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DRAINAGE PATTERN AND ITS DISTRIBUTION IN THE KATHMANDU VALLEY

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ABSTRACT

Drainages in the Kathmandu Valley traverse the hills made up of metasedimentary rocks and Sheopuri Injection Gneiss, and the plains of fluvio-lacustrine sediments. As the streams cut into the underlying rocks and structures of the region, they give rise to certain drainage arrangement. Seven types of drainage patterns are identified in the valley. They are Dendritic, Rectangular, Trellis, Sub- parallel, Barbed, Radial and Centripetal. The Kathmandu Valley as a whole is a centripetal drainage pattern and the other drainage patterns are distributed in different tributaries within the valley.

INTRODUCTION

Rivers are the most widespread and most effective erosional agents on the earth. Every river consists of a main trunk fed from a variety of branches, each running in a valley proportional to its size, (Playfair, 1802). As the streams flow downslope they are joined by other streams or tributaries, and the river run-off progressively increases and the drainage system of the area established.

The main drainage of the Kathmandu Valley is the Bagmati River, which originates from the Sheopuri Hill. The hill forms one of the watershed boundary at an elevation of 8962 ft (2732 m) and the river flows towards south-east colescing with Sialmati and Bagmati. It enters the plain at Mulkharka and then flows semi-circularly around the Gokarna ridge; again it flows south nearly straight upto 1.5 km. When it enters the centre of the valley, it takes a nearly right angle turn to follow the course made by the rivers Manohara and Hanumnte (Fig. 1). Then it takes a sudden right angle turn at Teku to follow the course of Bishnumati. Finally, the trunk river drains the entire valley from the southern margin of the watershed in the form of gorge, called Katuwaldaha Gorge forming many meanderings and some ox-bow lakes.

The course of the Bagmati River and its tributaries have already adjusted to the existing structures as water finds it easier to flow along the fault, joint and other lineaments (Bajracharya, 1988).

DRAINAGE PATTERN

The trunk river Bagmati and its tributaries around the watershed of the Kathmandu Valley traverse through three physiographic regions. There are the hills composed of metasedimentary rocks of Lower Paleozoic age, the Sheopuri hills composed of Injection Gneiss of Permian to Miocene Age (Arita et al, 1973. Stocklin and Bhattarai, 1977) and the plains composed of fluvio-lacustrine sediments of Quaternary age (Yoshida 1984). All these regions have their own distinct lithological and structural set up which mainly influence the drainage network in the area. The arrangement of the drainage segments (Thornbury, 1969) are the functions of;

i) Inequalities of rock hardness
ii) Structural controls
iii) Initial slopes
iv) Recent geologic and geomorphic history of the drainage basin (recent diastropism)
v) Time factor in drainage evolution
vi) Climatic conditions of the area.

As the streams cut into the underlying rocks and structures they give rise to certain drainage pattern. A single drainage pattern may be influenced by a single or multiple factors. Therefore, their analysis has a significance in the identification and interpretation of geomorphic features. They form one of the most immediate approaches to the understanding of structural and lithological control of landform evolution.

Different types of drainage patterns as observed in the Kathmandu valley are as follows:

i) Dendritic
ii) Rectangular
iii) Trellis
iv) Sub-parallel
v) Barbed
vi) Radial and
vii) Centripetal

Dendritic Drainage Pattern

Dendritic pattern is the most common type of drainage pattern. It is characterized by irregular branching of tributaries in several directions at almost any angle, but usually at an angle less than a right angle (Fig. 2). This pattern is developed on horizontally bedded rocks of uniform resistance or in the areas of crystalline rocks. It shows lack of structural control. The dendritic drainage pattern is observed mostly in the Sheopuri Injection Gneiss Zone. It is also observed in the metasedimentary rocks and the fluvio- lacustrine sediments.

