TOPOGRAPHY, DRAINAGE, IRRIGATION, GEOLOGY AND HYDROGEOLOGY OF SULTANPUR AREA

4.1. TOPOGRAPHY:

The regime has a gentle slope towards south-east with an average gradient of 1 in 5000. The plain is dissected by the Gomti river and its tributaries to produce a few ravines.

The average elevation of the region is 98.5 m above MSL, with a maximum of 111 m in the north-west and a minimum of 86 m in the south-east part (Fig. 6).

The slope in the vicinity of the Gomti river is moderate but away from the river channel they are extremely gentle. The southern and northern areas, with gentle slope, are prone to inundation and water-logging.

4.2. DRAINAGE SYSTEM:

The main rivers are the Gomti, the Sai and the Majhoi which are the tributaries to the Ganges. The area is mainly drained by the Gomti river. The drainage in the southern and northern portions is poor resulting in the development of jhils in an otherwise monotonous landscape.
Three sub-basins can be demarcated on the basis of the drainage characteristics, micro-relief and slope (Fig. 7). These are Gomti sub-basin (47.7%), Sai sub-basin (29.9%) and Majhoi sub-basin (22.4%).

4.3. IRRIGATION AND CANAL SYSTEM:

The main source of irrigation is through Sarda Canal System with Sultanpur and Jaunpur branch canals being the most important (Fig. 8).

The Sultanpur branch canal, extending from NW to SE, has two large distributaries, namely, Kurebhar and Phulpur. The distributaries irrigate an area of about 67030 ha out of 69293 ha of cultivable land.

The Jaunpur branch canal, which is roughly parallel to the Sultanpur branch, has six main distributaries, namely, Jais, Amethi, Tikri, Aurangabad, Gopalpur and Ramganj. The distributaries with minors irrigate an area of about 1.23 lakh ha out of 1.28 lakh ha of cultivable land.

Two other distributaries, Subeha and Singhpur, also irrigate the northern part of the area.
DRAINAGE SYSTEM OF SULTANPUR DISTRICT, U.P.

LEGEND

- STREAM
- BASIN (WATERSHED) BOUNDARY
- RIVER

Fig. 7

BASED ON S O I TOPO-SHEETS AND TM FCC

SCALE

Km
4.4. GEOLOGY:

Sultanpur area lies in the Ganga-Ghagra doab (interflue), and represents a part of the Indo-Gangetic alluvial plain of Quarternary age. The alluvium is supposed to has been brought down from the Himalayan ranges by the Ganga river system (Dutt, 1968).

4.4.1. Geological Evolution Of Indo-Gangetic Plain:

The Indo-Gangetic Plain is the largest alluvial plain in the world. It lies between the Peninsular India and the Himalayas (Fig. 9) and represents a rapidly sinking basin which has been filled with sediments deposited almost exclusively under the fluvial conditions.

The geological evolution of the Indo-Gangetic Plain has been explained variously. According to Eduard Suess, the great Austrian geologist, the plain represents a 'fore-deep' infront of a resistant mass of peninsula where the Tethyan sediments were thrusted southward and compressed against them. The 'fore-deep' which was a remnant of the sea of Tethys, was filled up by the sediments brought down by the Himalayan rivers in the north and peninsular rivers in the south. Thus the Indo-Gangetic plain came into existence. A similar view was, subsequently expressed by Misra (1981) and others.
Fig. 9 Diagrammatic representation of the Ganga Trough showing the main basin between the Peninsular highlands in south and the Himalayan region in north. Extension of the Peninsular and the Himalayan sedimentary formations can be seen below the alluvium (After Misra, 1981).
As evidenced by physical and geodetic conditions, the plains occupy a 'rift valley' formed due to sinking of earth's surface with pari passu alluvial deposition. The rift extending from the surface far down into the crust, about 32 km deep (Burrard, 1921). However, The Indo-Gangetic depression has been considered a true fore-deep with a downward of the Himalayan fore-land of variable depth, thrusting into flat plains by alluviation. According to geologists, vigorous deposition of sediments in the depressions would account for this vast tectonic trough (see Fig. 9).

Another view invokes a sag in the crust in the north of the drifting Indian subcontinent giving rise to a depression which was filled by the fluvial sediments. Subsequent uplift of sediments resulted in mountain range.

