CHAPTER 5

STREAMFLOW - GEOMORPHOLOGY

The two mantras X.82.1 and X.121.1 of Rig Veda represent the creation to have started with the origin of water and the cosmic golden egg (embryo) (हिरण्यगर्भ) which very well fits in the geological and biological evalution of the earth with the water age, origin of zoophytes, primeaval fishes, reptiles, invertebrats, vertebatess and mammals.

चक्षुषः पिता मनसा हि धीरो घृतमेने अजनन्नम्नमाने ।
यदेदन्ता अदन्दृहन्त पूर्व आदिद्द्यावापथिवी अप्रथेताम् ॥ RV.X,82.1 ॥

हिरण्यगर्भः समवर्तताग्रे भूतस्य जातः पतिरेक आसीत् ।
स दाधार पृथिवीं द्यामुतेमां कस्मै देवाय हविषा विधेम् ॥ RV.X,121.1 ॥

According to the Rig Veda the earth abounds in heights bears the burden of mountains, and supports the trees of the forests in the ground (क्षमा). She quickens for she scatters rain, and the showers of heaven are shed from the lightning of her clouds. She is great (महीं), firm (दृढ़) and shining (अर्जुनी).

Perhaps the Rigveda Aryans had the concept of knowing slopes also of a region by the help of rivers as indicated (RV.IX,88.6) below:

एते सोमा अति वाराण्यव्या दिव्या न कोशासो अभ्रवर्षाः ।
वृथा समुद्रं सिन्धवो न नीचीः सुतासो अभि कलशां असृग्रन ॥
RV.IV,88.6 ॥

Talking about the river flow whose turbulence is lost after meeting the oceans, the Rigveda says

समन्या यन्त्युप यन्त्यन्याः समानमूर्वं नद्यः पृणन्त ॥ RV.II,35.3 ॥

In the verses (IV,18.6 and IV,19.3) say that rivers are the daughters of sun & cloud. They run towards oceans breaking the soil, rocks etc. coming on their way. They flow in thrugh zig-zap paths

एता अर्षन्त्यलालाभवन्तऋितावरीरिव संक्रोशमानाः ।
एता वि पृच्छ किमिदं भनन्ति कमापो अद्रिंपिरिधिं रुजान्ति ।।
RV.IV,18.6 ।।

During Rigveda the Aryan were clearly aquanted with the river stages and its velocity at different stages. One verse (VI 24.6) mentions the high spead of mountaneous rivers flowing down the slope. Similarly verse VI 36.3 reveals the same fact.

वि त्वदापो पर्वतस्य पृष्ठादुत्थेभिरिन्द्रानयन्त यज्ञै : ।। RV.VI,24.6 ।।

By the time of Samveda, Yajurveda and Atharveveda the indians had come to acquire sufficient knowledge of physiography and geomorphology. This is established by the following geographical technical terms - उपह्वर (mountain slopes, SV.II, 5.9), इरिण (cleft or ऊपर), शिला (stony place), क्षयण (habitable place), काट (forest having a difficult communication), ह्रद (lake), लोप (rugged lands or bad lands)(Ts,IV,5.9.1). In the Samveda we come across a brief but fine description of a river mouth and as a wave of the sea opposit to the mouth of a river sends into it a portion of its water (SV XIV,4). The Prithvi Sukta (XII) of the Atharveveda, furnishes a concise account of physiography - mountains, snowcapped mountains, forest lands, plain areas (सम) and perennial stream or slopes (प्रवत). Following two Mantras of Atharvaveda say that if the water source is on mountains, then the river formed will be Perrenial and will flow with high speed (AV.I.,15.3) viz.

ये नदीनां संस्त्रवन्त्युत्सासः सदमाक्षिताः । A.V.I.,15.3 ।।

Similarly Verse (II,3.1) reveals the same fact saying that the rivers originating from snowclad mountains will keep on flowing in summer also.