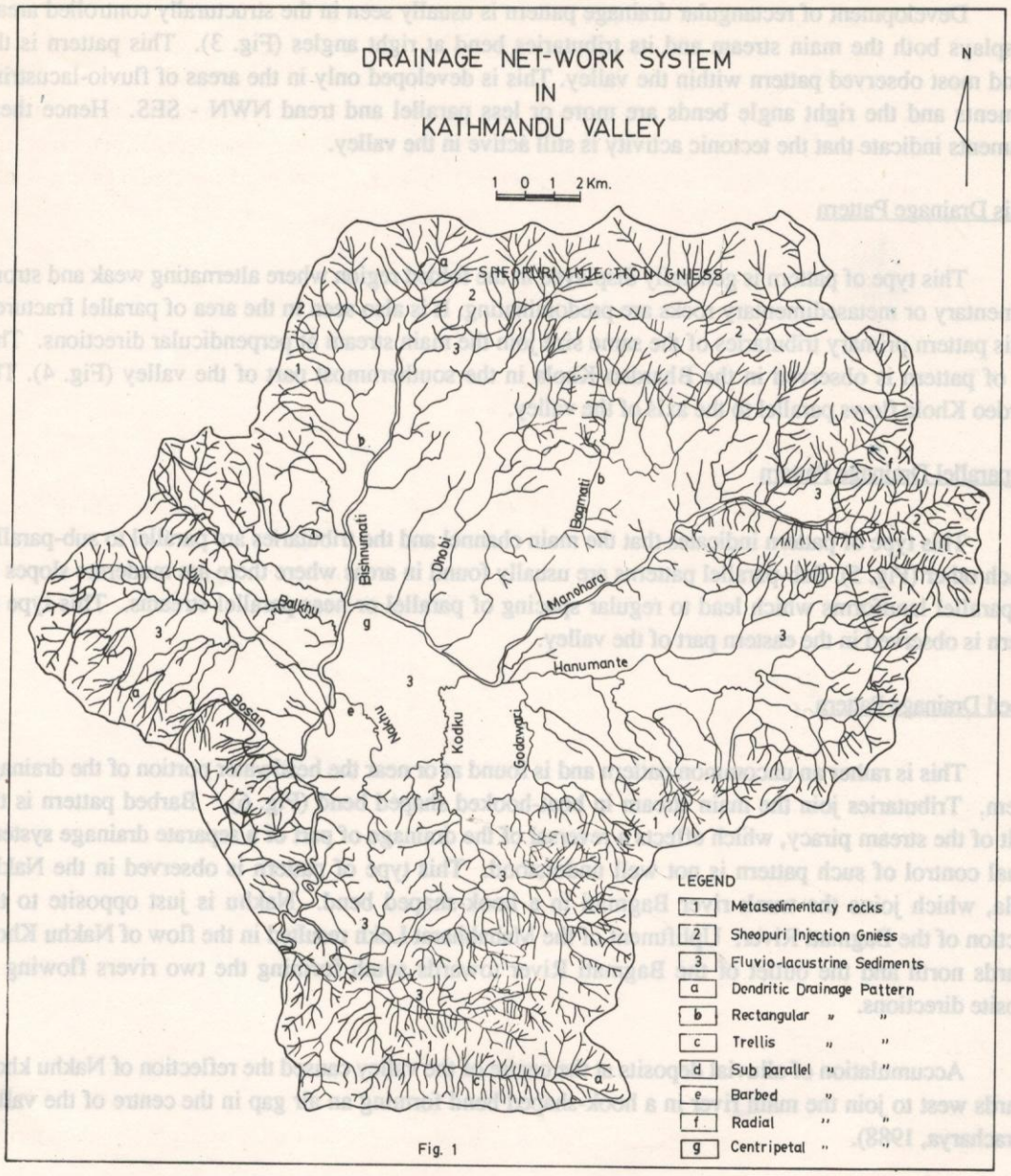
DRAINAGE NET-WORK SYSTEM
IN
KATHMANDU VALLEY
N
1 0 1 2Km.
SHEOPURI INJECTION GNEISS
Bishnumati
Dhobi
Bagmati
Manohara
Balkhu
Hanumante
Nakhu
Kodku
Godawari
Bosan
LEGEND
1 Metasedimentary rocks
2 Sheopuri Injection Gniess
3 Fluvio-lacustrine Sediments
a Dendritic Drainage Pattern
b Rectangular " "
c Trellis " "
d Sub parallel " "
e Barbed "
f Radial " "
g Centripetal " "

