CHAPTER 1

INTRODUCTION

The origin and evolution of agriculture and feeling need of irrigation are not separate processes. They are closely connected with the general course of history of Plant growing, with the invention of tools and irrigation techniques. In ancient days when advanced methodologies or principles of hydrology were unknown man had realized that water is essential for survival , and therefore the earliest civilizations were distinctly and Predominantly hydraulic in character as they owe their origin to reliable sources of water to meet their various needs. Rivers Played such a pivotal role in the life and living of those people that their civilizations came to be known as river valley civilizations, such as the Nile in Egypt, the Tigris Valley Civilizations in Mesopotamia, the Howang-Ho in China and the Indus in India. All these civilizations existed from 3000-2000 B.C. and their are historical evidences to show that certain engineering measures were adopted during that period in order to sustain as well as enhance benefits from rivers and also to Protect against damaging phenomeno of floods. Fall of these civilizations and gradual decay of some of them were partly prompted by mankind's creeping inability to cope up with adverse and damaging consequences of his interference with hydrology and hydraulics of the respective rivers in his attempts to derive benefits.

Ancient Indian literature show the development of Sciences (as also hydrological Science) which go back to the age of Vedas. It is a good fortune that the ancient Sanskrit works have been preserved and not lost through centuries of domination by alien races and alien cultures in India. The elite in the society cherished an abiding love and respect for Sanskrit learning and Sanskrit culture which enabled the learning and culture to survive inspite of being subjected to the "winds of

changes" of alien cultures.

It is true that, in the realm of spiritual values, the Indian heritage was great and sublime and perhaps unparalleled as testified by some of the great persomalities of the west who underwent the toil of learning Sanskrit and presenting the world with translations in English and German of the renowned texts of Vedas and Upanishads.

Sciences in Ancient India:

Very few workers in the scientific world are aware of how much science, as understood and accepted by scientists is contained in the ancient Sanskrit literature. It is a moot question whether the ancient sages had adopted the methods of modern science of laboriously collecting observational data and integrating them through apparopriate concepts into useful and acceptable truths. Observation as a medium of realising the underlying truths could not have been ignored.

Science is defined as ordered knowledge of natural phenomena and the rational study of the relations between the concepts in which these phenomena are expressed. It is in its widest sense, a systematic method of describing and controlling the material world. It can be seen, as it stands at any moment, as a logical and coherent account of that order which the scientists of the time finds in nature. It progressively affects man's life. In India, at the beginning of the third milennium B.C., an advanced state of Indus Valley Civilization existed at Mohenja-daro, Harrappa and elsewhere, and a scale had been discovered indicating the use of decimals. Preparation of the Vedic Calendar for various ceremonies and of rituals necessitated the study of heavenly bodies and of their movements, and this led to the advancement of the astronomical Science, (Prasad, 1980).

The sun light constitute seven colour rays was known to Vedic Aryans as it is clear from following mantra (RV.II, 12.12)

यः सप्तरश्मिर्वृषभस्तुविष्मानवासृजत्सर्तवे सप्त सिन्धून ।
यो रौहिणमस्फुरद्वज्रबाहुर्द्यामारोहन्तं स जनास इन्द्रः । (RV.II,12.12)

Which means that the sun containing red etc. seven colour rays is the cause of water flow in the rivers (because of rain). After rain it again attracts water from earth and this cycle goes on.

Indian arithmetic is remarkable in that there is evidence to show that as early as third century B.C. a system of notation was evolved from which the scheme of numerals that is in vogue even today has been copied. The Aryabhatta studied the summation of arithmetic series and attempted to solve quadratic indeterminate equations. Brahmagupta developed the application of explicitly general algebraic methods to astronomical problems. The beginning of the medical sciences go back to the age of the Vedas. The early beginnings of the art of healing and of the knowledge of healing herbs are found in the 'Kausikasutra' of the 'Atharvaveda'. Susruta and Charaka were well known surgens & physicians. The medical work of Vagbhata of the seventh century contains the first mention of mercury, (Prasad, 1980).

The most remarkable feature of the Buddhist Philosophy of India is the formulation of the atomic theory of Kanada (600 B.C.), (Prakash, 1965).

Biswas (1969) has rightly remarked that the growth of modern science in Europe would have been hardly possible without the background of poineering contributions from India, China and Arabian countries, well upto the 12th century A.D.

Domination of the foreign rulers for long time did not help in bringing the Scientific content of the Sanskrit literature to come to the fore. Even after independence, the situation did not improve for the obvious reason that there is no interaction between the modern scientists and the Sanskrit scholars. The scientist never bothered to know about the scientific content in the ancient Sanskrit literature while the

Sanskrit scholars never cared to bring to focuss the problems of scientific nature available in the Sanskrit works; they got entangled in such problems as 'Vyakarana','Mimansa' etc. Hence even to date the scientific content of the ancient works remained almost wholly unknown and unanalysed.