अदो यद्ववधावत्यवत्कमाधि पर्वतात् ।। AV.II,3.1 ।।

In the Gopathabrahmane the nomencleture for a meandering river is विपाट (II.8). It was also aquainted with two types of springs or falls, namely hot and cold,.... शीतोष्णाविहोत्सौ (G.B.II,8).

The celebrated epic Ramyana reveals very rich and accurate knowledge of various types of geomorpholigical patterns. Some of the geomorphological patterns in the Ramayana related to water are quoted below:

Rivers and rills and Plateous, caverns and fountains (II,54.42), the plain tracts (II,56.11), sandy banks of rivers (II,55.31).

सरित्प्रस्त्रवणस्थान् दरीकन्दरनिर्झरान् ।। Ramayana II, 54.42 ।।
समभूमितले रम्ये द्रुमैर्बहुभिरावृते । पुण्ये रंस्यामहे तात चित्रकूटस्य कानने ।।
Ramayana.II,56.11 ।।

विचित्रवालुकजलां हंससारसनादिनाम् ।
रेमेजनकराजस्य सुता प्रेक्ष्य तदा नदीम् ।। Ramayana II, 55.31 ।।

Those lands watered by the Ganga are dense and hard to track (II,85.4)

कतरेण गमिष्यामि भरद्वाजाश्रमं यथा ।
गहनोयं भृशं देशो गङ्गानूपो दुरत्ययः ।। Ramayana II, 85.4 ।।

Knowledge of water falls (II,94.13) and descent of a river (II,103.25) is described as below:

जलप्रपातैस्त्वभेदैर्निष्पन्दैश्च क्वचित् क्वचित् ।
स्त्रवद्भिर्भात्ययं शैलः स्त्रवन्मद इव द्विपः ।। Rama.II,94.13 ।।

नदीं मन्दाकिनीं रम्यां सदा पुष्पितकाननाम् ।। II,103.24 ।।

शीघ्र स्त्रोतसमासाद्य तीर्थं शिवमकर्दमम् ।
सिषिचुस्तूदकं राज्ञे तत एतद् भवत्विति ।। Rama.II,103.25 ।।

How after melting of snow, a mountaneous topography becomes charming is spoken of thus - हिमात्यये नगमिव वास्कन्दरम् (Ramayana II, 7.15). The author of epic has also marked "river erosion on non-resistant or soft steep river bank (II,63.46; V,34.19; VII,14.18).

रुणद्धि मृदु सोत्सेधं तीरमम्बुरयो यथा || Rama.II, 63.46 ||
चित्तं हरसि मे सौम्य नदीकूलं यथा रयः || Rama,V, 34.19 ||
सीदन्ति च तदा यक्षाः कूला इव जलेन ह || Rama,VII,14.18 ||

In VII,23.42 we read about the erosive action of the downpour of rain on mountains. viz.

सायकैश्चापवक्त्रभ्रष्टैर्वज्रकल्पैः सुदारुणैः ।
दारयन्ति स्म संक्रुद्धामेघा इव महागिरिम् || Rama.VII, 23.42 ||

The Mahabharata devides the Himalayan mountains into three regions. It mentions large tracts of desert several times (I,70.2). In certain context the word नदीकच्छ is used. Most probably it indicates the land form which nowadays called Delta.

एक एवोत्तमबलः क्षुत्पिपासाश्रमान्वितः ।
स वनस्यान्तमासाद्य महच्छून्यं समासदत् || M.B.,I,70.2 ||

नदीकच्छोद्भवं कान्तमुच्छ्रितध्वज संनिभम || M.B.,I,70.17 ||

In Paninis Astadhyayi (600-700 BC), we come across several important geomorphological patterns. The grammarian calls a river moving and breaking its banks as भिन्द्य and are whose water overflow the banks as उद्ध्य (III,1.15).

Glacier is named as हिमानी (IV,1.49) viz.