Fig. 1

Rectangular Drainage Pattern

Development of rectangular drainage pattern is usually seen in the structurally controlled areas. It displays both the main stream and its tributaries bend at right angles (Fig. 3). This pattern is the second most observed pattern within the valley. This is developed only in the areas of fluvio-lacustrine sediments and the right angle bends are more or less parallel and trend NWN - SES. Hence these lineaments indicate that the tectonic activity is still active in the valley.

Trellis Drainage Pattern

This type of pattern is generally displayed in the folded region where alternating weak and strong sedimentary or metasedimentary rocks are predominating. It is also seen in the area of parallel fractures. In this pattern primary tributaries of the same size join the main stream at perpendicular directions. This type of pattern is observed in the Bhardeo Khola in the southernmost part of the valley (Fig. 4). The Bhardeo Khola flows parallel to the axis of the valley.

Sub-parallel Drainage Pattern

This type of pattern indicates that the main channel and the tributaries are parallel to sub-parallel to each other (Fig. 5). Sub-parallel patterns are usually found in areas where there are moderate slopes or sub-parallel landforms which lead to regular spacing of parallel or near parallel streams. This type of pattern is observed in the eastern part of the valley.

Barbed Drainage Pattern

This is rather an uncommon pattern and is found at or near the headwater portion of the drainage system. Tributaries join the main stream in boat-hooked shaped bend (Fig. 6). Barbed pattern is the result of the stream piracy, which effects a reversal of the drainage of part of a separate drainage system. Actual control of such pattern is not well understood. This type of pattern is observed in the Nakhu Khola, which joins the trunk river Bagmati in a hook-shaped bend. Nakhu is just opposite to the direction of the Bagmati River. Upliftment of the Mahabharat Lekh resulted in the flow of Nakhu Khola towards north and the outlet of the Bagmati River towards south forming the two rivers flowing in opposite directions.

Accumulation of alluvial deposits at the centre of the valley caused the reflection of Nakhu khola towards west to join the main river in a hook-shaped bend forming an air gap in the centre of the valley (Bajracharya, 1988).

Radial Drainage Pattern

In the radial drainage pattern streams diverge from a centrally elevated features (Fig. 7). Volcanic cones, domes and isolated conical or subconical hills provide suitable condition for the development of such a pattern. This pattern is observed in the Dolpu Danda, north east of Sankhu village. The area lies

