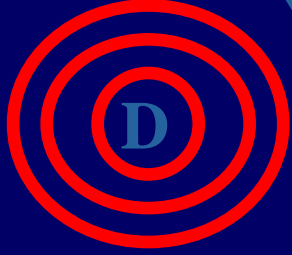
CATEGORY - III
FLOODS

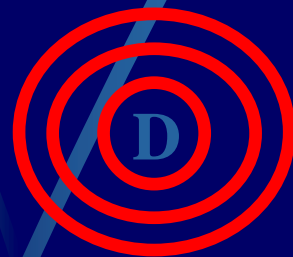
Third, the most critical situation is when the depression takes a straight northerly path from its position in Rajasthan and enters Pakistan along the Lahore division and then continues to move towards Rawalpindi division skipping the catchment of Sutlej and Ravi to the east. Under this condition, the Chenab and Jhelum catchments will be severely affected because, firstly, it is the north east sector of the depression which gets the heaviest precipitation and secondly because the depression reaches the vicinity of the Mangla catchment (along the plains) with most of its intensity still intact. Additionally, since the northwards movement of the depression is caused by the presence of a strong westerly wave to the north, heavy rains will always extend further north to cover the lower part of the Terbela catchment, Hazara division and the whole of Kashmir. The heaviest floods on record are caused during this situation (the 1928,1929 and 1992 flood situations).

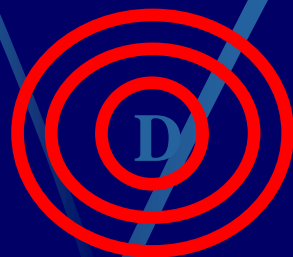


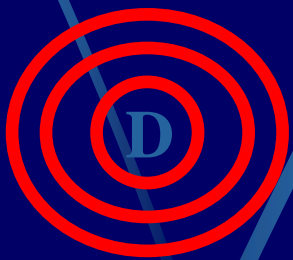
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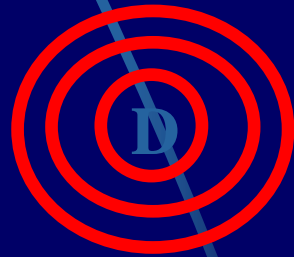


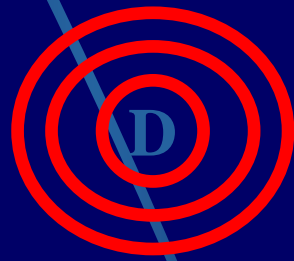


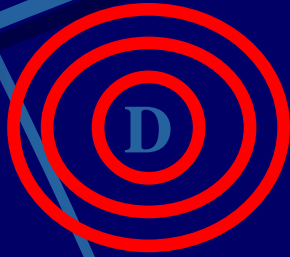


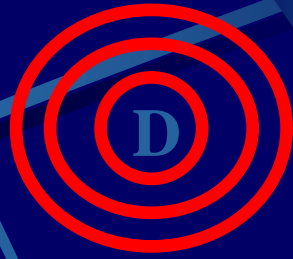




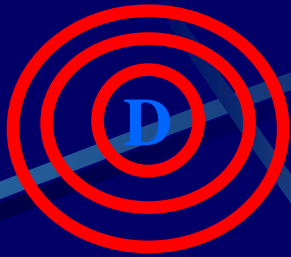












CASE STUDY OF 2001

During the flood season July–September 2001 the satellite & radar images helped a lot in determining the rainfall over the catchment areas of the neighbouring country. This quantitative cross-border rainfall estimate was an extremely useful input before the maximum runoff was reached in the plain of the Sutlej River. The rainfall estimates assisted in both determining the peak discharge value and the time of its arrival.

A timely forecast was issued on 15 August 2001 at 10:30 h and the actual peak occurred on 18 August at 00:00 h, which enabled the District Management of Kasur to evacuate the people and cattle, who were on the river bed of the River Sutlej and a heavy loss of life and property was avoided.

**SIGNIFICANCE OF SATELLITE
RELATED PRODUCTS VIS-À-VIS
NODAL POINT INFORMATIONS
FROM OBSERVATORIES**

The C-band QPF image obtained on 26 August 2002 at 04:00 PST (Pakistan Standard Time) showed hardly any rainfall activity over the upper catchment of the Jhelum River. Between 04:30 and 05:00 h, the rainfall at the rate of 2.5 mm h⁻¹ started over the reservoir, while the telemetric rainfall measuring stations located at PLI (Plandri), KTI (Kotli) and MAG (Mangla) indicated no rainfall in 2 h from 04:00 to 06:00 h. The whole catchment area (250 km²) of the reservoir was covered with rainfall intensity up to 5 mm h⁻¹ until this time while no ground verification could be made as the telemetric station reported no rainfall. The heavy rain band approached after 07:00 h PST. The rainfall decreased considerably over reservoir at 0330 GMT as indicated through radar echoes. The rainfall generated runoff into the Mangla Dam, which is the second largest reservoir in the country. The inflow jumped from 755.6 m³ at 06:00 h to 3197.9 m³ at 10:00 h.