Hydrology in Ancient India:

In contrast to the ancient western science containing wild theories on the origin of water, the ancient Sanskrit literature contains the most valuable and highly advanced scientific discources on hydroscience.

The Vedic texts which are more than 3000 yrs. old, contain valuable refeerences on 'hydrological cycle'. The most important concept on which the modern science of hydrology is founded, are scattered in Vedas in various verses which are in the form of hymns and prayers addressed to various dieties. Likewise other Sanskrit literature have valuable discources regarding hydrology.

The historical development of hydroscience have been dealt by many writers (Baker and Horton, 1936; Chow, 1964; Biswas, 1970); but in all these works references to the contributions made in ancient India is conspicuously absent (Prasad, 1980). Chow (1964) dividing the history of hydrology mentioned following western scholars leaving Indian scholars and their great contribution.

He has given the references of Homer (about 1000 B.C.), Thales, Plato, Aristotle in Greece, Pliny in Rome and many Bible scholars of that time. All above western scholars were believing in the wild theories regarding origin of water as quoted below. Thales an Ionion philospher stated that the sea water is driven into rocks by wind is the cause of ground water. Plato (427-347 B.C.) the great Athenian philospher stated that the water of seas, rivers, springs etc. come from a large underground reservoir and go back to the same. Aristotle

(384-322 B.C.) said that water of the springs etc. is derived from the underground water through system of underground openings. Famous stoic philospher Lucius Annacus Sencca (4 B.C. - 65 A.D.) declared that rainfall can not be the source of springs and underground water, because it penetrates only a few feet into the earth (Prasad, 1980). Marcus vitruvious who lived about the time of Christ conceived a theory saying that ground water is th part of rainfall originated through infiltration. From all abo e references of western scholars we gather the low level of development of hydroscience in western world. But the contemporary India had highly advanced knowledge of all aspects of water science.

The origin and evoluation of agriculture and experience in irrigation on the territory of India or anywhere in the world are not seperate processes, as evidenced from following hymns.

कृषिश्च मे यज्ञेन कल्पंताम ।
वृष्टश्च मे यज्ञेन कल्पंताम ।। यजुर्वेद, 18-9 ।।
मारुतश्च मे यज्ञेन कल्पंताम ।। यजुर्वेद, 18-17 ।।

These hymns illustrate the importance of Yajna's (यज्ञ;Sacrifice) for rain, agriculture, and air or environment and their interelationship.

In ancient India the well developed concepts of different facets of hydrology were available. Water is not lost in the various processes of hydrological cycle namely evaporation, condensation, rainfall, streamflow etc. but gets converted from one form to other was known during Vedic and Puranic times. Water uptake by plants, division of water into minute particles by sun rays and wind, different types of clouds, their heights, their rainfall capacities etc. alongwith the prediction of rainfall quantity in advance by means of observing the natural phenomena of previous years are also available in Puranas, Vrhat Sanhita (550 A.D.), Meghamala (900 A.D.) and in other literature. The references of raingauges are available in Arthasastra of Kautilya (400 B.C.), and Astadhyayi of Panini (700 B.C.). The quantity of rainfall in various parts

of India was also predicted by Kautilya. Indians were acquainted with cyclonic, orographic effects on rainfall and radiation, and convectional heating of earth and evapotranspiration. Various other references of infiltration, interception, stream flow and geomorphology [in Ramayana (200 B.C.) the reference of artesian wells is available], erosive action of rainfall, etc. were also known. Ground Water development and water quality consideration were getting sufficient attention as evidenced by Vrhat Sanhita (550 A.D.). Water management and conservation, well organized water pricing system in 400 B.C., construction methods and materials of dam, tanks etc., bank protection, spillways and other minor considerations reflect the high stage of development of water resources and hydrology in ancient India.

Numerous references exist in Vedic literature, Arthasastra, Puranic sources, Vrhatsanhita, Mayuracitraka, Meghmala, Jain, Buddist and other ancient Indian literature which enumerate the status of hydrology and water resources in ancient India.

The following elements of hydrology and water resources as they are inferred in above ancient Indian literature and also discussed by some of the authors such as Tripathi (1969), Prasad (1980), Prasad (1987), and others have been reviewed, and analysed in present study.

1. Hydrologic Cycle
2. Precipitation, Cloud formation, measurement etc.
3. Interception and Infiltration
4. Stream flow and Geomorphology
5. Ground Water
6. Evapotranspiration
7. Water Quality
8. Water use and conservation.