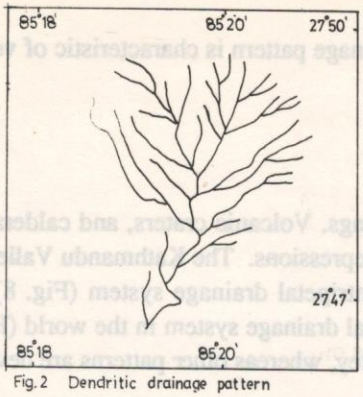

Fig. 2 Dendritic drainage pattern

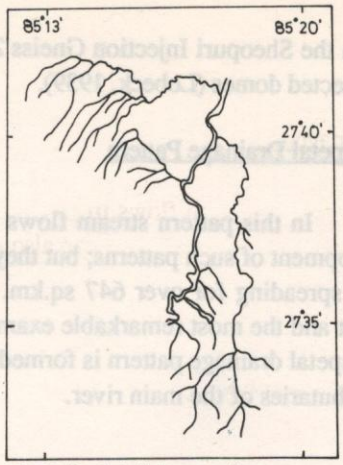

Fig. 6 Barbed drainage pattern

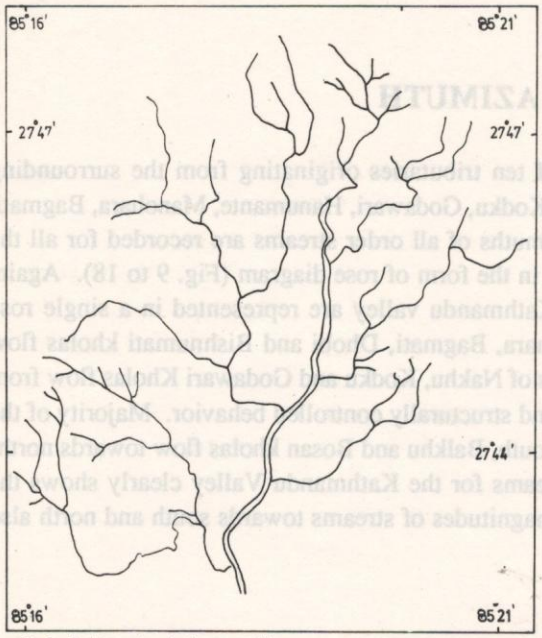

Fig. 3 Rectangular drainage pattern

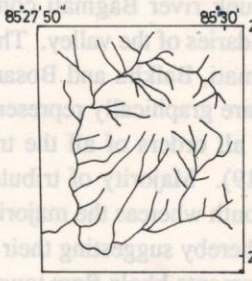

Fig. 7 Radial drainage pattern

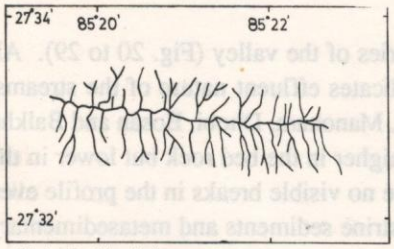

Fig. 4 Trellis drainage pattern

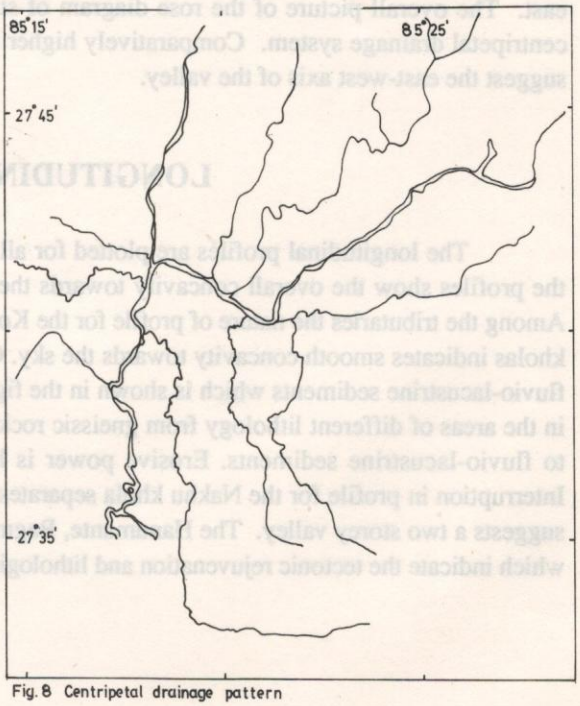

Fig. 8 Centripetal drainage pattern

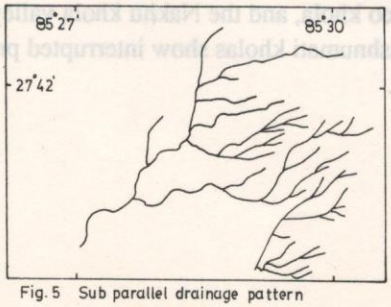

Fig. 5 Sub parallel drainage pattern

within the Sheopuri Injection Gneiss Zone. A radial drainage pattern is characteristic of very young and undissected domes (Lobeck, 1939).