Regarding the age of the formation, it is believed that deposition of the alluvium began with the uplift of Siwaliks from Middle Pliocene to Pleistocene period and continued up to the present. The Indo-Gangetic depression must have come into existence during the later stages of Himalayan orogeny. The formation of the depression, probably, began in Upper Eocene and attained its maximum during the third upheaval in the Middle Miocene. Since then gradual filling of sediments made it into a level plain with a very gentle seaward slope. The broad uniformity of detritus suggests that it was subsiding through the Pleistocene times. The Upheaval of the Himalayan
mountains from Middle Pleistocene to Recent times, would rejuvenate young streams, thereby, increasing their carrying capacity, leading to rapid filling of the depression.

Oldham (1917), on the basis of geological observations, estimated that the maximum depth of the trough near its northern limit was 4600 meters. This rose (upward) southward to merge with the Vindhyan Uplands of the Deccan. The gravity, magnetic and seismic surveys suggests that thickness of the alluvial cover varies from 1000 m to 2000 m. Glennie's (1932) geodetic estimates gave a thickness greater than 3000 m. Borings sunk for artesian wells in the alluvial tract upto 1606 m encountered no basement rocks.

The red Sirbu shales of Upper Vindyan age were however, encountered below 379.36 m depth in a boring at Aligarh (C.G.W.B., 1976).

4.4.2. Tectonic Framework of Ganga Basin:

The Ganga Basin extends as a monotonous alluvium filled plain between Delhi and Saharsa. It is bounded by Delhi-Hardwar ridge on the west and Munger-Saharsa ridge on the east (Sastri et al., 1971). The central part of the Ganga Basin is characterised by a prominent geophysical feature generally referred to as 'Faizabad ridge' and considered as the northern extension of the Bundelkhand Granitoid massif (Fig. 10).
TECTONIC MAP OF GANGA BASIN & ADJOINING AREAS

NOTE A: Dots indicate the youngest sedimentary sequence directly overlying the basement.
Dense hachings indicate the oldest sedimentary sequence (thickness not according to scale) and the age of the basement.

LEGEND

SEDIMENTARY COVER OF GANGA BASIN

GONDWANA (LOWER AND UPPER UNDIFFERENTIATED)
UPPER CARBONIFEROUS-LOWER CRETAEOUS
UPPER PROTEROZOIC-LOWER PALAEOZOIC
LEGGOE (OECCAN TRAPS/RAJMAHAL TRAPS, ETC.)

TECHTONIC AND STRUCTURAL FEATURES

Fig. 10
(AFTER TECTONIC MAP OF INDIA, 1969 BY OIL & NATURAL GAS COMMISSION)
4.4.3 Geology/Geomorphology of Sultanpur Area:

Sultanpur area lies in the Central Gangetic plains of Quaternary age, on the Faizabad ridge. The basement depth is estimated at around 1000 meters. Although sub-surface is not known, it is likely that the Granites which were encountered in drilling at Kanpur may be present as basement rocks in the Gomti Valley too (Rao et al., 1982).

The deposit consists chiefly of various grades of sand, silt and clay in a vertical section at Amethi (Fig. 11). Very coarse sand or gravel layers are not so common. Zones of kankar (calcium carbonate) occasionally occur in very fine-grained strata.

Succession:

The alluvial deposits of Sultanpur area are referred to as Older Alluvium and Newer Alluvium. The Older Alluvium, have of greater extent distributed away from the flood plain of River Gomti. The Newer Alluvium occupies the low-lying areas of the flood plain of the river basin and the narrow flood plains of its tributaries. The Older Alluvium is designated as Sultanpur Alluvial Formation. The Newer Alluvium has been sub-divided into Gomti Older Flood Plain Formation and Gomti Recent Flood Plain Formation (Iqbaluddin et al., 1990). Khan et al. (1992) have designated the Older
Fig. 11 GENERAL LITHOLOGICAL VARIATION IN VERTICAL SECTION, AMETHI, SULTANPUR DISTRICT. (After U.P. Jal Nigam & G.W.I.O., Lucknow)
Alluvium as Varanasi Older Alluvium (VOA). The Newer Alluvium has been subdivided into Gomti Terrace Alluvium and Gomti Recent Alluvium. The geomorphic units have been used along with lithology as stratigraphic indicators for mapping the formational units. An interpretation of geological and geomorphological units attempted from the TM FCC imagery (Fig. 12) as image characteristics are presented in Table 7. A generalized sequence of the lithostratigraphic (geological) units along with lithology and associated geomorphologic units is presented in Table 8 and 9.