RESULTS

Though there was a sudden increase of inflow into the Mangla Dam from 755.6 m³ to 3197.9 m³ in almost 3 h, the inflow could be effectively predicted in the distributed hydrological modelling. From the viewpoint of the reservoir operation, the prediction resulted in effective reservoir operation to treat additional inflow without causing any flood peak or danger of spillover.

26-08-2002
At 0400 UTC

IR Image

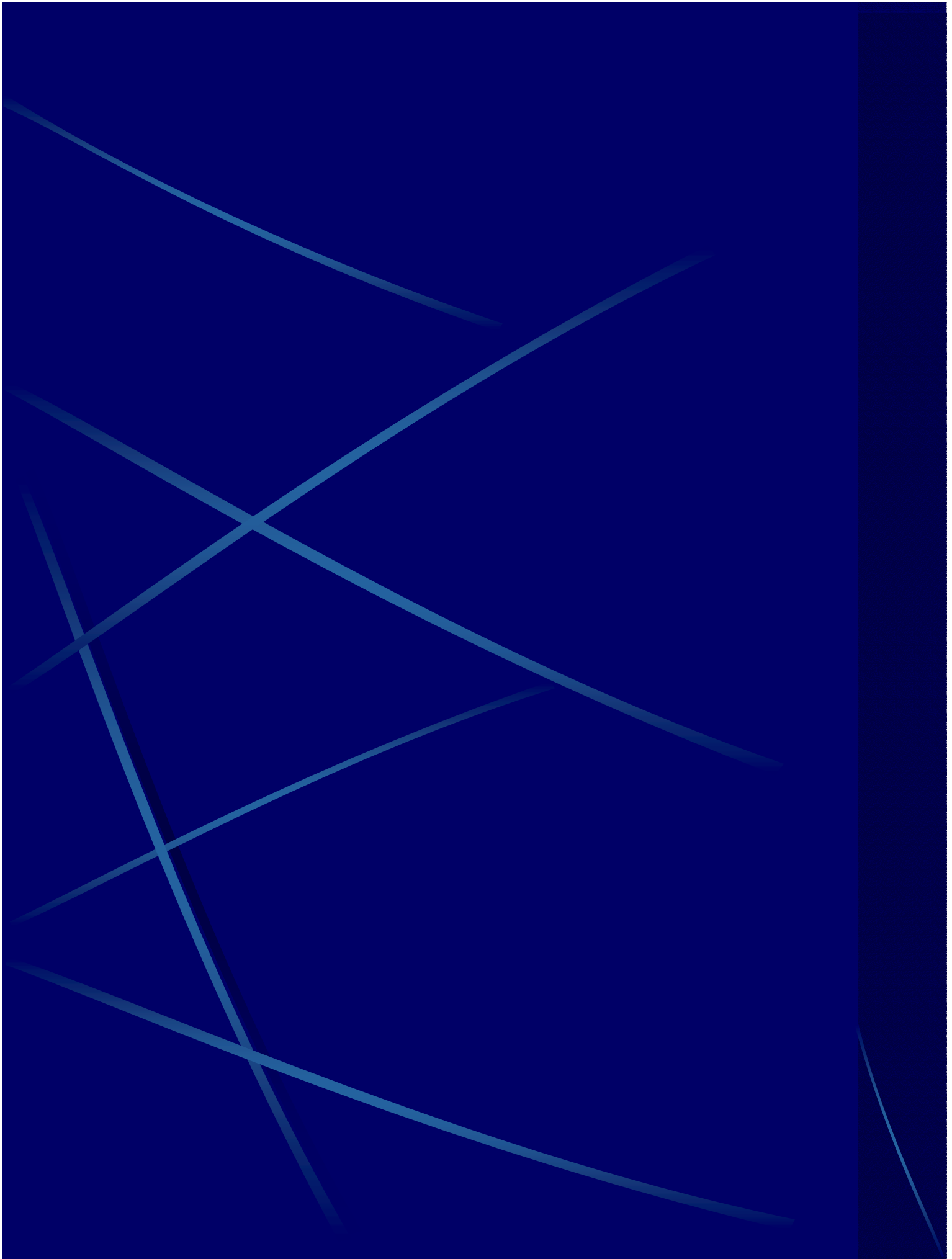


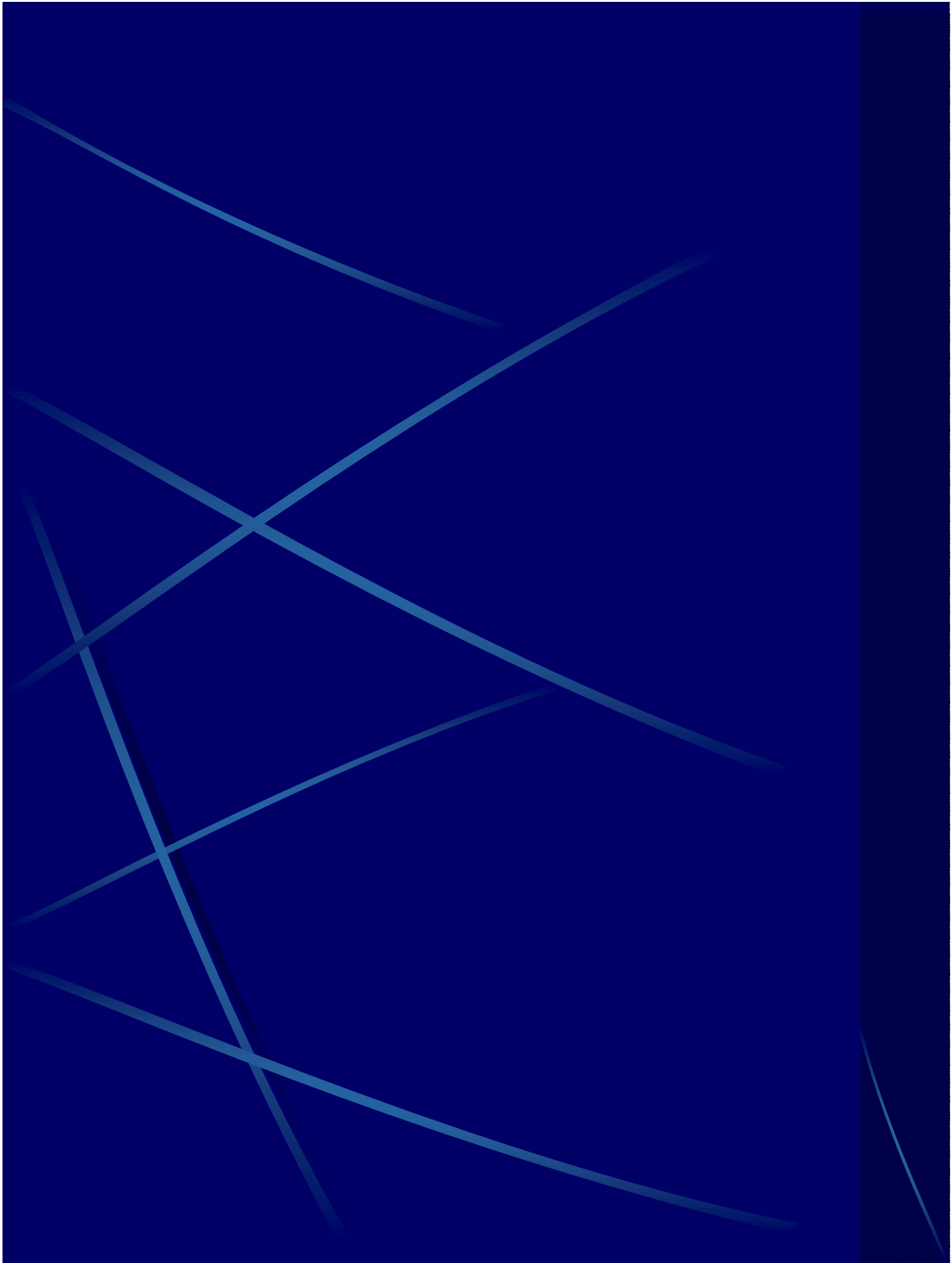
**TELEMETRIC
RAINFALL IN INCHES
AT**

	KOTLI	KALLAR	PLANDARI
0600	NIL	NIL	NIL
0700	0.57	0.25	NIL
0800	1.03	0.42	NIL
0900	0.05	0.10	0.10
1000	0.02	NIL	NIL

MANGLA DAM

INFLOW 26,700 AT 0600
INFLOW 1,13,000 AT 1000





**TELEMETRIC
RAINFALL IN INCHES**

AT

	KOTLI	KALLAR	PLANDARI
0600	NIL	NIL	NIL
0700	0.57	0.25	NIL
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0900	0.05	0.10	0.10
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MANGLA DAM

INFLOW 26,700 AT 0600

INFLOW 1,13,000 AT 1000

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