Centripetal Drainage Pattern

In this pattern stream flows from the surroundings. Volcanic craters, and calderas provide the development of such patterns; but they can also form in depressions. The Kathmandu Valley is a tectonic basin spreading for over 647 sq.km. area forming a centripetal drainage system (Fig. 8). This is the largest and the most remarkable example of the centripetal drainage system in the world (Holmes 1965). Centripetal drainage pattern is formed as a unit in the valley, whereas other patterns are developed within the tributaries of the main river.

DRAINAGE AZIMUTH

The trunk river Bagmati consists mainly of ten tributaries originating from the surrounding watershed boundaries of the valley. They are Nakhu, Kodku, Godawari, Hanumante, Manohara, Bagmati, Dhobi, Bishnumati, Balkhu and Bosan Kholas. Azimuths of all order streams are recorded for all the tributaries and are graphically represented separately in the form of rose diagram (Fig. 9 to 18). Again, the azimuth of all orders of all the tributaries for Kathmandu valley are represented in a single rose diagram (Fig. 19). Majority of tributaries of Manohara, Bagmati, Dhobi and Bishnumati kholas flow from north to south whereas the majority of tributaries of Nakhu, Kodku and Godawari Kholas flow from south to north thereby suggesting their initial slopes and structurally controlled behavior. Majority of the streams of Hanumante khola flow towards west and south, Balkhu and Bosan kholas flow towards north-east. The overall picture of the rose diagram of streams for the Kathmandu Valley clearly shows the centripetal drainage system. Comparatively higher magnitudes of streams towards south and north also suggest the east-west axis of the valley.

LONGITUDINAL PROFILE

The longitudinal profiles are plotted for all the ten tributaries of the valley (Fig. 20 to 29). All the profiles show the overall concavity towards the sky which indicates effluent nature of the streams. Among the tributaries the nature of profile for the Kodku, Godawari, Manohara, Dhobi, Bosan and Balkhu kholas indicates smooth concavity towards the sky. Gradients are higher in the bed rock but lower in the fluvio-lacustrine sediments which is shown in the figures. There are no visible breaks in the profile even in the areas of different lithology from gneissic rock to fluvio-lacustrine sediments and metasedimentary to fluvio-lacustrine sediments. Erosive power is higher in the gneissic and metasedimentary rocks. Interruption in profile for the Nakhu khola separates the Bhardeo khola, and the Nakhu khola valley also suggests a two storey valley. The Hanumante, Bagmati, and Bishnumati kholas show interrupted profiles which indicate the tectonic rejuvenation and lithological change.