Geomorphologically, the terrain has been classified into three major landforms as follows (Khan et al., 1992):

i) Varanasi Older Alluvial Plain:

This plain is the flattish sprawling, oldest and highest alluvial surface covering most parts and replete with relict trails and strings of palaeochannels, tals, oxbow lakes of ancestral degenerated palaeodrainage system.

ii) Gomti Older Flood Plain:

This plain comprises two terrace levels. The higher level terrace level (T₂) is of erosional nature over Varanasi Older Alluvium and the younger (lower) terrace (T₁) is patchy and lenticular.
QUATERNARY GEOLOGICAL AND GEOMORPHOLOGICAL MAP OF SULTANPUR DISTRICT, U.P.

LEGEND
GOMTI RECENT ALLUVIUM (NA)
GOMTI TERRACE ALLUVIUM (NA)
VARANSI OLDER ALLUVIUM

N.A.: NEWER ALLUVIUM

LEGEND
GOMTI RECENT FLOOD PLAIN
GOMTI OLDER FLOOD PLAIN
VARANSI OLDER ALLUVIAL PLAIN
TERRACES
PALAEOCHANNEL
NATURAL LEVEE
OX-BOW LAKE
MEANDRING SCAR
POINT/CHANNEL BAR
WATER-LOGGING

Fig. 12

INTERPRETATION FROM LANDSAT TM FCC

SCALE
5 0 5 10 Km
<table>
<thead>
<tr>
<th>Geology/Geomorphology</th>
<th>Image Characteristics</th>
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</thead>
<tbody>
<tr>
<td><strong>Newer Alluvium</strong></td>
<td></td>
</tr>
<tr>
<td>Gomti Recent Alluvium/ Gomti Active Flood Plain</td>
<td>- White, purplish blue and pink (mixed tone),</td>
</tr>
<tr>
<td></td>
<td>(Light tone, linear pattern along river channel and flood plain, irregular shape).</td>
</tr>
<tr>
<td></td>
<td>- Point bar - White tone (Light tone)</td>
</tr>
<tr>
<td></td>
<td>- Oxbow lake - Bluish tone (Dark tone)</td>
</tr>
<tr>
<td>Gomti Terrace Alluvium/ Gomti Older Flood Plain</td>
<td>- Medium red and Bluish tone pinkish and medium red tone (Medium to light tone, matted texture, irregular pattern and shape).</td>
</tr>
<tr>
<td></td>
<td>- Palaeochannel/ meandering scar - Bluish tone (Dark tone)</td>
</tr>
<tr>
<td><strong>Older Alluvium</strong></td>
<td></td>
</tr>
<tr>
<td>Varanasi Older Alluvium/ Varanasi Older Alluvial Plain</td>
<td>- Pinkish, purplish and white tones (saline). (Medium to light tone, fine texture, irregular pattern and shape)</td>
</tr>
<tr>
<td></td>
<td>- Natural levee - Pinkish (Medium tone)</td>
</tr>
<tr>
<td></td>
<td>- Palaeochannel/ meandering scar - Greyish with white patches (saline/sodic), (Dark and light tone).</td>
</tr>
<tr>
<td></td>
<td>- Water body Blue tone (Very dark tone)</td>
</tr>
</tbody>
</table>
Table 8 Succession of Sultanpur area (After Iqbaluddin et al., 1990).