इन्द्रवरुणभवशर्वरुद्रमृडहिमारण्ययवयवनमातुलाचार्याणिमानुक ||
Astadhya,IV,1.49 ||

Topography and Geomorphology have not been left out of the campus of the versatile genius of Kautilya (4th century BC). At

certain context he talks of such varities of land as "forests, villages, waterfalls, levlel plains and uneven ground", stretching between the Himalayas and Ocean (Arthasastra, Trans. by Shamshastri P.404). At various places be speaks of fertile, infertile, cultivable, uncultivable and waste land, which reveals that he must have possessed good knowledge of the science of soil also.

The Vayu Purana refers to various types of topography namely lakes, dales, barren tracks (Chapter 38), rocky throughs between mountains (अन्तद्रोणी)(38.36).

पश्चिमायां दिशि तथा येन्तरद्रोणिविस्तराः ।
तान्वर्ण्यमानांस्तत्वेन श्रृणुतेमान्द्विजोत्तमाः || Vayu,38.36 ||

The chapter also speaks a large number of hot springs in a mountainous region (38.78).

तथा ह्यनलतप्तानि सरांसि द्विजसत्तमाः ।
शैलकुक्ष्यन्तरस्थानि सहस्त्राणि शतानि च || Vayu,38.78 ||

In the Markandeya Purana we come across a peculiar type of topography found "in the Kimpurusaversa and seven other countries" where water bubles up from the ground (53.21-22).

नवस्वपि च वर्षेषु सप्त सप्तकुलाचलाः ।
एकैकस्त्रिस्त था देशे नद्यश्चाद्रि विनिः सृताः || Markandeya P.53.21 ||

यानि किं पुरुषाद्यानि वर्षाण्यष्टौ द्विजोत्तमः ।
तेषूद्भिज्जानि तोयानि नैवं वार्यत्र भारते || Markandeya P.53.22 ||

The Vishnu Purana (II,5.3) classified the soils of subterranean region in seven categories, (1) Black (2) White or Yellowish (3) Blue or Red (4) Yellow (5) Gravelly (6) Hilly or boulder and (7) Golden hued, viz.

शुक्लकृष्णाः पीताः शर्करा: शैलकाञ्चनाः ।
भूमयो यत्र मैत्रेय वरप्रासाद्भाण्डता || Vishnu, II, 5.3 ||

The Jain work Vrhatsetrasamsa (6-7 century AD, Tripathi, 1969) appears to be quite scientific and mathematical enumerations conforming to some hydrographical or hydrological law, but actually they contain a small grain of truth. For example "the dimension of a river at its mouth when it enters ocean is ten times that is possesses at its source in a lake or the like (I.227). But the knowledge contained is appreciable atleast qualitatively. A Buddhist literature Anguttaranikaya (before 400 BC), classifies lakes into four categories (Part II, Page 105, Tripathi, 1969).

In the celebrated law work Manusmriti, a lake has been termed as गर्त (IV.203).

नदीषु देवखातेषु तडारोषु सरः सु च ।
स्नान समाचरेन्नित्यं गर्तप्रस्त्रवणेषु च ।। Manusmriti,VI,203 ।।

From the above discussion we gather that in ancient India the knowledge of streamflow and geomorphology was well developed on scientific lines. The techniques of knowing slope of an area by means of a flowing river and dimension of river at various stages alongwith velocity were developed. Mountaneous rivers are generally perennial and deposition of fertile soil periodically on flood plains was understood which is in accordance to the modern experiences. Various types of topographies such as springs, water falls, mountaineous, plateaue, eroded land etc. alongwith many geographical terms such as शिला, इरिण, क्षयण, लोप were used. Land classification such as fertile, infertile, cultivable, waste land etc. and soil classifications such as black, yellow, red, gravelly, boulders etc. well before 4th century B.C. which are in vogue even at present can be regarded as the important achievement of the ancient Indians in this field.