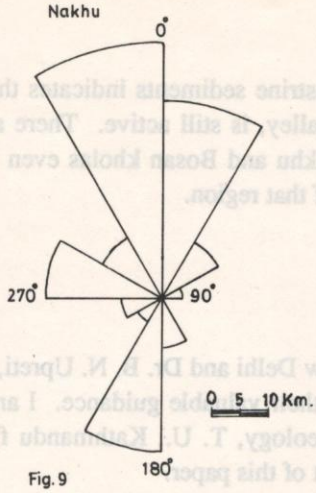

Fig. 9

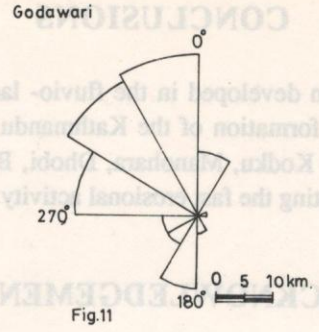

Fig.11

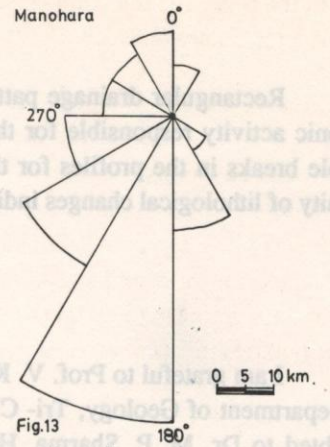

Fig.13

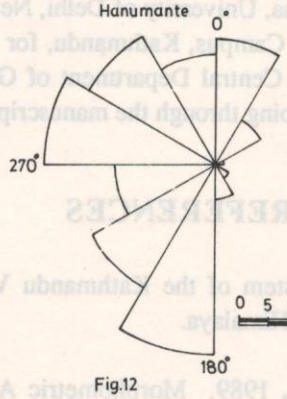

Fig.12

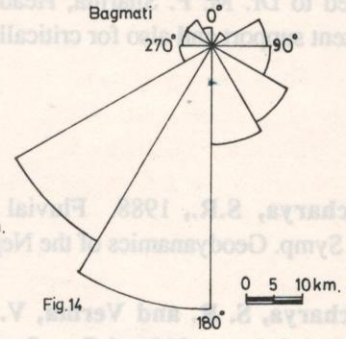

Fig.14

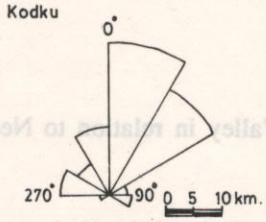

Fig.10

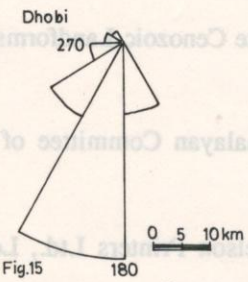

Fig.15

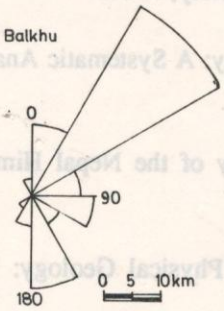

Fig.17

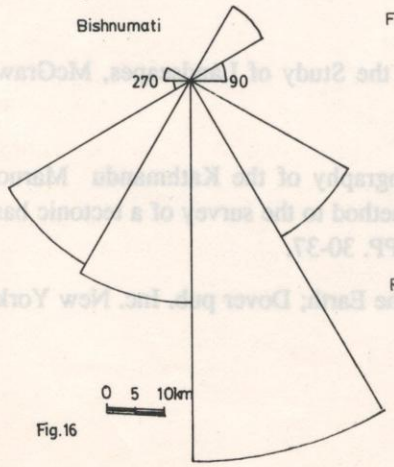

Fig.16

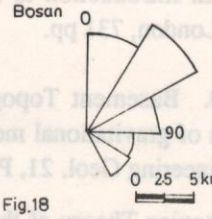

Fig.18

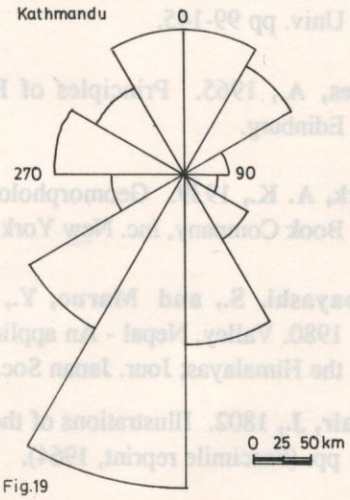

Fig.19

CONCLUSIONS

Rectangular drainage pattern developed in the fluvio- lacustrine sediments indicates that the tectonic activity responsible for the formation of the Kathmandu valley, is still active. There are no visible breaks in the profiles for the Kodku, Manohara, Dhobi, Balkhu and Bosan kholas even in the vicinity of lithological changes indicating the fast erosional activity of that region.