<table>
<thead>
<tr>
<th>Era</th>
<th>Geological Formation</th>
<th>Lithology</th>
<th>Geomorphic Unit</th>
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<tbody>
<tr>
<td>Q</td>
<td>Newer Alluvium</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Gomti Recent Flood Plain Formation</td>
<td>Micaceous gray sand.</td>
<td>Flood plain/Point bar/Channel bar (T₁)</td>
</tr>
<tr>
<td>U</td>
<td>Older Alluvium</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>Gomti Older Flood Plain Formation</td>
<td>A cyclic sequence of brownish yellow silt and gray micaceous sand.</td>
<td>Lower Terrace (T₁)</td>
</tr>
<tr>
<td>T</td>
<td>Sultanpur Alluvial Alluvial Formation</td>
<td>A sequence of gray/yellow/brown clay/silty clay loam/silty loam/loam</td>
<td>Vast flat peneplain, marked by tals cut-off meanders, palaeochannels</td>
</tr>
<tr>
<td></td>
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</tr>
</tbody>
</table>

FAIZABAD RIDGE
(Base not seen)
<table>
<thead>
<tr>
<th>AGE</th>
<th>Lithostratigraphic units</th>
<th>Lithology</th>
<th>Morphostratigraphic units</th>
</tr>
</thead>
<tbody>
<tr>
<td>H</td>
<td>Gomti Recent Alluvium</td>
<td>Grey, micaceous medium to fine grained point bar/channel bar sands and over bank silts (5m)</td>
<td>Gomti Active Flood Plain</td>
</tr>
<tr>
<td>O</td>
<td>Gomti Terrace Alluvium</td>
<td>Multiple fill, cyclic sequence of grey micaceous, medium to fine sands, silt and clays (5-10m)</td>
<td>Gomti Older Flood Plain</td>
</tr>
<tr>
<td>N</td>
<td>Middle Vanarasi to Older Alluvium</td>
<td>Polycyclic sequence of yellowish, brownish, silt and clays with frequent kankar desiccations and grey, brownish sands with occasional interbeds of calcareous sandstone and grits (exposed thickness: 5-20m)</td>
<td>Varanasi Older Alluvial Plain</td>
</tr>
<tr>
<td>E</td>
<td>Upper Pleistocene Alluvium</td>
<td>Not exposed and Subsurface occurrence inferred from CGWB borehole record</td>
<td>Banda Older Alluvium Gravelly coarse gravelly coarse qartzofelspathic sand grits with lithoclas of charts jaspar variegated clays total thickness 220m approx.</td>
</tr>
</tbody>
</table>

------------------- Disconformity -------------------

Bundelkhand Grainite/Vindhyan (Basement concealed interpreted from Geophysical Surveys)
iii) Gomti Active (Recent) Flood Plain:

The plain has abundance of point bars and channel bars, restricted to the present day bank lines of meandering Gomti.

Environmental hazards observed in the area include soil alkalinisation/salinisation, seasonal water-logging, badland formation and bank erosion, mainly confined to Varanasi Older Alluvium and annual/periodic flooding of Gomti terraces.

4.5. HYDROGEOLOGY:

4.5.1. Occurrence of Ground Water:

The ground water occurs under the water-table and in confined aquifers at shallow and deeper levels. In shallow aquifers, the ground water occurs under the water-table conditions and in deeper aquifers it occurs under semi-confined to confined conditions.

Three aquifer zones have been identified by the Central Ground Water Board in the region. They are (Fig. 13):

1. The shallow aquifer, upto 15 m below ground level (b.g.l).
2. The middle level aquifer (semi-confined) between 10-70 m b.g.l.
3. The deep aquifer (confined) at a depth greater than 100 m b.g.l.
SUB-SURFACE LITHOLOGICAL CORRELATION IN PARTS OF SULTANPUR DISTRICT
ALONG A-B

LEGEND
+ State tubewell

After CGWB Lucknow
The main source of ground water in the area can be attributed to:

1. Seasonal precipitation
2. Recharge when the streams are in spate
3. Seepage from the network of canal system
4. Return seepage from irrigation
5. Lateral inflow from adjacent areas

About 273 well observation stations were established under NRDMS, DST project, A.M.U. Aligarh on grid basis at intervals of 2'30" longitude and 2'30" latitude. Measures of water level were obtained in the premonsoon period of 1987.

4.5.2. Depth to Water Level Map:

The map of depth to water level below ground level shows an isotropic distribution in the vertical and horizontal spread of sand bodies within the Quaternary alluvia (Fig.14).

The contour patterns show higher values (range 8-10 m b.g.l.) along the Gomti river becoming gradually shallower away from it. The water level is shallower in the southern and northern parts of the area (<4 m b.g.l.) in the Sai and Majhoi sub-basins which flank the Gomti sub-basin.

Ground water quality is poor (saline) in shallow water-table area.