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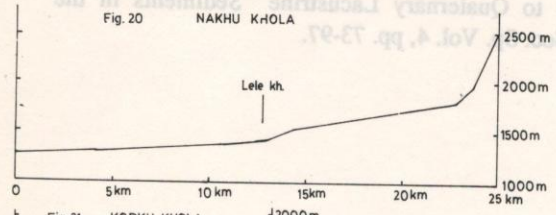
Fig. 20 NAKHU KHOLA
Lele kh.
2500 m
2000 m
1500 m
1000 m
0
5 km
10 km
15km
20km
25 km

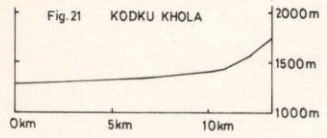
Fig. 21 KODKU KHOLA
2000 m
1500 m
1000 m
0km
5km
10km

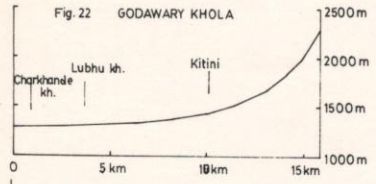
Fig. 22 GODAWARY KHOLA
Charkhande kh.
Lubhu kh.
Kitini
2500 m
2000 m
1500 m
1000 m
0
5 km
10km
15km

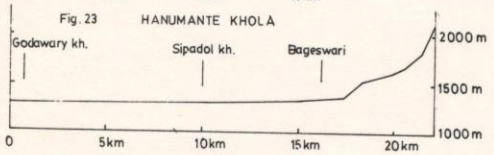
Fig. 23 HANUMANTE KHOLA
Godawary kh.
Sipadol kh.
Bageswari
2000 m
1500 m
1000 m
0
5km
10km
15km
20km

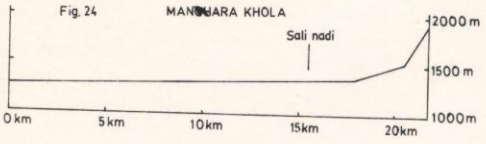
Fig. 24 MANDHARA KHOLA
Sali nadi
2000 m
1500 m
1000m
0 km
5km
10km
15km
20km

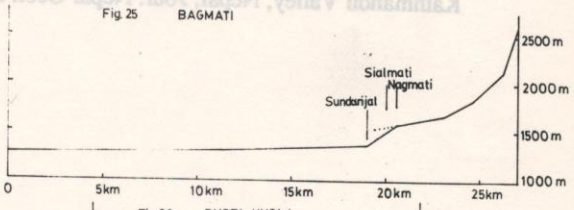
Fig. 25 BAGMATI
Sialmati
Nagmati
Sundarijal
2500 m
2000 m
1500 m
1000 m
0
5km
10km
15km
20km
25km

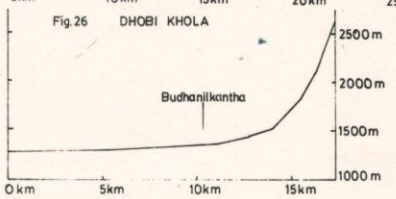
Fig. 26 DHOBI KHOLA
Budhanilkantha
2500 m
2000 m
1500m
1000 m
0 km
5km
10km
15km

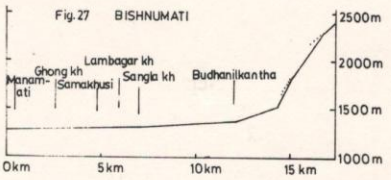
Fig. 27 BISHNUMATI
Manam-ati
Ghong kh
Samakhusi
Lambagar kh
Sangla kh
Budhanilkantha
2500m
2000m
1500 m
1000 m
0km
5km
10km
15 km

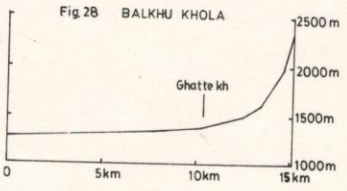
Fig. 28 BALKHU KHOLA
Ghatte kh
2500 m
2000m
1500m
1000m
0
5km
10km
15km

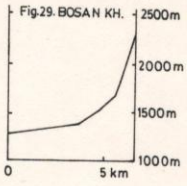
Fig. 29. BOSAN KH.
2500m
2000m
1500m
1000m
0
5 km

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